Turning Tides: Sustainability Measures for Shark Conservation

By:
Vivian Guido

Supervised by:
Mark Terry
Leesa Fawcett

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Abstract

This major project paper explores the critical role of environmental documentary films in addressing the lack of ocean-related environmental education programs in academic and non-academic settings. Focusing on marine conservation and biodiversity, particularly sharks, the study showcases how sharing scientific knowledge through documentary films facilitates easy and comfortable engagement with ocean-related topics. By targeting youth, who are well-acquainted with technology and media, the research emphasizes the potential of documentary films to improve environmental knowledge retention, thus advancing ocean literacy and awareness.

The study incorporates in-person observations of at-risk marine environments, such as coral reefs and seagrass meadows, as well as endangered marine species, primarily sharks and rays, to assess specific conservation needs and understand the correlation between ocean and human health. Through visual documentation, the film presents compelling evidence of global ocean health decline, urging governments, policymakers, and the public to prioritize socio-political changes. Among the evidence presented, an interview with marine biologist and shark scientist David McGuire offers valuable support and credibility to the information and examples being shared.

Aligned with the United Nations Sustainable Development Goal #14, the research shares the current state of oceans and their biodiversity. By bridging science, policy, and education through film, it contributes to increasing ocean literacy and inspires conservation behavior. The paper concludes by affirming the effectiveness of film and media as educational tools, breaking language barriers and providing universally understandable evidence that encourages future efforts to promote ocean stewardship.

Foreword

At a time when ocean health decline is at its most crucial point, the urgency to conserve our marine ecosystems and biodiversity is at its highest. This major project examines how documentary film can increase ocean literacy and stewardship, particularly among youth, while promoting marine conservation. In this paper I address the following learning objectives:

Component 1: Marine ecosystem degradation and marine species decline: Conserving the ocean and its resources

LO 1: I will study the main impacts on marine species and their habitats for the purpose of assessing the ocean ecosystems most affected and susceptible to changes and how these outcomes influence a sustainable future on the planet.

LO 2: I will analyze impacts of human activities such as fishing, pollution, and other climate change events on ocean and aquatic biodiversity for the purpose of understanding how to improve ocean conservation globally.

LO 3: I will be analyzing the global impacts of oceanic changes on sharks, to help assess the balance and health of marine ecosystems and their relationship to human health.

Component 2: Environmental education and ocean literacy: Creating more environmentally aware and ocean literate societies

LO 1: I will be analyzing the current lack of ocean related environmental education with the purpose of addressing the low levels of ocean literacy and awareness among youth.

LO 2: I will be researching the effects of marine related environmental education on the values of young people with the purpose of understanding how a change in values towards the ocean and its resources can enhance attitude and behavior.

LO 3: I will study how increased ocean awareness and literacy can affect environmental decision making, conservation behavior, and social and political change.

Component 3: Film and media as a tool for education: Helping youth experience and understand the ocean through documentary film

LO 1: I will be examining the effectiveness and efficiency of film and media as a tool for education for the purpose of increasing ocean literacy.

LO 2: I will be surveying and assessing the ability of film to share information on endangered marine species and their habitats.

LO 3: I will be studying the engagement or likely engagement of youth in ocean-related programs and activities after acquiring adequate environmental education through digital tools.

LO 4: I will be creating an original documentary film in order to educate youth on marine conservation, global health, and ocean policy for the purpose of increasing ocean literacy.

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Glossary

Algae: Simple plants, without a true stem, leaves, or roots, and possessing chlorophyll; this includes almost all seaweeds.

Biomass: Total weight or volume of organisms in a given area.

Carcharhinidae: Also known as requiem sharks, largest family of living sharks; found worldwide especially in tropical waters; dorsal fin lacks spines.

Cetacean: A marine mammal of the order Cetacea; a whale, dolphin, or porpoise.

Coral Bleaching: Bleaching occurs when stress causes corals to expel symbiotic algae (zooxanthellae) resulting in a loss of color (hence the appearance of being bleached). Several factors can cause bleaching, however, the biggest driver resulting in mass bleaching events is warming ocean temperatures.

Crustacean: Diverse group of organisms including crabs, lobsters and shrimp.

Diversity: The species richness of an area.

Eutrophication: The release of excess nutrients (primarily nitrogen and phosphorus) into a water way arising from human activities (industry, mining, farming, storm drains etc.). Excess nutrients promote increased algal growth, sometimes resulting in massive and lethal "blooms".

Elasmobranch: Any of a subclass elasmobranchii of cartilaginous fishes that have five to seven lateral to ventral gill openings on each side and that comprise the sharks, rays, skates and more.

Habitat Loss: The destruction of ecological structures and functions vital to maintaining the richness, diversity and abundance of marine species native to an area.

IUU Fishing: Illegal, unreported and unregulated fisheries and fisheries markets.

Literacy: The quality or state of being literate; educated.

Migrations: The movement of animals from one area to another by well-defined routes usually triggered by a periodic factor of some kind.

Ocean: The whole body of saltwater that covers nearly three fourths of the surface of the earth.

Ocean Literacy: An understanding of the ocean's influence on society and society's influence on the , with the goal of helping humanity make more informed and responsible decisions regarding the ocean and its resources.

Ocean Acidification: A decrease in the pH (increase in the acidity) of the Earth's oceans. An increase in atmospheric CO2 leads to a rise in oceanic CO2 levels through continual air-sea gas exchange. When CO2 dissolves in the ocean it reacts with seawater and carbonate, leading to a decrease in the amount of available carbonate in the ocean.

Overfishing: Arguably the most serious and detrimental human impacts on marine ecosystems, fishing depletes the stock of fish in (a body of water) by too much fishing.

Photosynthesis: The process in which green plants and some other organisms use sunlight to synthesize foods from carbon dioxide and water. This is how most energy enters the biosphere.

Plankton: Organism that cannot move independently of the currents.

Sphyrnidae: Also known as Hammerhead Sharks are often found in tropical and temperate oceans and have flattened blade-like extensions on either side of the head, with the eyes and nostrils placed at or near the ends.

Part 1: Introduction

1.1 Problem Statement

The ocean is the vital life support system of the planet, providing necessary resources for the development of humankind and other species. Present and future societies will depend on healthy oceans not only for food, but for the regulation of climate and the generation of oxygen, which we breathe. The oceans also serve as a foundation for a considerable amount of the world's economy through sectors such as tourism and fisheries. Ocean biodiversity has been declining for the past 50 years, and most significantly, in the past two decades where we have seen large-scale negative impacts such as ocean warming and acidification, sea level rise, and overfishing affect marine species and their habitats (WWF, 2015). Marine predators are some of the most affected, facing a large-scale extinction due to rapid population decline and habitat destruction, both brought on by human activities (Hopkins & Miller, 2021). Moreover, science has shown that marine predators, particularly sharks, serve as an excellent indicator of ocean health as they regulate the balance of marine ecosystems at the top of the ocean trophic levels.

