

A Tan For Us, A Burn For The Ocean: Uncovering Sunscreen Pollution

Applying Behavioural Insights to Design a Sustainable Solution to the Problem of Sunscreen Pollution



London School of Economics and Political Science

PB403 Societal and Environmental Psychology Summative Coursework
January 2026

Course convenors: Dr Fred Basso & Prof Saadi Lahlou

Other teachers: Dr Atrina Oraee

Miki Maekawa, Barnaby Dougherty, Greta Pientka, Preksha Gupta, Cheryl Wang

Table of Contents

1. Introduction	5
2. Background	5
2.1 Emergence of sunscreen as an environmental contaminant.....	5
2.2 Pathways of Sunscreen Pollution	6
2.3 Ecological Impacts on Marine Life	6
2.4 The challenge of “reef-safe” marketing.....	6
2.5 The Case of Hanauma Bay, Hawaii	7
2.6 Current Interventions	8
3. Stakeholder Analysis	8
3.1 Public organisations	9
3.1.1 Governmental bodies	9
3.1.2 Science agencies	10
3.2 Profit makers	10
3.2.1 Tourism Industry	10
3.2.2 Sunscreen Manufacturers.....	10
3.2.3 Retailers.....	11
3.3 Affected Publics	11
3.3.1 Tourists	11
3.3.2 Local communities.....	12
3.4 Opportunities for collaboration	12
4. Application of Theoretical Concepts.....	13

4.1 Activity Theory and Installation Theory 13

4.2 Social Network Analysis..... 14

4.3 Window of Opportunity..... 16

5. Solution Proposal..... 16

5.1 “ReefSafe Access” 16

5.2 Logistics 17

5.3 Implementation..... 20

5.4 Communication 21

6. Discussion and Limitations..... 21

References 24

Appendix 28

Table of Figures

Figure 1: <i>Stakeholder map</i>	9
Figure 2: <i>Tourist's activity grid for beach visit</i>	13
Figure 3: <i>Tourist's activity grid for beach visit</i>	13
Figure 4: <i>Installation Theory's three layers (Lahlou, 2017, p. 34)</i>	14
Figure 5: <i>Social network analysis</i>	15
Figure 6: <i>Standardised "reef-safe" sunscreen label</i>	18
Figure 7 <i>Colour-coded sunshades signalling sustainable behaviour</i>	19
Figure 8: <i>Distribution of UV-protective clothing through tourism infrastructure</i>	20

1. Introduction

Sunscreens, a product used to protect human health from the harmful effects of ultraviolet (UV) radiation, are causing an unexpected threat to the marine ecosystem. When thousands of tourists travel to admire the crystal-blue waters and vibrant coral reefs of coastal holiday destinations, they remain unaware that the product protecting their skin is damaging the very ecosystem they came to observe. Each day, 36 kilograms of sunscreen is deposited into the aquatic environment, bringing along with it the harmful organic and inorganic ultraviolet filters (Downs et al., 2022). Oxybenzone and octinoxate are identified as two of the most damaging chemicals present in sunscreens which harm marine life significantly (Just-Sarobé, 2025). Research has shown that coastal waters were 262 times more toxic than the high-risk level considered for corals due to the presence of oxybenzone (Damikouka et al., 2024). Sunscreen pollution is a growing environmental and social concern that requires more attention from governments, tourism industries, retailers, and local communities alike.

2. Background

2.1 Emergence of sunscreen as an environmental contaminant

Sunscreen products have become widely recognised as a critical environmental pollutant in marine systems across the globe. The sun care industry, which was worth approximately \$13.6 billion in 2023 and is projected to grow to \$25.3 billion by 2033, reflects the extensive global consumption of these products (Florent et al., 2024). Simultaneously, the organic and inorganic ultraviolet radiation filters that compose these sunscreens have been identified in water samples from geographically diverse locations, including the Antarctic and North American Arctic regions, suggesting their capacity for long-distance environmental transport (Damikouka et al., 2024). Due to their continuous release and persistent presence in aquatic systems, these chemical compounds have been classified as emerging contaminants of concern by the United States Environmental Protection Agency (U.S. EPA) (Downs et al., 2022). This problem is especially severe in coastal tourism areas, where substantial quantities of these harmful substances are transferred directly into marine environments. Research indicates that approximately 36 kilograms of sunscreen potentially enters aquatic environments daily from one thousand beachgoers (Chatzigianni et al., 2022).

2.2 Pathways of Sunscreen Pollution

Sunscreen contamination reaches marine ecosystems through various routes. The primary direct pathway involves recreational swimming and water sports, where products applied to skin are released through perspiration and water immersion (Downs et al., 2022). Indirectly, traditional wastewater treatment facilities demonstrate insufficient capacity to eliminate the ultraviolet filters, resulting in these chemicals entering the marine systems through municipal sewage or treated wastewater discharges. In some instances, these contaminants have even been found in drinking water supplies (Chatzigianni et al., 2022).

Beach shower facilities represent another critical source of contamination. When individuals rinse off after swimming, sunscreen residues are washed off from skin surfaces (Downs et al., 2022). When these showers lack connections to municipal wastewater treatment infrastructure, they may be classified as pollution points under the U.S. Clean Water Act. The wastewater can collect in pools that flow directly to the shoreline (Downs et al., 2022). Watercraft shower facilities similarly contribute to pollution, as numerous recreational boats have freshwater washing amenities that discharge wastewater directly into marine environments (Downs et al., 2022).

2.3 Ecological Impacts on Marine Life

The environmental consequences of sunscreen contamination are extensive. Coral reef ecosystems, which provide habitat for approximately one-quarter of marine species, demonstrate vulnerability to these pollutants (Florent et al., 2024). Numerous organic ultraviolet filters have been documented to induce coral bleaching, a stress response in which corals lose their colouration (Chatzigianni et al., 2022). Certain chemical ingredients cause death of coral tissue while others produce developmental abnormalities in coral larvae and suppress overall coral growth (Chatzigianni et al., 2022). The compounds oxybenzone and octinoxate have been specifically identified as causing particularly severe damage to coral reefs (Just-Sarobé, 2025).

2.4 The challenge of “reef-safe” marketing

In response to increasing consumer awareness regarding the harmful effects of sunscreen products, cosmetic manufacturers have employed marketing terminology such as “reef-safe,” “green,” and “eco-friendly” on product labels, leading to greenwashing by them (Chatzigianni et al., 2022). No standardised toxicity assessment protocol currently exists for coral reef ecosystems that could establish definitive thresholds for the types and concentrations of chemicals permissible

in sunscreen formulations, making it challenging to understand which products are genuinely “reef-safe” (Florent et al., 2024). This regulatory deficiency requires governmental support for standardised labelling requirements that would enable informed consumer decision-making while promoting corporate responsibility in product development (Damikouka et al., 2024). The lack of enforcement allows companies to deviate from these recommendations without facing legal consequences, placing the burden of knowledge on consumers and enables corporations to avoid accountability (Florent et al., 2024).