Ocean conservation and stewardship are of paramount importance to mediate ocean health decline and ensure that marine species and habitats are being protected and monitored. The protection and conservation of marine ecosystems and the biodiversity inhabiting them affects the future of our planet and the well-being of all its inhabitants, aquatic and on land, as we are all dependent on healthy oceans for survival and development. Current research has indicated that with the threats to ocean health at an all-time high, the levels of ocean literacy among global populations are still relatively low (Guest, Lotze & Wallace, 2015; Kelly et al., 2021). It is important to consider education, particularly science and environmental education, as a key asset in furthering scientific and ocean literacy, thus increasing informed and responsible decision making in regards to the ocean and its resources. With more ocean literate citizens, society can prioritize and value ocean conservation and health, as they understand how they and the ocean are linked.

Finding innovative and engaging ways to share science information, particularly among youth, is becoming increasingly important as young people will have to face the brunt of climate

change impacts in the coming future. This research explores film and digital media as a method of environmental science education with the goal of increasing ocean literacy. The film I have created serves as a learning tool for young people on a global scale to become more familiar with the ocean and form an emotional connection with marine biodiversity. This emotional connection or interest paired with accurate scientific information shared through a film can help influence youth to become engaged with marine science, policy, and conservation. Most current research shows that film can be an exceptionally useful learning tool with the current generation of technologically aware youth. However, not many studies address the connection of film to science education and, in particular, ocean literacy and stewardship. Therefore, it is crucial to look at broader methods and tools for education in today's academic and non-academic learning settings as a way to effectively share marine science information.

The United Nations Sustainable Development Goals (SDGs) have designated goal #14 *Life Below Water*, to help *conserve and sustainably use the oceans and marine resources for sustainable development* (United Nations, 2016). This goal consists of 10 targets and indicators to help monitor progress as we work towards protecting 30 percent of the oceans by 2030 (Figure 7.1). The United Nations has also proclaimed the *UN Ocean Decade* (2021-2030) to support efforts to reverse and mitigate ocean health decline, particularly linked to climate change and destructive human practices, and support sustainable development. Through these strong and significant commitments made by the UN to protect the oceans, humankind must work together to participate in marine learning and conservation, while also leaning on governing bodies to uphold their promises to protect the oceans for a sustainable future.

1.2 Research Objective

Like many of us who were young around the ocean, we have seen significant changes in a relatively short period of time. These changes are negatively impacting our current future and those of younger generations. The objective of this research is to serve as an educational medium and tool for youth to understand and value the importance of marine life and aquatic ecosystems, vital to human survival on the planet. This research also aims to empower youth to be more informed on ocean related climate issues and engage with ocean conservation. Additionally, a goal of this research is to evaluate the progress of various marine issues addressed in the UN

SDG #14 and determine the current most crucial improvements to be made within those issues. The evaluation of ocean literacy levels among youth on a global scale were analyzed through related literature in order to improve policy and educational approaches to marine and environmental science learning. Finally, the objective of this research is to share and captivate young people through film, in order to offer them a more engaging and effective learning experience that will increase their ocean literacy and stewardship.

1.3 Background of Study

As of today, less than eight percent of the oceans are protected, and only three percent of oceans are highly protected (Gibbens 2021; Briggs 2020). Covering over 70 percent of the planet, the oceans provide food for over three billion people, they play a key role in regulating climate, they host a large number of the planet's biological diversity and offer valuable economic activities (Wright, 2017). Due to the increasing levels of pollution, immense growth of overfishing of marine species, and rapidly changing oceanic climates, oceans are facing greater threats every day. Due to human induced global warming, fragile marine habitats and finite aquatic biodiversity, which directly support human life, are at risk of extinction (United Nations, 2022). These ecosystems and the species within them are vital to human survival on the planet in many ways, and at the current rate, future generations may never be able to experience the beauties of the ocean or utilize the resources it provides for sustainable development.

Of these important marine species, large marine predators are an integral part of maintaining the balance of marine ecosystems and ensuring ecosystem wide species health (Hammerschlag et al., 2019). Sharks, in particular, can be an effective indicator of ocean health as they are at the top of the ocean trophic levels and food chain, maintaining species health and diversity below them (Hopkins & Miller, 2021). Sharks also have an impact on a variety of marine habitats and ecosystems such as coral reefs, seagrass meadows, and mangrove forests. Regrettably, shark species have seen a global decline of over 70 percent and, in some cases, critically endangered shark species such as hammerhead sharks have reached a decline of over 90 percent (Hopkins & Miller, 2021). There are some studies within the past decade that have explored the gaps in marine predator conservation, however most come to similar results: that protections are not consistent among all shark species, and not all protections are recognized and

upheld internationally. Conservation measures and protective statuses for sharks are specific to certain species, however due to the rapid decline of these animals, some data is not present to enforce such protections. For example, if a shark has gone undocumented for some time in a particular part of the world and there is no recent data on that species, they may be excluded from protective laws being put in place, and thus still be at risk. Additionally, even though some international measures and laws have been put in place, such as restrictions on shark fin trade and sale through Convention of International Trade of Endangered Species (CITES), or on fishing and pollution through the United Nations, upholding those legislative decisions is ultimately up to individual nations. There is no system thorough enough to monitor or enforce international measures on the national scale, to hold countries, corporations and individuals accountable for actions or behaviors that are detrimental to ocean wildlife. Overall, the level of awareness, understanding, and value attributed to sharks and their habitats is not sufficient to promote their conservation as a global paradigm.

Attributing value and respect to the ocean often comes from a broader sense of knowledge and understanding. By knowing the impacts the ocean has on humankind, and humankind's impact on the ocean, in relation to development and survival on the planet, prioritizing its conservation should be at the forefront of everyone's minds. With the risks to ocean health at an all time high, the level of ocean literacy among global populations are still relatively low in comparison to the magnitude of ocean health decline (Guest, Lotze & Wallace, 2015; Kelly et al., 2021). Only a select few communities across the globe have access to adequate ocean related environmental education, most commonly coastal or island nations who have rich histories, cultures, and values related to the ocean, as well as a core dependency on marine resources for survival and development. Upon evaluating several ocean literacy studies from around the world, evidence has shown that oftentimes, ocean literacy and awareness levels of youth living in or near coastal or island areas is significantly higher than those in urban areas (Guest, Lotze & Wallace, 2015; Young, 2017; Mogias et al., 2019). Ensuring that globally, there is a standard of scientific, environmental and ocean literacy that young people especially are cognisant of, not only allows for more educated communities but continues to highlight the value and importance of marine conservation for sustainable development (Santoro et al., 2017; Lee, 2019; Kelly et al., 2021; Ferreira et al., 2021).