2.5 The Case of Hanauma Bay, Hawaii

Hanauma Bay in Oahu, Hawaii, serves as a representative example of concentrated sunscreen contamination in high-tourism coastal areas. Under Hawaii Administrative Rules, the bay is designated as Class AA waters, requiring that these waters remain in their natural state, with minimum levels of pollution and change in the water quality due to human activity or other sources (Downs et al., 2022). Despite this protective designation, the bay experiences significant contamination challenges. Oxybenzone has been identified in 100% water samples collected throughout Hanauma Bay, with measured concentrations spanning a range from 136 to 27,880 nanograms per litre (Downs et al., 2022). In specific locations, oxybenzone was measured at concentrations 262-fold higher than the threshold level classified as posing high risk to coral organisms (Damikouka et al., 2024).

Research has established that swimmers constitute a primary contamination source for oxybenzone at Hanauma Bay, though beach showers also contribute to overall bay contamination (Downs et al., 2022). Analysis of beach sand collected from four shower facilities revealed detectable concentrations of nine different ultraviolet filter compounds (Downs et al., 2022). Sunscreen residues can still contaminate the bay through shower wastewater and stormwater runoff, as Hanauma Bay’s shower facilities discharge directly into shallow subsurface areas rather than connecting to municipal wastewater treatment infrastructure (Downs et al., 2022).

The observable effects of these contaminations are significant. Hanauma Bay’s waters have a greyish appearance even during calm weather conditions, and swimmers report mixed sunscreen fragrances on their skin (Downs et al., 2022). During the 2020 Covid-19 pandemic lockdown, when tourists and recreational activities were prohibited for nine months, the water clarity improved dramatically to restore a blue coloration, and substantial increase in fish and invertebrate population

densities were documented (Downs et al., 2022). This unplanned natural experiment demonstrated the direct connection between human activity, sunscreen contamination, and ecosystem condition.

However, there are substantial economic pressures that frequently conflict with conservation priorities. Marine and coastal tourism generates approximately \$143 billion in economic output for the U.S. annually (Florent et al., 2024). In 2021, the City of Honolulu established a visitor limit of 1,000 individuals per operating day at Hanauma Bay, as a potential solution to reducing the contaminant load (Downs et al., 2022). However, despite documented ecological impacts from excessive tourism, the city discontinued this regulation in the second quarter of 2021, and the Bay now receives more than 2,000 daily visitors (Downs et al., 2022).

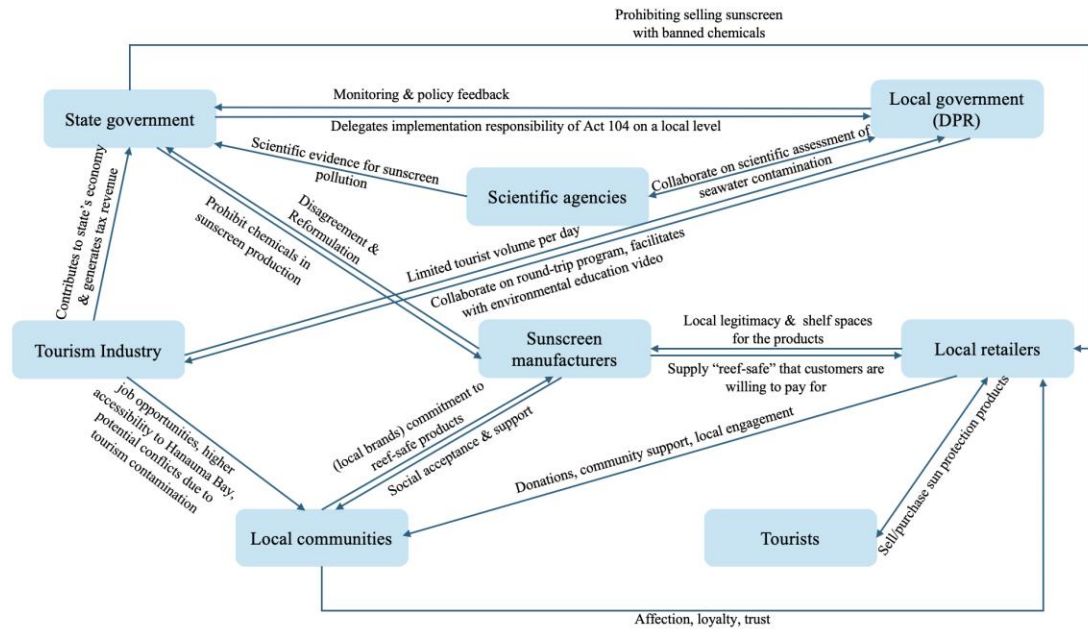
2.6 Current Interventions

Following increased consumer awareness of the dangers to marine life, oxybenzone utilisation in sunscreen formulations has declined significantly since 2019, driven by implementation of bans on their sale or use in locations including Hawaii, the Marshall Islands, and Thailand (Downs et al., 2022). Hawaii's Act 104, implemented in 2018, established the first statewide prohibition on sunscreens, making the sale and distribution of personal care products containing oxybenzone without a medical prescription unlawful (Florent et al., 2024). In 2020, Hawaii implemented additional measures, including a two-year pilot program installing mineral-based alternative sunscreen dispensers at Hanauma Bay Beach, with the dispensers featuring informational messaging regarding the harmful effects of sunscreens (Florent et al., 2024).

3. Stakeholder Analysis

Stakeholders related to sunscreen pollution at Hanauma Bay are intricately connected to each other (Figure 1). The most relevant stakeholders are categorised into three main groups: public organisations, profit-makers, and affected publics.

Figure 1: *Stakeholder map*



3.1 Public organisations

3.1.1 Governmental bodies

The State of Hawaii government plays a crucial role in regulating sunscreen pollution through policymaking. As part of the state government, the Hawaii Department of Land and Natural Resources (DLNR) established Hanauma Bay as a Marine Life Conservation District (MLCD), which enabled the state to exercise regulatory authority to protect its ecological environment (Gardner, 1999). This provided a legal foundation for the following conservative management and environmental interventions. More recently, the enforcement of the state law Act 104 constrains the availability of reef-harming sunscreen products in Hawaii, which directly influences other stakeholders, including manufacturers, retailers, and tourists. The limited legal sunscreen options prompt the manufacturers and retailers to shift toward reef-safe products, significantly shaping tourists' purchasing patterns, particularly given that over half of the tourists purchase sunscreens in Hawaii (Levine, 2020).