For many young people, especially in today's technological age, when they care about something, they take initiative to share and discuss it (Boulianne, Lalancette & Ilkiw, 2020; Szymkowiak et al., 2021). Oftentimes, they do so loudly and in numbers, as seen with the recent "Fridays for Future" climate rallies (Sabherwal et al., 2021; Wahlström et al., 2019). In a 2020 study, by the Canadian Ocean Literacy Coalition (COLC) it was determined that almost 77 percent of participants agreed that they learned about the ocean through media (News, social and digital media, film) (Figure 7.2) (Glithero & Zandvliet, 2020). Other global studies on ocean literacy have shown similar results (Leitão et al., 2018; Mogias et al., 2019; Lin et al., 2020). By using film and media as a method of educating people on the importance of the ocean and its biodiversity in relation to planetary and human health, viewers can develop a higher level of understanding of several different types of scientific issues (Terry, 2020). Specifically, attitudes and behaviors of youth towards technology and digital media as an educational tool, allows for more collaboration and sharing of information in a way that is interesting and exciting for them (Cheng et al., 2013; Terry, 2020). The use of film, social networks, and broadcast media are an area that many young people are comfortable and keen with, and therefore can easily understand and engage with these forms of learning (Terry, 2020), making them more eager to learn and oftentimes influence them to participate in related projects or conservation efforts.

In order to thrive on this planet for generations and sustainably utilize marine resources, ocean and environmental literacy and an overall standard of scientific understanding must be achieved on a national and international level. The United Nations sustainable development goal #14 *Life Below Water* aims to conserve and sustainably use the oceans, seas and marine resources for sustainable development, discusses the current state of the oceans, and attainable approaches and solutions to improve human actions and behaviors towards aquatic environments (United Nations, 2016). Each of the ten targets of this goal focus on specific impacts facing the ocean and these targets are followed by indicators of how progress can be measured. As of 2023, destructive trends in ocean health are still significant, with ocean acidification continuing to rise above baseline conditions, increasing marine pollution of all kinds and ongoing IUU and overfishing activities (Our World in Data, 2023; United Nations, 2023). In 2019, more than a third of global fish stocks were overfished and although the expansion of marine protected areas

is higher than ever before, there is still a long way to go to achieve the conservation of 30 percent of global waters by 2030 (United Nations, 2022). In current literature, no one study addresses all the gaps in the area of ocean literacy and marine conservation, however the literature does support the theory that education and conservation are linked as a tool for sustainable development.

Therefore, the film focuses specifically on how marine science and environmental education mixed with storytelling can influence and improve values, understanding, and behaviors of young people towards the ocean. Additionally, the project will serve as an informative medium for people to understand their impact on the ocean and the oceans impact on them. While informing viewers of ocean related climate issues in the scope of SDG #14 *Life Below Water*, there is a particular focus on sharks as an indicator of ocean health, thus bringing awareness to the importance of marine predator and habitat conservation. Finally, this work will be used as a medium to help bring upon social and political change in relation to the United Nations sustainable development goal #14 *Life Below Water* through the evaluation of the progress of the SDG #14 *Life Below Water* targets and the presentation of the film at the UN climate conference. The film project I will produce for this research will be submitted to the UN climate conference and policy makers through the *Youth Climate Report* project and will act as a tool for environmental education as well as socio-political change. By following the journeys and studying the challenges of sharks as apex predators of the ocean, I will evaluate and address the UN sustainable development goal #14 *Life Below Water*, for the purpose of increasing ocean literacy and marine conservation.

Part 2: Literature Review

2.1 Ocean health and marine species decline

As climate change increases, the oceans are facing greater threats every day. Marine biodiversity is declining rapidly and aquatic ecosystems are deteriorating. This severely impacts the ocean's ability to support planetary and human health as well as their potential to sequester and store carbon in the face of global warming (Hilmi et al., 2021). Oceans provide food for over three billion people, they play a key role in regulating climate, they host a large number of the planet's biological diversity, and offer valuable economic activities (Wright, 2017). Our overuse of ocean resources has become increasingly unsustainable through unregulated or poorly enforced industrial pollution from burning of fossil fuels, as well as the continuously increasing commercial and illegal fishing (Armstrong, 2020; Vierros, 2017). Humankind's business as usual mentality in regards to physical development has come only at the expense of our planet, and the undeniable evidence that changes must be made to ensure a sustainable future are at their most crucial point (Armstrong, 2020).

The planet's marine cycles demonstrate how changes to one factor can directly or indirectly affect others. McCauley (2015) claims that this relationship is particularly clear in the context of fisheries. The present rate of overfishing and IUU (illegal, unreported and unregulated) fishing have reduced certain fish stocks by up to 90 percent, some species even being fished to extinction (Lotze, 2009). Consequently, some of the most significant declines with widespread impacts on other marine species and habitats are marine predator declines. What this means is that the rapid decline of marine predators, particularly shark species is causing a chain reaction within several aquatic ecosystems causing an imbalance in reef fish populations and their productivity affecting an ecosystem's ability to sustain itself (Mariwether, 2018; MacNeil, 2020). The two main reasons for shark population decline are overfishing and habitat loss (Pacoureau et al., 2021). Coral reefs, for example, when exposed to an overpopulation of smaller reef dwelling fish, frequently experience a loss of carbon sequestering algae (Cole, 2008; Seraphim, 2020). Without reef sharks present on reefs to feed on some of the fish, those smaller species overgraze the coral vegetation and the corals cannot absorb and store as much carbon as usual. In a 2020 study by MacNeil, the common assumption that reef sharks are present in all of

the world's coral reef ecosystems is disproved, when a global study showed that sharks were not observed on about 20 percent of surveyed reefs. This study also known as the *Global Finprint Project* surveyed 371 reefs globally, studying the relative abundance of shark species captured through baited remote underwater video systems (BRUVS) (Figure 5). MacNeil (2020) also determined that 63 percent of the 15,165 deployed BRUVS did not record the presence of a single shark, indicating a clear decline in global reef shark species. Without healthy shark populations, reef fish that usually help in the movement of coral polyps through feeding, would be stripping away the coral's defense system against global warming (Cole, 2008; Seraphim, 2020). This reduces the growth of corals causing less productive ecosystems that are more susceptible to changes such as bleaching from temperature or acidity change (Mariwether, 2018). Therefore, sharks are essential for healthy reefs and reef ecosystem species diversity.