A branch of the local state government, Honolulu's Department of Parks and Recreation (DPR), is responsible for the day-to-day management of Hanauma Bay. DPR's main interest lies in preserving the ecological environment at Hanauma Bay while ensuring the quality of tourist

experiences. To do so, DPR limits the maximum number of visitors per day and closes the bay for two days a week to reduce the pollutants in seawater. DPR also supervises a mandatory visitor education program that includes a film that visitors are required to watch before entering the Bay. Additionally, DPR oversees managing facilities like beach showers, and monitors the seawater quality in collaboration with other agencies such as the Hawaii Department of Health (DOH) (Rodgers & Severino, 2025). Therefore, regulatory management led by the local government in Hawaii is highly influential in shaping tourists' behaviour and mitigating sunscreen pollution.

3.1.2 Science agencies

Several science agencies collaborate with the Hawaiian government to work on the issue of sunscreen pollution together. Science agencies play a key role in providing scientific information that promotes policy change. The Haereticus Environmental Laboratory (HEL) is a scientific nonprofit that promotes conservation and restoration of endangered ecosystems, such as coral reefs, through research, education, and advocacy (Friends of Hanauma Bay, n.d.). Therefore, HEL would have high interest in sunscreen pollution intervention at Hanauma Bay, where the coral reef system has been threatened (Doust et al., 2024).

3.2 Profit makers

3.2.1 Tourism Industry

Tourism in Hawaii has become increasingly popular, making it a major contributor to the state's economy (Rodgers et al., 2023). Specifically, Hanauma Bay has been identified as one of the most economically valuable Marine Managed Area (MMA) sites for recreation and is particularly popular for ocean recreational activities such as snorkelling, diving, and swimming (van Beukering & Cesar, 2004). Given the significant role of Hanauma Bay in generating recreational tourism revenues, the tourism industry has a strong economic incentive to support and invest in the interventions that aim to address sunscreen pollution at the site, as the industry's long-term profitability relies heavily on Hanauma Bay's ecosystem health (Rodgers et al., 2023).

3.2.2 Sunscreen Manufacturers

Sunscreen manufacturers have direct control over their formulations. Although the Consumer Healthcare Products Association claimed, in 2019, that oxybenzone and octinoxate were used in most of the sunscreen products, much less of these chemical ingredients were found in the

sunscreen products after the legislative prohibition came into effect in 2021. This suggests sunscreen manufacturers have changed their formulations to follow the law. However, many manufacturers removed the two banned chemical ingredients but replaced them with another chemical, octocrylene, which can also harm the marine ecosystem (Akerlof et al., 2023). Despite the sunscreen law, the manufacturers still have some leeway in complying with the ban. It is therefore believed that only the mineral-based and plant-based sunscreens are truly considered as “reef-safe” products, stressing the need to support sunscreens from local brands in Hawaii (Gibson, 2018). Examples of sunscreen products made in Hawaii include Little Hands Hawaii, Mama Kuleana Waterproof, and others. These manufacturers are known for using natural and biodegradable ingredients, and for their strong commitment to being marine-friendly (Kanai, 2023).

3.2.3 Retailers

Retailers in Hawaii are another important stakeholder group that is heavily influenced by the state's sunscreen law. Sunscreen products are available at retail shops, pharmacies, and convenience stores (Friends of Hanauma Bay, n.d.). These retailers are key decision-makers who determine which sunscreen products are available to sell. Apart from generating profits, the local retailers are also motivated to contribute to their community through monetary donations and community events, to be socially responsible and gain affection and reputation, thus maximising their long-term profitability (Razalan et al., 2017).

Wearing clothing, sunhats, and sunglasses is often recommended as a more effective and environmentally friendly method to protect against UV rays (Chatzigianni et al., 2022). In addition to encouraging customers to buy reef-safe sunscreen products, retailers also hold the power to strategically increase the accessibility of alternative sun protection options to motivate more sustainable consumption patterns (Peleg Mizrachi & Tal, 2024).

3.3 Affected Publics

3.3.1 Tourists

Tourists are the primary users of Hanauma Bay and therefore have a direct influence on its marine ecosystem. While tourists value their experiences at Hanauma Bay and protect themselves from sunburn and skin cancer, they also demonstrate dedicated support for the sunscreen law by buying reef-safe sunscreen products, even at higher prices (Thomas et al., 2024). Therefore,

informing tourists about the sustainable ingredients in sunscreen is imperative to empower them to make better choices when selecting products (Levine, 2020).

3.3.2 Local communities

The interests of local communities are closely tied to tourism and the ecological environment of Hanauma Bay. Hanauma Bay has significant historical and cultural meanings for the local communities who have lived here for thousands of years (Park, n.d.). Therefore, they would place immense importance on protecting the Bay's natural environment. Simultaneously, local communities also benefit from the expansion of job opportunities created by the tourist industry in Hawaii, particularly at Hanauma Bay (Rodgers et al., 2023).

3.4 Opportunities for collaboration

Although the government prioritises conservation and private tourism industries are driven by profitability, there is still room for these two stakeholders to collaborate. For instance, the local states' DPR launched a concession program in November 2025 with Roberts Hawaii, a locally owned and employee-owned company that provides eco-friendly transportation and a streamlined reservation system. Tourists who sign up for this program take electric buses, which eases traffic and frees up parking spaces for locals. At the same time, Roberts Hawaii facilitates a mandatory 10-minute educational video by playing it to the tourists on the bus to empower them with knowledge about environmental preservation before reaching the sites. This program aims to maintain a balance between the demands of making profits and providing good travel experiences whilst fulfilling the responsibility of preserving nature at sites like Hanauma Bay (Serota, 2025).

Furthermore, the shared goal of profitability creates strong potential for collaboration between sunscreen manufacturers and local retailers. Specifically, global manufacturers can provide the internationally recognised reef-safe products required by the state of Hawaii law. By doing so, they use their brand reputation to attract customers that enhance sales volumes for local retailers, while showing alignment with local environmental values focused on chemical-free ocean protection to expand their market share and reputation (Schau et al., 2023). Moreover, local retailers and manufacturers can provide reef-safe sunscreen products to tourism operators, enabling their distribution to visitors at Hanauma Bay.

4. Application of Theoretical Concepts

4.1 Activity Theory and Installation Theory

Drawing on Vygotsky's (1978) concept of Activity Theory (AT), we examined the activity in our system as a “complex, mediated act” (p. 40). This allowed us to deconstruct the “true motives” (Leontiev, 1978) of the stakeholders at Hanauma Bay into tasks, motives/goals, contributions, and rewards (see Figure 2). This analysis revealed that the actors in our system all have valid motives, but there often exists tension between these motives and the outcomes of the tasks they undertake. For example, tourists are motivated to apply sunscreen to preserve their personal health, meaning that pollution caused by sunscreen is a completely unintended consequence. Our intervention aims to 'remediate' this activity by providing reef-safe alternatives that satisfies the motives without creating an ecological cost.

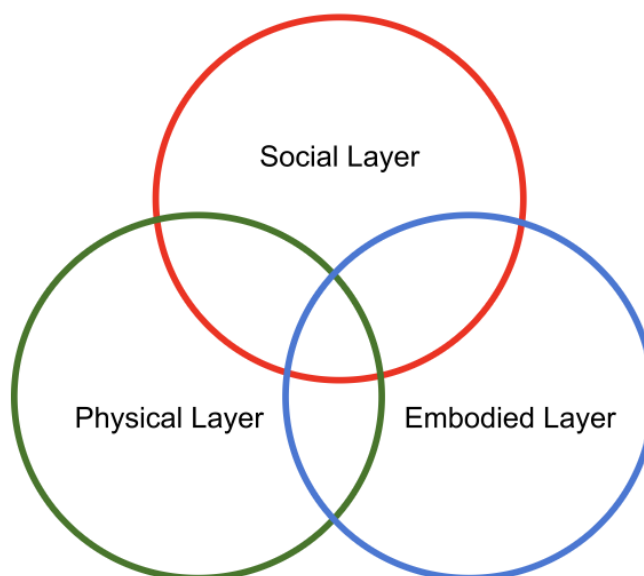
Figure 2: *Tourist's activity grid for beach visit*

Actor	Task	Actor's Motive/Goals	Contributions from Actor	Actor's Rewards	Affordances	Competences	Regulations
Government	Enforce sunscreen regulations	To protect environment, prevent harms	Operate legal observations	Maintain order	Authority People	Knowledge of sunscreen contamination	Law
Tourism Industry	Invite more customer to tourist beach	To make profit	Business operations	Sustain the business	The company Staff Customer	Information of local regulations	Brach location
Retailers	Selling Sunscreen product	To make profit	Opens store	Earn money	The store equipment Products	Information of consumer product needs	Operation hours
Tourist	Visiting the beach and enjoy the time	Not to get sunburn Reduce skin cancer risk	Purchase and stock the sunscreen product	Feel prepared	Swim wear Beach towel Water bottle Transport	Knowledge of sunlight harmfulness	Transport Limited schedule e.g holiday

Hanauma Bay has a range of stakeholders which influence how behaviour is channelled, and to analyse these channels, we used Installation Theory (IT) (Lahlou, 2017). IT complements AT by illustrating how practices and behaviours become “installed” and manifest as observable behaviour through three distinct layers: physical affordances, embodied competencies, and social regulation (Lahlou, 2017). We first examined the current consumption of chemical-based sunscreen, not through the lens of individual consumer negligence but rather because of historically and socially structured consumer activity. Next, we proposed solutions that would align the channels and shape the system towards regenerative, ecologically based action (Figure 3).

Figure 2: *Tourist's activity grid for beach visit*

Figure 3: *Installation Theory's three layers (Lahlou, 2017, p. 34)*



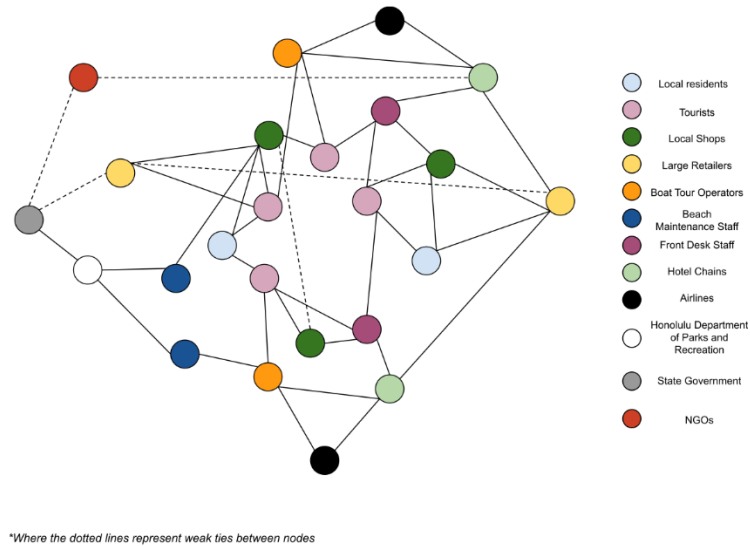
Based on the principles of Installation Theory, the activity of a visitor at Hanauma Bay is not merely a collection of random choices, but a path channelled through a specific societal installation. By mapping this journey from arrival to departure, we can identify exactly how current structures facilitate pollution and where a strategic intervention can repair the system to ensure ecological sustainability (see Appendix A). The primary intervention point in this installation is the application of sunscreen phase, specifically targeting the "Social Space" to repair the "Inner Space" of the visitor. While visitors possess the embodied competence to protect their skin, the installation historically lacked the social regulation to steer them toward "reef-safe" alternatives.

4.2 Social Network Analysis

Social Network Analysis (SNA) is a methodological approach used to examine the relationships and flows among people, groups, or organisations within a social system (Valente, 1996). This approach has the benefit of revealing patterns, dynamics, and connections between entities we may not have considered before analysis. SNA allows us to pinpoint the key actors who hold considerable influence and leverage points that ensure our intervention effectively spreads throughout the system. When applying SNA to sunscreen pollution at Hanauma Bay, we placed “nodes” for the prominent actors in the system and used “edges” to signify the relationship between

the nodes (Figure 4). This allowed us to explore the “centrality” of certain nodes and identify the key actors that bridge the gap between different nodes.

Figure 4: *Social network analysis*



Degree Centrality: identified by the number of connections a node possesses, this captures which individuals in the network are highly connected (Valente, 1996). In our analysis, it appeared that “Tourists,” “Local Shops” and “Hotel Chains” obtain the highest degree of centrality.

Closeness Centrality: a measure of how quickly an individual or organisation can reach other members in the network. This is based on the shortest paths between them, identifying actors best positioned to spread information efficiently (Valente, 1996). “Front Desk Staff” and individuals operating trips for tourists, “Boat Tour Operators,” were identified as possessing significant closeness centrality.

Between Centrality: a measure of the extent to which a given node acts as a “bridge” or gatekeeper along the shortest paths between other pairs of nodes. This is key for identifying those with the most control over the flow of information across the network (Valente, 1996). From our analysis it emerges that “Local residents” and “NGOs” are critical brokers. The Hanauma Bay locals act as authority nodes, enforcing norms and social sanctions on tourists who misbehave. Furthermore, NGOs provide external pressure that justifies change from the government and retailers.