In ecosystems such as seagrass meadows where sea turtles and dugongs often graze, the presence of sharks is imperative to sustain carbon sequestration. Seagrass meadows are powerful carbon sinks, and in many cases are known to sequester up to 20 percent of the earth's carbon dioxide (Macreadie et al., 2014). Their rate of carbon absorption is up to 35 times faster than that of tropical rainforests and can store up to 90 percent of their carbon in their soil and sediment (Macreadie et al., 2014; Lee et al., 2021). A study by Heithaus et al. (2014) showed that predators such as tiger sharks, white sharks and even hammerhead sharks indirectly and positively affect plant growth and thus carbon sequestration in seagrass ecosystems (Figure 7.4). Heithaus et al. (2014) also determines that sharks can initiate and influence trophic cascades in blue carbon ecosystems such as seagrass meadows, mangrove forests and coral reefs. Another study conducted by Gallagher et al. (2022) determined that tigersharks do have a strong fidelity for seagrass ecosystems and can often hunt in these areas. Additionally, it was discovered in Gallagher et al's (2022) study that the tiger sharks for this study spent about 72 percent of their time over seagrass ecosystems when swimming across shallow banks (Figure 7.5) . This means that with healthy shark populations, seagrass can maintain and continue absorbing carbon, but if too heavily overfished from an ecosystem, can cause a blue carbon sink to become less productive and even collapse. Findings from Heithaus et al. (2014) and Gallagher et al's (2022) study suggest that marine predator conservation must be considered, particularly in carbon storing ecosystems, to avoid further degradation because as carbon sinks lose their productivity,

atmospheric carbon increases and climate changes can occur more rapidly (Allemand, 2016; Alongi, 2020). Sharks have huge conservation potential, especially through national and international governance and enforcement of marine species and habitat regulations.

In addition to environmental implications, Mariwether (2018) claims that the decline of marine life and their habitats have a notable impact on humans. Humans are impacted by the overconsumption of polluted or sick fish stocks from contaminated marine ecosystems, which have been linked to a variety of health issues, and soon, the lack of available fish for communities most dependent on the ocean for food because of overfishing (Vierros, 2017). Sharks are known to feed primarily on sick or weak fish, minimizing the subpar individuals that could be fished for consumption and possibly affecting human health. A study by Alberghini et al. (2022) states that fish ingest and absorb toxins that have entered the oceans due to human activities, and these chemicals such as mercury, heavy metals, BPA, PCBs and pesticides can have detrimental effects on the human body after long term exposure or consumption. Alberghini et al. (2022) also describe the notable impacts of these chemicals on the human body including cancers, neurological disorders, reproductive system damage, and cardio-vascular system damage to name a few. For coastal communities and Island nations, these effects are felt first as they are the most physically and culturally dependent on the ocean's resources (Mariwether, 2018). Sharks significantly contribute to the reduction of subpar fish, helping to strengthen the stock and promote a healthier ecosystem.

Not only are sharks helpful in supporting healthy ecosystems and in turn healthy communities on land but sharks provide significant socio-economic benefits to a multitude of countries around the world, especially coastal and island nations. Sharks maintain marine habitats that are enjoyed by travelers and tourism, contributing largely to the GDP of many countries globally, especially island nations. Globally, divers and photographers are seeking areas that have sharks and the healthy marine ecosystems associated with regions with healthy shark populations. Shark-based ecotourism has tremendous benefits for the health and well-being of many coastal communities who are concerned with protecting their environment. According to a study by Cisneros-Montemayor (2013), global shark tourism generated about $314 million annually and was projected to surge to $780 million in the next 20 years. Now halfway through

that 20 year period, shark tourism has continued to grow proportionately to that prediction on both national and international levels (McGuire, Guido & Koepfer, 2023).

Marine tourism activities around the world employ local fishers and community members, utilizing local knowledge, much of which is passed down through generations (Poepoe et al., 2007). Sutcliffe & Barnes (2018) claims that applying local indigenous knowledge from coastal communities offers both a cultural and ecological learning experience where an information exchange takes place between visitors and residents regarding marine conservation. When this information is shared, not only does it increase ocean related environmental awareness but, it influences visitors to continue partaking in ecotourism activities (Poepoe et al., 2007). For sharks specifically, the attitudes and behaviors of many are often directly influenced by popular media sharing incorrect information about these incredible marine predators, thus negatively influencing people's perceptions of shark conservation (Sutcliffe & Barnes, 2018; Clua, 2018). Therefore, by offering authentic, and unbiased opportunities for visitors to experience sharks, and learn about how they are vital to oceanic and human health, allows visitors to value sharks and their protection (Sutcliffe & Barnes, 2018). There is a strong scientific view that non-consumptive wildlife tourism provides substantial conservation value to vulnerable and endangered species through educating tourists about the value of many animals of critical importance in marine ecosystems (Clua, 2018). Internationally, there could be a significant decrease in pressure for extractive uses of sharks through increased conservation efforts and shark tourism activities, boosting global economies and community livelihoods. However, the growing demand for shark products, principally shark fins for shark fin soup, threatens the future of these valuable industries (Clarke et al., 2007).

Understandably, it may not always be possible for people to participate in hands-on, in-person interactions with the ocean and marine life, particularly youth. This is why it is so important to provide proper learning opportunities and experiences that allow them to learn about the ocean and the importance of conservation. This research and film project specifically addresses the top issues with ocean conservation and shark decline and how they are related to other aspects of marine and human health. The film, while following the UN SDG goals, evaluates the relation between ocean health and marine predators as well as the value of sharks

and shark conservation in respect to coastal and island communities particularly the Hawaiian islands and marine tourism. Finally, my film addresses the current management and enforcement of oceans and fisheries in connection to ideal socio-political developments towards achieving SDG #14.

2.2 Environmental Education and Ocean Literacy

Ocean literacy is defined as an understanding of the ocean's influence on you and your influence on the ocean (Fielding, Copley, & Mills, 2019). An individual who is ocean literate has the ability to understand essential principles and fundamental concepts about the functioning of the ocean and can make informed and responsible decisions regarding the ocean and its resources. By promoting awareness and understanding of marine science issues among youth, we empower the next generation to make informed decisions that protect our oceans. Through interactive and engaging educational initiatives, young individuals become more conscious of the environmental challenges faced by our oceans, such as plastic pollution, overfishing, and climate change impacts. Equipped with this knowledge, they are inspired to take action, advocate for sustainable practices, and can become active participants in marine conservation projects for future generations.