4.3 Window of Opportunity

The current behaviour of tourists visiting Hawaii does not come from malicious intent. The environment is dictated by choices that make the most convenient option an eco-harmful one. Faced with a genuine health requirement of UV protection and a greenwashed retail market, tourists naturally default to the cheapest, most familiar brands. It would be unjust to describe this behaviour as negligent. Instead, it should be viewed as a rational response to a physical installation where clear, reef-safe affordances are required. Furthermore, it is unrealistic to expect tourists to become environmental experts who can seamlessly vet chemical-based sunscreen products and find reef-safe alternatives. By shifting the responsibility away from tourists and instead onto the hospitality infrastructure itself, we can normalise sustainable protection as a baseline service. Our SNA and tourist activity grid (Appendix A) identified that the application of sunscreen phase is the optimal point of intervention. By mobilising “high-betweenness” nodes, we can introduce a systematic change and inject reef-safe alternatives precisely when tourists are most receptive to local guidance, effectively overriding established habits.

5. Solution Proposal

5.1 “ReefSafe Access”

This study identifies the key intervention point at the moment when visitors choose how to protect themselves from sun exposure before entering reef environments. As shown earlier, these choices are rarely guided by environmental concern and are instead shaped by habit, convenience, and availability within tourism settings.

ReefSafe Access addresses this structural mismatch by shifting responsibility away from individual decision-making and embedding reef-safe sun protection directly into tourism infrastructure. Rather than asking visitors to assess ingredients or environmental consequences themselves, the intervention reshapes the choice environment so that reef-safe options become the default. Locally produced mineral sunscreen, UV-protective clothing, and physical shade infrastructure are made readily available at key points along the tourist journey, including airports, hotels, snorkelling operators, beach entrances, and high-impact sites such as Hanauma Bay. Visitors may use these options immediately or exchange non-compliant products upon arrival.

In line with IT, ReefSafe Access intervenes across physical affordances, embodied competencies, and social regulation (Lahlou, 2017). By aligning material availability, practical ease, and social signalling, the intervention makes reef-safe sun protection both the simplest and most socially expected option. Embedding these practices within existing tourism systems allows the intervention to address sunscreen pollution at its systemic source, while continuing to prioritise human health and visitor comfort.

5.2 Logistics

ReefSafe Access would be funded through a combination of state-level environmental protection funds, tourism-related levies, and partnerships with the hospitality and transport sectors. The local government, DPR, local retailers, and local communities would coordinate operational responsibility.

Previous research shows that the Hawaiian sunscreen market already offers mineral-based, reef-safe products aligned with state regulations banning oxybenzone and octinoxate (State of Hawaii, 2018). Additionally, local producers manufacture these products within Hawaii, supporting regional economic activity while leveraging existing production capacity and regulatory compliance. The intervention therefore focuses on collaboration between these manufacturers, the tourism industry, and local retailers to ensure that reef-safe sunscreen is distributed and made highly visible at key intervention points along the tourist journey.

All reef-safe sunscreen products distributed through ReefSafe Access are marked with a standardised sticker that signals environmental compliance as shown in Figure 5. This visual marker allows reef-safe behaviour to be immediately recognisable within shared beach and tour spaces. In contrast, sunscreen products without this marker become equally visible as non-compliant, subtly internalising the environmental externality through social feedback rather than formal enforcement.

Figure 5: *Standardised “reef-safe” sunscreen label*



(Visual material generated using an AI image-generation tool (ChatGPT, OpenAI, 2026))

Additionally, sunshades are provided through rental systems, with clear colour differentiation to signal participation and reinforce social norms around reef-safe behaviour as shown in Figure 6. Visitors who use reef-safe sunscreen or alternative sun-protection measures receive green sunshades, signalling environmentally compliant behaviour, while those who continue to use harmful sunscreens are provided with red ones. This colour-coding system operates at the social regulation layer of IT by making sun-protection behaviour visible within shared beach spaces (Lahlou, 2017). As a result, reef-safe behaviour is positively signalled, while non-compliance becomes publicly identifiable, creating informal social pressure to adopt sustainable practices. The sunshades are then sponsored and branded by sustainable sunscreen brands, enabling product promotion while supporting the implementation of ReefSafe Access and generating additional income, and thus incentives for local rental services to participate.

Figure 6 *Colour-coded sunshades signalling sustainable behaviour*



(Visual material generated using an AI image-generation tool (ChatGPT, OpenAI, 2026))

A principal component of ReefSafe Access is the normalisation of UV-protective clothing as a primary form of sun protection. UV-protective clothing offers a simple and highly effective alternative that eliminates chemical runoff entirely. ReefSafe Access integrates UV-protective clothing, including rash guards, swim shirts, hats, and lightweight cover-ups, into the tourism infrastructure through a combination of free provision, rental schemes, and purchase options at hotels, snorkelling tours, and beach access points. At high-impact sites such as regulated bays and snorkelling tours, visitors receive free or refundable rash guards that can be returned after use or kept for a small fee. Hotels and resorts further reinforce this practice by including UV-protective shirts as standard amenities or within activity packages, reframing protective clothing as a normal part of the travel experience. In addition, locally designed UV-protective clothing is made available for purchase, positioning it as a functional souvenir rather than a restrictive measure. The free provision of UV shirts is partially financed through advertising partnerships, drawing on models such as FreeWater (Patterson et al., 2021), where branded products are funded by aligned sponsors who can then use the tourists as a billboard to advertise their brand. Logos from sustainable brands, local businesses, or environmental initiatives placed on the garments enable wide distribution at no

cost to visitors. Recognizing that many tourists value tanning as part of their holiday experience, ReefSafe Access does not seek to discourage sun exposure outright. Instead, it promotes partial coverage norms, where UV-protective clothing is worn during high-risk activities such as swimming, snorkeling, or prolonged water exposure, while uncovered time remains acceptable in other contexts.

Figure 7: *Distribution of UV-protective clothing through tourism infrastructure*



(Visual material generated using an AI image-generation tool (ChatGPT, OpenAI, 2026))

5.3 Implementation

While ReefSafe Access is intended as a long-term, scalable intervention, it would initially be implemented as a small-scale pilot project, allowing for testing, refinement, and stakeholder buy-in before broader rollout. Implementing ReefSafe Access in a single site allows for concentrated monitoring of behavioural change, water quality indicators, and visitor acceptance. The pilot would run across one full peak-tourism season, allowing sufficient time to establish new routines among visitors and service providers. Behavioural change in tourism contexts is often collective and norm-

driven, meaning that early adoption by a small group yields limited benefit. Introducing ReefSafe Access at the site level ensures simultaneous uptake and reduces the perceived cost of compliance.

Following evaluation of the pilot, the intervention could be expanded to additional locations and eventually integrated across other Hawaiian Islands, incorporating lessons learned from the initial implementation. Endorsement plays a critical role in this process. Support from local government authorities and conservation organisations is essential to legitimise the intervention. Their involvement signals that ReefSafe Access reflects local priorities rather than external environmental demands, increasing acceptance among both residents and visitors.