Based on a 2020 study by the Canadian Ocean Literacy Coalition (COLC) it was determined that 25 percent of participants do not believe that the ocean influences their daily life, and 27 percent were unsure or neutral on that statement (Shiffman, Yumagulova, & Glithero, 2020). This indicated that a quarter of all participants were not aware of the very basic scientific information linking oceans to human health or survival. However, over 70 percent of participants were willing to make changes to support ocean health (COLC, 2020). Additionally, it was determined that almost 77 percent of participants learned about the ocean through media (news, social and digital media, film) rather than through formal education (Figure 7.2) (Glithero & Zandvliet, 2020). This suggests two very important factors: Environmental education in academic or other educational settings are not effective or engaging enough to youth, and that digital avenues offer a more interesting and understandable array of science content for youth to learn and retain. In a similar COLC study, almost 25 percent of participants indicated they engage with ocean literacy through educational programming (Figure 7.3) (Shiffman,

Yumagulova, & Glithero, 2020), which further suggests that there are environmental and ocean literacy curricula and programs present in academic settings however they may not be engaging enough for students. Therefore, improving environmental education programs on a global scale can significantly increase the level of ocean literacy, while also reducing barriers for citizens to engage in environmentally responsible behaviors, particularly those who may not have had any direct experience with the ocean (Guest, Lotze & Wallace, 2015).

Based on the International Ocean Literacy Survey (IOLS) and other national ocean literacy evaluations, the basic understanding of ocean science issues among school aged youth, particularly in middle and high school levels, was lacking in 40 percent of participants (Guest, Lotze & Wallace, 2015). In the Mediterranean region of Europe, of the students evaluated, 53 percent were found to possess insufficient knowledge to correctly answer many ocean literacy survey questions (Mogias et al., 2019). Over half of the students possessed rather moderate to low knowledge of ocean sciences issues, and also shared misconceptions about their connection and dependence on ocean resources. In Asian countries such as China, Taiwan, and Japan, only about 60 percent of evaluated students were familiar with ocean concepts based on scientific information (Lin et al., 2020). Also, Lin et al. (2020) indicated that student's ocean literacy was at a basic level but had room for significant improvement.

In a comparative study by Leitão et al. (2018) between the United Kingdom and Portugal, the same lack of knowledge in four core subject questions in an ocean literacy survey were evaluated. Many of which were science based questions, the subjects of eutrophication, acidification, ocean and atmospheric carbon and oxygen as well as the extent of the explored ocean were incorrectly answered by up to 68 percent of students, showing considerable room for improvement (Leitão et al., 2018).

In the Middle East, 50 percent of evaluated participants were lacking adequate environmental and science knowledge to successfully complete the survey. Low levels of ocean knowledge and understanding can be attributed to the fact that the ocean sciences only constitute a minor part of national academic curricula in the region (Pocze et al., 2020; Mokos et al., 2021; Mogias et al., 2022).

Finally, in North America, moderate to low levels of ocean literacy have been evaluated with levels not exceeding 40-60 per cent from middle to high school grades (Plankis & Marrero, 2012; Guest, Lotze & Wallace, 2015). Additionally, more than half of the participants from North American countries: Canada and The United States, could not successfully answer more than 4 questions in the ocean literacy surveys given, due primarily to marginalized environmental education. Youth in higher grades that had ocean-related courses had a greater breadth and depth of knowledge; however most of their ocean knowledge was coming from media sources such as social media, film and television rather than in academic settings (Plankis & Marrero, 2012; Guest, Lotze & Wallace, 2015). Additionally, people living within proximity to the ocean or sea had slightly higher levels of environmental awareness and ocean literacy.

Conservation within a local context requires an understanding of the historical and cultural knowledge, emphasizing the framework from which people derive meaning and identity. In the case of Hawaii, an important understanding is that to care for the ocean supports a prosperous future for all. What this means is that the sea works in partnership with the land, providing sustenance and serving as a pathway and communication link with other lands and peoples (Kanaÿiaupuni & Malone, 2006). Positive environmental values and behavior are a result of this identity, which is influenced by demographic factors specific to the Hawaiian people. Young Hawaiians today are still being taught these principles through schools, education programs, and leadership development programs based on their culture (Kanaÿiaupuni & Malone, 2006). In Hawaii, not only is ocean literacy passed down through generations of families due to the cultural value of the "*ʻĀina*" (*ʻāina* is Hawaiian for that which feeds, that being the land and its produce, as well as the sea and the all the things from it we can collect and harvest to sustain ourselves with), but ocean literacy is taught in school and other academic and non academic programs (U.S. National Park Service, 2021).

While in coastal areas environmentally friendly behavior may be increased due to socio-economic and community dependance on these resources, it is equally as important for urban centers to have a standard level of knowledge and awareness for youth, promoted through academic and non academic sources (Hunt, 2021; Mnyusiwalla, 2021). Environmental education

and ocean literacy play crucial roles in creating more ocean literate societies and fostering marine stewards therefore, utilizing a variety of learning and educational tools to share science information is paramount. Utilizing creative learning opportunities as well as STEM initiatives to integrate environmental learning in school programs is a growing advantage. Studies show that in today's digital age, there are a wide variety of educational settings which include digital learning environments (Websites, mobile apps, and online media); media (including TV, film and radio). A study by Dontre (2020), discusses digital media and technology as not always being popular among traditional classroom settings due to the ongoing debate on technology and digital media being a distraction rather than a benefit. However, studies have shown for quite some time that in the context of ocean science, there is relative effectiveness of classroom documentary film presentations on marine mammals or other species of marine life (Fortner, 1985; Laursen & Brickley, 2011; Bennett, Cooper, & Rock, 2020). As the underwater world is so visually appealing, there is a particular advantage to film and media usage in this field as the visual content itself is so engaging and interesting to youth that they are often drawn to this medium and retain significantly more information than when completing non visual learning activities (Bennett, Cooper, & Rock, 2020). Ren (2022) claims that utilizing and tailoring digital and creative mediums to offer a diversified ocean experience for young people, allows for a higher retentiveness and an increased immersion and curiosity in learning more about it.

The film will serve as a tool for ocean literacy by presenting science information to viewers in an engaging and easy to understand format. The film will present a variety of different topics based on the UN SDG #14 targets and indicators and will explain them thoroughly while also providing a visual aspect for clarity. As film is a medium that goes beyond language due to its visual component, each “chapter” of the film, based on a target of goal 14, will allow a wider audience to grasp concepts and themes linked to marine conservation. With the inclusion of interview footage with a marine biologist and shark scientist, the visual evidence will be supported by science, and further inspire viewers to take interest and action in issues that impact their future. Studies have indicated that environmental education, though present, is still considerably underrepresented in many school curricula in a variety of areas (Öllerer, 2015),

including marine and coastal science, therefore this film will fill that gap with ocean specific climate issues and information.

Finally, the impact of the film being shared with schools, other academic programs or centers, and in widespread media, provides a standard of ocean literacy to be shared with youth to help them develop respectful values, attitudes and behaviors towards the ocean. Additionally, expanding the reach of my film by submitting to the COP28 climate conference and to film festivals, particularly environmental and ocean film festivals, can help to further promote ocean literacy and stewardship on a larger scale.

2.3 Film and media as a tool for science education

Film and media are incredible tools to help people engage in local and global climate issues, particularly today, where we live in a digital age, through our devices and social media platforms. It is evident today more than ever, that a standard level of environmental knowledge can be achieved on a global scale and connecting people through media and technology can aid in the sharing of information on scientific topics. In a 2020 study, by the Canadian Ocean Literacy Coalition (COLC) it was determined that almost 77 percent of participants agreed that they learned about the ocean through media (news, social and digital media, film) (Figure 7.2) (Glithero & Zandvliet, 2020). A study by Terry (2021) claims that by using film and media as a method for educating people on the importance of the environment and its biodiversity in relation to planetary and human health, they can develop a higher level of understanding of several different types of scientific issues. The use of film, social networks, digital technologies, and broadcast media are an area that many young people are comfortable and keen with, and therefore can easily understand and engage with these forms of learning (Cheng et al., 2013; Terry, 2020), making them more eager to learn and oftentimes influence them to participate in related projects.

New and emerging technologies have a large potential for ocean related environmental education through captivating images that many are not able to see in person. New technologies also have the ability to make sharing and understanding knowledge between people across the globe easier than ever before (Bruce, 2019). A study by Kelly et al. (2021) states that

technologies such as videos, video games and social media tools provide engaging and emotional experiences for youth that can, when used correctly, encourage them to learn more on environmental topics. The use of film and media as an educational tool can help engage and influence young people to form connections with the ocean and become more involved in ocean related climate issues that affect them (Bruce, 2019; Kelly et al., 2021). Kelly et al. (2021) also claims that youth with heightened scientific and environmental awareness may be more active in conservation efforts, research, environmental justice gatherings or events and recreational activities, because they understand how they may be impacted.

Many documentaries advocate for specific viewpoints on social or scientific issues and since the rise of digital streaming services it can be argued that these platforms bring environmental documentaries to a broader audience than their broadcast television counterparts (Yeo & Silberg, 2021). As much as scientists are held accountable by the peer-review process because of professional norms, there are no such standards for film. It is common for nature documentaries to incite empathy towards threatened species and in a way "play on viewers emotions" however documentaries have always had the potential to inspire change, and alongside true and accurate information, the emotional aspect of a conservation film plays an important role in inciting that change. Other influential factors of documentary films as a tool for socio-political change are the legislative factors and outcomes (Boissat, Thomas‐Walters, & Veríssimo, 2021). Seale (2023) states that a key way to spread awareness through film is by achieving social and political changes on specific conservation issues, and as a result of intelligent, truthful and powerful filmmaking, public opinions change and sway socio-political decisions on an issue. In the case of ocean and marine life conservation, people become very attached to the animal subjects throughout the film, and when exposed to both emotional visuals and compelling science, their opinions can be swayed.

For example, *Blue Planet II*, a series widely praised for creating a tidal shift in behavior and policy change on single-use plastics, showed the impact of microplastic pollution on ocean wildlife. The final episode of the series included footage of an albatross chick killed by a plastic toothpick, alongside the sentimental but truthful testimony of a scientist (Seale, 2023). The information presented in this documentary can be corroborated by several marine and

environmental scientists, and has been studied for quite some time in a variety of global destinations (Seale, 2023). This episode was followed by a huge shift in public conversation around plastic, leading to increased attendance for beach-clean-ups, an explosion in the use of reusable products, and legislative changes in several nations worldwide (particularly the UK and EU countries on single use plastic bans) (Seale, 2023). As similar documentary films and series became popular on streaming platforms, public interest in marine conservation surrounding plastic pollution has grown significantly.

There are also criticisms toward film as a tool for education and socio-political change. Some critics claim that media based learning, specifically through film, has the potential to misinform viewers. A study by Cooper & Nisbet (2016) states: there is no regulatory body or ethical code that governs the reliability and validity of documentary film information and by spreading incorrect information, viewers' perceptions may be falsely swayed to believe inaccurate information, affecting public thinking and knowledge of scientific issues. In the context of environmental science and policy this can be especially dangerous as scientific and political misinformation can cause loss of scientific integrity and decrease the urgency of the current issues (Bar-Ilan & Halevi, 2020). The media plays an important role for advancing ocean literacy (Guest, Lotze and Wallace, 2015; Ashley et al., 2019) and in North America specifically, media is the predominant source for learning about ocean issues (Glithero & Zandvliet, 2020), however misinformation in relation to conservation is still present and powerful if not thoroughly fact-checked.

Take the documentary *Seaspiracy* for example. This film is a prime example of a filmmaker embarking on a ‘‘hero’s journey’’ to pinpoint the cause of ocean degradation, and advocate for his own specific viewpoint on fisheries. *Seaspiracy* as a film was not effective at science communication, and quite frankly created several misconceptions regarding ocean related climate issues, particularly fisheries, that still linger in society today (Sousa, 2021; Marine Stewardship Council, 2021). Some misconceptions included “The oceans will run out of fish by 2048” and “There’s no such thing as sustainable fishing or sustainable seafood, fishing is bad and veganism is the only way to protect the oceans” (Sousa, 2021). The film spends a shocking amount of time trying to, and successfully using “gotcha” journalism to weasel

non-profits into making statements that are damaging or discreditable to their cause (Sousa, 2021). As I have worked directly with one of the scientists interviewed and misinterpreted in the film, I know these statements to be untrue, alongside many others in the scientific community. Despite its viral success, the general lack of integrity of the filmmakers to share true and accurate science, while pushing an unrealistic and unsustainable agenda for most people, does not make for an effective environmental learning tool. A study from the Center for Social Media at American University, interviewed 45 documentary filmmakers and found that often the manipulation of individual facts was done if it meant telling a story more effectively and helped viewers grasp the main, and overall truthful, themes of a story (Aufderheide, Jaszi, & Chandra, 2009). Therefore it is imperative to understand that even though documentary films are a popular hit through the availability of digital or social media, they can still cause significant harm through misinformation.