5.4 Communication

The success of ReefSafe Access depends on clear, consistent communication that supports adoption without relying on moral appeals or environmental guilt. Drawing on SNA, communication efforts focus on trusted intermediaries and established information channels. Hotels, tour operators, airlines, and park authorities act as primary communicators, providing short, practical explanations of ReefSafe Access at key moments such as flight arrivals, hotel check-in, and tour briefings. Messaging emphasises convenience and local norms, framing reef-safe sun protection as “how things are done here,” rather than as an environmental sacrifice.

Direct communication tools, such as QR codes at access points and short instructional videos, support visitors in understanding how to use the service. Visual cues, including colour-coded sunshades and signage, reinforce participation and create visible social proof. These measures help normalise reef-safe behaviour and reduce uncertainty for visitors unfamiliar with local regulations. By integrating communication into existing tourism touchpoints and relying on trusted local and institutional actors, ReefSafe Access avoids information overload while ensuring that visitors receive consistent guidance throughout their stay.

6. Discussion and Limitations

Overall, we focused on the persistent problem of sunscreen pollution in Hanauma Bay in Hawaii, despite the prohibition of oxybenzone and octinoxate in the production of sunscreen. To resolve this issue, tourists’ activity trajectories during a trip to Hanauma Bay were broken down into small steps to identify the intervention points. Then, three layers from IT were applied to promote change in people’s behaviour, which includes providing physical affordances, enabling

competencies, and creating social norms. However, we must also consider the limitations that come along with implementing ReefSafe Access.

Despite Hanauma Bay being a highly frequented tourist site, ReefSafe Access is limited in its geographic scope. Therefore, its overall impact remains moderate on the broader scale of marine chemical contamination across Hawaii. Furthermore, the success of this intervention depends on participation from the hospitality sector and tourists. Installing material affordances, such as hotel-distributed sunscreen, is required to encourage tourist use. However, there may be resistance to this change due to brand loyalty or existing perceptions of the ineffectiveness of mineral-based sunscreen. Despite the Hawaiian state government's opposition to chemical-based sunscreen, as evidenced by the ban of oxybenzone in sunscreen products (Levine, 2020), to successfully implement ReefSafe Access would require institutional endorsement and public buy-in. This may prove to be challenging because of consumers' experiences of greenwashing and distrust in environmental regulations, which has led to general scepticism towards sustainability initiatives (Lepper, 2024). To mitigate this issue, ReefSafe Access integrates a pedagogical component designed to target the tourists' embodied layer in collaboration with the physical installation. The provision of reef-safe sunscreen, a new material affordance, alongside gaining ecological literacy, allows us to restructure the tourists' perceptions regarding chemical impacts. This dual-layered approach ensures that the physical availability of mineral-based sunscreen is underpinned by internal competency, transforming a simple swap of products into a long-lasting cognitive shift.

A primary challenge for the ReefSafe Access intervention is the difficulty of monitoring compliance without infringing on tourist privacy. Our proposed system of social signalling, which utilises green sunshades for reef-safe users and red for others, leverages the social layer of the installation to create normative pressure and relies on a trust-based model rather than active surveillance. The invisibility of sunscreen application makes verification on the beach come off as invasive, necessitating a reliance on self-reporting. Consequently, there may be situations where tourists provide dishonest signals to avoid the social sanctions associated with polluting behaviour. While this dishonest signalling is a limitation, it represents a necessary trade-off to maintain a positive environment while still attempting to foster a stigma towards chemical-based sunscreens through visible social proof.

While the promotion of UV-protective clothing aims to reduce chemical reliance at the physical layer, it introduces a potential risk of creating negative externalities. The mass production of new

apparel threatens to feed into the destructive cycles of the 'fast fashion' industry, potentially contributing to wasteful resource depletion. To mitigate this, our intervention prioritises a circular economy approach. This is done using recycled marine plastics for production. However, we recognise that any increase in material consumption carries an inherent ecological footprint. Furthermore, localising this production in Hawaii presents a significant opportunity for community benefits. By creating green-sector jobs for the residents identified in our SNA, we can ensure that the intervention provides socio-economic reinvestment while shifting the norm from cheap chemical sunscreen to durable physical protection.

References

- Akerlof, K. L., Loevenich, J., Melena, S., & Lipsky, C. A. (2023). What's local policy got to do with it? Testing the efficacy of federal interventions to protect coastal parks from sunscreen chemical pollution in Hawaii and North Carolina. *Marine Policy*, 157, 105849. <https://doi.org/https://doi.org/10.1016/j.marpol.2023.105849>
- Allen, K. (2021, May 28). *Your guide to reef-safe sunscreens in Hawai'i*. *Hawaii Magazine*.
- Chatzigianni, M., Pavlou, P., Siamidi, A., Vlachou, M., Varvaresou, A., & Papageorgiou, S. (2022). Environmental impacts due to the use of sunscreen products: a mini-review. *Ecotoxicology*, 31(9), 1331-1345. <https://doi.org/10.1007/s10646-022-02592-w>
- Damikouka, I., Anastasopoulou, M., & Vgenopoulou, E. (2024). Sunscreens in the aquatic environment and potential solutions for mitigation of sunscreen pollution. *Euro-Mediterranean Journal for Environmental Integration*, 9(4), 1833–1850. <https://doi.org/10.1007/s41207-024-00655-4>
- Doust, S. N., Haghshenas, S. A., Bishop, E. E., Risk, M. J., & Downs, C. A. (2024). Fine-scale geographic risk assessment of oxybenzone sunscreen pollution within Hanauma Bay using hydrodynamic characterization and modeling. *Sci Total Environ*, 906, 167614. <https://doi.org/10.1016/j.scitotenv.2023.167614>
- Downs, C. (2018). *Haereticus Lab Study Finds Sunscreen Pollution Threatens Hanauma Bay in Hawaii*. Retrieved Jan 23 from <https://www.prunderground.com/haereticus-lab-study-finds-sunscreen-pollution-threatens-hanauma-bay-in-hawaii/00123373/>
- Downs, C. A., Diaz-Cruz, M. S., White, W. T., Rice, M., Jim, L., Punihaole, C., Dant, M., Gautam, K., Woodley, C. M., Walsh, K. O., Perry, J., Downs, E. M., Bishop, L., Garg, A., King, K., Paltin, T., McKinley, E. B., Beers, A. I., Anbumani, S., Bagshow, J. (2022). Beach showers as sources of contamination for sunscreen pollution in marine protected areas and areas of intensive beach tourism in Hawaii, USA. *Journal of Hazardous Materials*, 438. <https://doi.org/10.1016/j.jhazmat.2022.129546>