In the film that accompanies this research, it was especially important to avoid two obvious factors: misinformation and the casting of the primary issues in a negative light. I think these are two elements that can help set this film apart from others. Additionally, the film acts more as a digital and visual progress report on the UN SDG #14 *Life Below Water*, encouraging change and future progress rather than reprimanding mistakes and practices that we are actively working towards improving. Certainly there will be honest problem statements and feedback so that viewers can grasp the concepts and problems at hand, however the purpose of the film is to engage and influence youth to partake in conservation while increasing their ocean literacy through science learning. My hope is that the film is an effective and engaging way for people to experience and understand the ocean, while giving them the tools and information they need to become better ocean stewards.

Methodology

The goal of this project is to use documentary film as a tool for science and environmental education to increase ocean literacy, particularly among youth. This project is a qualitative study and will consist of 4 main approaches: observation, literature review, interview and filmmaking.

The first method of this research will be observation, where I will observe sharks in a variety of natural environments, this will be done through scuba diving and underwater videography. The observation and documentation of marine environments is necessary to improve the global understanding of ocean systems and the impact of human activities on marine environments (NOAA, 2023; UNESCO, 2021). Additionally, ocean observations are vital to improve how humankind forecasts climate issues, ocean health, and aquatic impacts, so we can better manage our marine environment and its resources (NOAA, 2023; UNESCO, 2021). As an extremely vulnerable and largely uncharted territory, ocean conservation is a topic on which many are still generally unfamiliar with, therefore, applying knowledge to better manage this environment, based on visual scientific evidence is imperative (Bindoff et al., 2019). Accordingly, the observation and documentation portion of this research is qualitative in nature.

Filmmaking is used in this research to disseminate scientific and environmental information and provide qualitative information in a visual context. Film will be used as a data collection tool, a source of information, and a method of communication between professionals, researchers and viewers (Shrum & Duque, 2008). All of this information will then be presented through visual technology to maximize the sharing and understanding of scientific data and socio-political facts to a wider audience (Shrum & Duque, 2008). As a presentation medium, documentary film especially, can be formatted to grasp the attention of both expert and lay audiences in relation to environmental issues. Knowledge mobilization for this research will encompass sharing scientific information about the ocean with the public, especially youth through digital forms.

Interviews are used in conservation research and are a flexible method of analysis and or validation from a relatively smaller group of participants. The interview will be with a marine biologist and NGO shark conservationist David McGuire to evaluate and discuss the relationship between sharks and ocean health as well as ocean awareness, conservation and ocean health. The interview in my film serves as a commentary and expert opinion on the success of SDG #14: *Life Below Water* in relation to scientific findings, and status of marine conservation from a professional. This type of research will also serve to provide scientific credibility to the information being shared on film. The interview will be semi-structured, with questions already chosen and a general plan for the conversation, but flexible and exploratory in response to the interviewees' answers (Young et al., 2018). The information provided and verified from the scientific lens will be mostly qualitative in nature.

This research relied on a literature review of ocean literacy, environmental education and marine conservation; surveys were particularly useful to assess the level of students' proficiency with marine sciences and environmental understanding (Fauville et al., 2018). The research also relies on surveys from the international ocean literacy surveys to evaluate the level of ocean literacy among youth. Secondary research I used was conducted by scientists and researchers in the environmental science and education fields and was also qualitative in nature.

Filmmaking Process

For the creation of the film, I first started by traveling to San Francisco, California to meet with a colleague and mentor David McGuire. Mr. McGuire is a marine biologist and shark scientist from southern California, working in the area of shark and ocean conservation through his non-profit Shark Stewards. Shark Stewards works towards marine conservation by eliminating the shark fin trade, the world's greatest threats to shark species, and focuses on policy change and education in North America and Asia. They are based in Berkeley, California but have project chapters in Hawaii, southern California and throughout Asia. Shark Stewards actively partner with NOAA and the Ocean Protection Council in the National marine sanctuaries and California Marine protected areas for a variety of projects.

First contact with Mr. McGuire was made throughout my experiential learning class, where I worked as an ocean communications “intern” to assist them with a variety of educational outreach and policy projects. As an Emmy-Award-winning filmmaker and editor, Mr. McGuire also offered to help me with my film as it was on the topic of shark and ocean conservation, particularly within the context of the UN SDG #14, a goal Shark Stewards is also working towards. He allowed me to travel with him to Hawaii where he also was working on a film and mentored me in underwater videography with professional equipment, joined me on dives and participated in an interview. He is in a way the main character and voice in the film providing powerful insight and scientific knowledge on the current state of the oceans, the progress of SDG #14 and the conservation value of sharks on a global scale.

The first step in the filmmaking process was to formulate 10 questions based on SDG #14, the questions would be concise but not too specific, therefore multiple interviewees could answer and give their opinion on the matter (Appendix 1). The only in-person interview was with David McGuire of shark stewards; however, there was one virtual interview with another shark scientist and marine biologist Choy Aming, and an interview conducted by the *Youth Climate Report* project, with environmental and climate scientist and lecturer Amy Harvey. Mr. McGuire’s interview is the only one to appear on camera in the film and will provide real life case studies and examples from Hawaii and other areas where filming took place. The interview

with Mr. McGuire was filmed at his residence in Kona, Hawaii and was filmed on *Sony A7III* and *Sony A6600* with *rode* microphones, the full run time of the interview was around 55 minutes in length before edits.

For the content of my film there are three main types of footage: Main A-roll, collected by myself and Mr. McGuire throughout our dives in Hawaii and California, Secondary B-roll, collected separately to this project at a time previous to May 2023 and finally royalty free stock footage obtained from online sources. For the main B-roll footage both Sony *A7III* and Sony *A6600* cameras were used with protective underwater housings and lights to film marine life, particularly sharks in a variety of Hawaiian and other waters. Ideally shots of sharks or marine life in situations related to the 10 SDG #14 targets were collected to use in relation to spoken narration and interview footage in the film. For example, if the interviewee discussed the impacts of plastic pollution on sharks, we attempted to collect and match the footage to that time in the film through editing. A total of eight dives were carried out off the Kona coast on the Big Island of Hawaii and four dives off the northern California coast. Most of these dives offered views of reef and tiger sharks as well as a variety of turtles, moray eels and several species of reef fish. Additionally, footage of coral reef ecosystems are frequently present in the collected footage.