- Downs, C. A., Bishop, E., Diaz-Cruz, M. S., Haghshenas, S. A., Stien, D., Rodrigues, A. M. S., Woodley, C. M., Sunyer-Caldú, A., Doust, S. N., Espero, W., Ward, G., Farhangmehr, A., Tabatabaee Samimi, S. M., Risk, M. J., Lebaron, P., & DiNardo, J. C. (2022). Oxybenzone contamination from sunscreen pollution and its ecological threat to Hanauma Bay, Oahu, Hawaii, U.S.A. *Chemosphere*, 291, 132880.
<https://doi.org/https://doi.org/10.1016/j.chemosphere.2021.132880>
- Florent, Y., Nemoto, M., Rowley, A., Isabelle Villegas, M., & Pratt, V. (2024). Dangers of Oxybenzone in Sunscreens on Coral Reefs: Proposed Policy Approaches. *Journal of Science Policy & Governance*, 24(1). <https://doi.org/10.38126/JSPG240106>
- Friends of Hanauma Bay (n.d.). *Reef Friendly Sunscreen Guide*. F. o. H. Bay.
<https://friendsofhanauabay.org/wp-content/uploads/Reef-Eco-Friendly-Sunscreen-Guide-online-vs2.pdf>
- Friends of Hanauma Bay. (n.d.). *Sunscreen Pollution*. Retrieved Jan 23 from
<https://friendsofhanauabay.org/portfolio/sunscreen-pollution/>
- Gardner, E. A. (1999). A victim of its own success: Can user fees be used to save Hanauma Bay. *Ocean & Coastal LJ*, 4, 81.
- Gibson, D. W. (2018). *With Its New Sunscreen Law, Hawaii Aims to Set a Gold Standard for the World to Follow*. Natural Resources Defense Council. Retrieved Jan 23 from
<https://www.nrdc.org/stories/its-new-sunscreen-law-hawaii-aims-set-gold-standard-world-follow>
- Just-Sarobé, M. (2025). Sunscreens and Their Impact on Human Health and the Environment: A Review. *International Journal of Dermatology*, 64(11), 2011–2018.
<https://doi.org/10.1111/ijd.17800>
- Kanai, M. (2023). *Kid-Friendly Reef-Safe Sunscreens Made in Hawai‘i*. Honolulu Magazine. Retrieved Jan 23 from <https://www.honolulumagazine.com/reef-safe-sunscreens-made-in-hawaii/>
- Lahlou, S. (2017). *Installation theory: The societal construction and regulation of behaviour*. Cambridge University Press.
- Leontiev, A. (1978). *Activity, Consciousness, and Personality*. Englewood Cliffs, NJ: Prentice-Hall.
<https://www.marxists.org/archive/leontev/works/activity-consciousness.pdf>

- Lepper, J (2024), *Half the public think companies are 'greenwashing their sustainability initiatives'*. Better Society Network. Retrieved Jan 25 from <https://www.bettersociety.net/Half-the-public-think-companies-are-greenwashing-their-sustainability-initiatives.php>
- Levine, A. (2020). Sunscreen use and awareness of chemical toxicity among beach goers in Hawaii prior to a ban on the sale of sunscreens containing ingredients found to be toxic to coral reef ecosystems. *Marine Policy*, 117, 103875. <https://doi.org/https://doi.org/10.1016/j.marpol.2020.103875>
- Mansour, M. R., Abushukur, Y., & Mohammad, T. F. (2024). Navigating the changing landscape of reef-safe/reef-friendly sunscreens: current bans and accessibility. *Archives of dermatological research*, 316(6), 310.
- OpenAI (2026). *ChatGPT (DALL·E image generation)*. Available at: <https://chat.openai.com>
- Park, H. B. S. (n.d.). *Hanauma Bay History*. Hanauma Bay State Park. Retrieved Jan 24 from <https://hanaumabaystatepark.com/hanauma-bay-history/>
- Patterson, K., Walion, A., Randall, A., Solomon, E., Dunphy, S., & Anabelle, L. (2021). The world's first free beverage company. AIM2Flourish. <https://aim2flourish.com/innovations/the-worlds-first-free-beverage-company>
- Peleg Mizrahi, M., & Tal, A. (2024). Fast Fashion, Sustainability, and Nudge Theory: Examining the Effects of Choice Architecture on Consumption of Sustainable Fashion over Fast Fashion. *Sustainability*, 16(19), 8586. <https://www.mdpi.com/2071-1050/16/19/8586>
- Razalan, D. M., Bickle, M. C., Park, J., & Brodahl, D. (2017). Local retailers' perspectives on social responsibility. *International Journal of Retail & Distribution Management*, 45(2), 211-226. <https://doi.org/10.1108/ijrdm-01-2016-0006>
- Rodgers, K. u., Graham, A., Cranston, S., Tripler, A., & Scidmore-Rossing, K. (2023). Assessing carrying capacity using demographics, visitor experience and field studies: the case of Hanauma Bay Nature Preserve. *Tourism Recreation Research*, 49, 1-16. <https://doi.org/10.1080/02508281.2023.2173930>
- Schau, H. J., Akaka, M. A., & Segabinazzi, R. C. (2023). Localized globalization through structures of common difference and the in-store curation of a glocal retailscape. *Journal of Retailing*, 99(4), 634-653. <https://doi.org/https://doi.org/10.1016/j.jretai.2023.11.007>

- Serota, N. (2025). *New concession aims to improve access to Hanauma Bay*. City and County of Honolulu. Retrieved Jan 24 from <https://www.honolulu.gov/dpr/dpr-news/new-concession-aims-to-improve-access-to-hanauma-bay/>
- Severino, K. u. S. R. S. (2025). *Hanauma Bay Biological Carrying Capacity Quarterly Progress Report November 2025*. https://www.honolulu.gov/dpr/wp-content/uploads/sites/34/2025/11/Hanauma-Bay-HBAY-Carrying-Capacity-Report_Fall-2025.pdf#page=2.74
- State of Hawai‘i. (2018). *Act 104 (SB2571): Relating to water pollution*. https://www.capitol.hawaii.gov/session2018/bills/SB2571_.HTM
- Thomas, T., Fat, M., & Kearns, G. (2024). Sunscreens: potential hazards to environmental and human health. *Frontiers in Marine Science*, 11. <https://doi.org/10.3389/fmars.2024.1471574>
- Valente, T. W. (1996). *Social network thresholds in the diffusion of innovations*. *Social Networks*, 18(1), 69–89. [https://doi.org/10.1016/0378-8733\(95\)00256-1](https://doi.org/10.1016/0378-8733(95)00256-1)
- van Beukering, P., & Cesar, H. (2004). Economic analysis of marine managed areas in the Main Hawaiian Islands. *University of Hawai‘i, USA: HCRI Research Program*. Available online at: https://www.nodc.noaa.gov/archive/arc0017/0001756/1.1/data/1-data/papereconomicanalysis_final_30apr04.pdf
- Vygotsky, L. S. (1978). *Mind in Society: The Development of Higher Psychological Processes*. Cambridge, MA: Harvard University Press.

Appendix

APPENDIX A: *Activity grid of tourist's behaviour trajectory*

Task	Actor's Motive/Goals	Contributions from Actor	Actor's Rewards	Affordances	Competences	Regulations	Comments
Plan Holiday	Enjoy holiday & make sure everything goes smoothly	Do online research, Apply for visa	Dream about joyful experiences they will have during the trip	Secure budget & time Take holiday approval	Knowledge of sunscreen contamination	VISA Budget Working hours	
Book-ing	Save money (booking at the last minute can be expensive) & plan so do not have to worry during the trip	Book hotels Buy flying tickets Book beach/sea activities	Sense of security Saving money	Finances Laptop/Computer/Tab/Phone Internet connection	The company Staff Customer	Booking availability Budget	
Packing	Prepare everything needed during the trip	- Prepare what you plan to take. - Put items in your suitcase	Be prepared and organised for your holiday (no need to feel rushed)	Suitcase Passport/ID Swimsuit Clothes Water sports equipment Towels Etc...	Knowledge of what is needed for your holiday	Size of suitcase Carry-on liquid size	Sunscreen regulations at Hanauma Bay must be aware of this stage.
Trans-port	Arrive the Hanauma safely and smoothly	Go to airport Drive car	Sense of fulfilment by nearing the destination.	The train, taxi, bus	Choose the right transportation. Be on time. Stick to the plan.	Operation hours Luggage allowance	
Arriving at Hanauma	To settle down & fully rest to get ready for the trip to the beach	Hotel check in Open the suitcase & take out items (e.g., toiletries, pyjamas)	Feel ready to enjoy their holiday	Hotel reservation confirmation Passport/ID Room card/key	Being aware of the procedure of hotel check in	Operation hours	

Before going to the beach	To get ready	Dress up Put on make up Put on sunscreen Prepare things they need at the Hanauma Bay (e.g., sunglasses, hat, camera, cell phone, sunscreen, make-up products, etc) - Make a reservation, in advance, to have access to the beach	Feel confident	A) Use sunscreen brought from home	Knowledge of necessary gear/equipment for the beach. Understanding of the procedures required to access the beach.	Beach operation hours. Sunscreen ban law effected from 2021.	We divide behaviour trajectory into 2 types who A) brought the sunscreen from home (which is harmful) and B) purchase safe sunscreen at Hanauma.
				B) Shopping at site to buy safe sunscreen -Apply safe sunscreen			
At the Beach	Enjoy the trip & try out various kinds of activities by the beach/ in the sea Show off their bodies	Enter Park using reservation Photographing Lie on the beach Go into the sea Drinks	Feel fulfilled after spending time in nature Sense of relaxation	Snorkelling, Dolphin watch, Shark cage dives, Reef scuba tour	Skills of swimming & snorkelling	Must have prior reservation to initially enter the beach	
Leave the beach	Have an appearance adapted to the outside of the beach.	Wash off sunscreen at the beach shower	Feel ready for the next action. (go back to the accommodation, dinner, or meet up)	Beach shower, Towel, Clothes to change, Body soap, gel for skin care after sunburn	Showering, knowledge of washing harmful sunscreen off at the beach causes pollution.	Limited showering time and spot.	Pain Point: Some people may not be aware that washing off sunscreen causes pollution, while others may continue to do so even though they are aware of the issue.

APPENDIX B: *AI Declaration*

AI was used to generate images

can you please create an image from a sunscreen sticker explained in the below text . Reef-safe sunscreen is clearly identifiable through standardised, highly visible packaging, making environmentally compliant behaviour immediately recognisable in shared beach spaces.

Bild erstellt • Reef-sicherer Aufkleber für Sonnencreme



📄 📌 🔄 ...

even more noticeable in a neon color and directly on the suncream

Bild erstellt • Sonnencreme für korallenfreundliche Strände



👍 🗨️ ⬇️

📌 Weitergeben

📄 📌 🔄 ...

Additionally, sunshades are provided through rental systems, with clear colour differentiation to signal participation and reinforce social norms around reef-safe behaviour. Visitors who use reef-safe sunscreen or alternative sun-protection measures receive green sunshades, signalling environmentally compliant behaviour, while those who continue to use harmful sunscreens are provided with red parasols. This colour-coding system operates at the social regulation layer of Installation Theory by making sun-protection behaviour visible within shared beach spaces (Lahlou, 2017). As a result, reef-safe behaviour is positively signalled, while non-compliance becomes publicly identifiable, creating informal social pressure to adopt sustainable practices. The sunshades may be financed and branded by sustainable sunscreen producers, enabling product promotion while supporting the implementation of ReefSafe Access and generating additional income for local rental services.

Can you please create an image of these described sunshades with the branding of the reef save suncrems and the colour code where all sunshades are green and one sunshade of a person at the beach is red



Bild erstellt • Schützendes Paradies am Strand



+ Stelle irgendeine Frage



through advertising partnerships, drawing on models such as FreeWater, where branded products are funded by aligned sponsors who can then use the tourists as a billboard to advertise their brand. Logos from sustainable brands, local businesses, or environmental initiatives placed on the garments enable wide distribution at no cost to visitors, while linking brand visibility to tangible environmental responsibility. Recognising that many tourists value tanning as part of their holiday experience, ReefSafe Access does not seek to discourage sun exposure outright. Instead, it promotes partial coverage norms, where UV-protective clothing is worn during high-risk activities such as swimming, snorkelling, or prolonged water exposure, while uncovered time remains acceptable in other contexts

Please create an image collages of these clothes described in the text at the different distribution points

Bild erstellt • UV-Schutz für ein nachhaltiges Erlebnis



AI was used to understand how to cite a webpage on EndNote

how can I cite this on endnote:
<https://friendsofhanauabay.org/portfolio/sunscreen-pollution/>

Nice, this is a **classic NGO informational page** — very common in sustainability work, and **easy to get wrong** in EndNote if you treat it like a blog. Here's the **clean, marker-safe way** to do it.

✓ How to cite this in EndNote

Reference Type

👉 Web Page

Fill in the fields like this

Author

Friends of Hanauma Bay

- ✓ Corporate author (NGO)
- ✗ Do NOT invent an individual author

how to cite this on endnote: <https://www.nrdc.org/stories/its-new-sunscreen-law-hawaii-aims-set-gold-standard-world-follow>

This one is an **NGO advocacy article** (NRDC), so you should cite it as a **Web Page** in EndNote — very similar to Friends of Hanauma Bay, but with a **clear publication year**.

✓ How to cite this in EndNote

Reference Type

👉 Web Page

👉 Fill in the fields like this

Author

Natural Resources Defense Council

(Use the full organisation name, not NRDC)

Year

2018