When editing the film, the editor and myself worked closely to create a compelling story that also met the requirements of a documentary film, particularly the sharing and visualization of scientific knowledge. What this means is that each chapter of the film discusses and evaluates a target of the SDG #14 but also provides definitions, example or case studies and compelling visuals to support the information being told, thus increasing the possibility for interest, engagement, and content retention. The format is similar throughout the entirety of the film with an introduction, an opening statement and simple explanation of the subjects explored in the film such as the SDG goals, marine conservation, shark protection, marine education and policy. The film is then concluded with an outro that summarizes the progress and need for improvement of goal #14 and what outcomes we can expect in the coming future. The film was carefully assembled on Adobe Premiere Pro with professional quality visual and audio clips interconnected and superimposed to tell a cohesive and effective story that flows well through scientific, environmental and political information.

Some key factors included in the film that help inform the viewer are most notably the high quality footage of sharks and their impacts on the ocean. As previously mentioned, the goal of this film was not to showcase human atrocities towards the ocean and particularly shark species, but to inform, inspire and engage. Several ocean related documentary films spend hours showing and discussing shark finning and fishing with gruesome images and very clearly emphasize all of the death and destruction in a harsh and overly negative light. This can be especially shocking, uncomfortable and depressing for youth, and was not the goal of this particular film. As much as those atrocities are a reality around the world, providing viewers, especially youth with the comfort and reassurance that there are solutions and that even small acts can make an impact, allows young people to engage with the presented science content more easily and stress free.

In the film there are several contributions towards filling the gaps in present literature on ocean literacy, marine and shark conservation as well as documentary film as a tool for education and socio-political change. My documentary film first and foremost evaluates and addresses the progress of SDG #14 *Life Below Water* through real time visual observation and evidence presented on film. Footage that provides similar views on ocean issues from around the globe suggests that many of these issues are in fact happening simultaneously rather than in one isolated area, meaning that socio-political change is necessary to address the problem. The progress is also discussed by three professionals in the marine biology field, one of which is interviewed on film, all of which is supported by secondary literature. Not only does the science connect a variety of scientific professionals from different global destinations but the supporting literature from an even wider geographic scale supports the claims made by interviewees. Finally, the physical film itself serves not only as a tool for socio-political change presented to policymakers at the United Nations but also serves as an educational tool. Through the evidence and science information listed in the film that is communicated by a multitude of global professionals, policy makers and governance actors can choose to implement legislation to resolve ocean related climate issues. Additionally, the film has the potential to significantly increase ocean literacy among youth by serving as a classroom tool and activity for youth to engage with. The film can be used in formal or informal academic settings to convey the

message of marine conservation and the importance of ocean stewardship. The effectiveness of the film to continue educating and achieving socio-political change can be evaluated as the film grows and is shared among more and more viewers, and can be evaluated as the value of ocean conservation rises in relation to overall marine conservation and health increase.

What I learned through the making of this film and the completion of this Master's project is that the time and patience that goes into making a film cannot be rushed. In the context of my own film, I would have liked to and should have started the filming and editing of the film sooner in the year (ie. earlier in the winter term, rather than in the spring), however due to funding schedules at York University and back and forth with scholarship and grant prospects my research schedule was pushed back to April/ May. This late start gave me less time to edit and put together the film independently and required me to outsource an editor. Another important lesson I learned was in regards to the cost of producing such a project. The process and financial burden of creating a full-length documentary film is quite high and equipment and post production costs are constantly changing and increasing. In my situation I exceeded this project budget by almost 30 percent leaving me minimal funds to outsource editing for the film and causing me to use personal savings. As much as this can be expected with any creative type of project it's not ideal to surpass a budget, especially at the master's level when student work is mostly paid for with academic funding. This experience, however, will definitely be beneficial for future film projects.

With respect to the physical filming process for my documentary, I learned that the interview process can be very challenging, particularly when traveling to collect interview footage. Having the option for virtual interviews is always helpful, but otherwise, ensuring that the interview is the first piece of the documentary to be filmed and if possible well in advance to ensure more ease and clarity in scriptwriting, videography, image capture and editing. Due to the weather in Hawaii, we wanted to take advantage of diving and filming days and ended up filming the interview at the end of the trip, which did slow down the filmmaking process in a way. Filming the interview first also offers more time for reshoots, corrections and additions to the footage. Finally, the last thing I learned throughout the process of this research and filmmaking was to thoroughly test and dive with underwater photography equipment before

starting filming. As I am a relatively new filmmaker, I had experience with small camera equipment on dives prior to my trip, however working with professional equipment requires significant training time in order to get used to it and produce quality footage. It took a few days of diving to get used to the larger and more buoyant camera equipment needed to produce this film. Filming with a small go pro or other small to medium sized cameras requires less practice and time training your body to be comfortable using them, especially underwater. An issue I encountered in the first two days of diving in California and the first day of diving in Hawaii is that my underwater camera housing was quite large and in turn, buoyant. This became especially difficult and exhausting to carry with me on dives, particularly because filming sharks and reef creatures requires stabilization and adaptability. With a camera constantly trying to float up to the surface of the water while you are between 18 to 30 meters of depth contributes to a significantly higher air usage and in turn a shorter, more annoying dive. Moreover, a large portion of footage from those first few dives was unusable as the camera was not stable and the footage was too shaky. It took a few dives to find a solution to this problem: attaching dive weights to the bottom of the camera housing to make it neutrally buoyant. Neutral buoyancy allowed the camera to feel weightless underwater and sit properly on my arm, or attached to my scuba gear, while also making underwater filming much easier and smoother. This camera weighting process should also be considered for any additional lighting or mounts attached to the camera housing.

Discussion and Outcomes

The end result of my film is a 50-minute educational documentary titled *Turning Tides: Sustainability Measures for Shark Conservation* (Appendix 2). The film will be added to the United Nations *Youth Climate Report* map and the full length film will be submitted for vetting for an official screening at the COP28 climate conference in Dubai. The film will also be submitted to a variety of ocean and environmental film festivals throughout North America and other worldwide locations to expand the reach of the documentary. Private screenings of the film will also be organized for certain non-profit and educational institutions such as Shark Stewards, and York University. Finally, through an educational distributor, the film can be submitted to various school boards as a learning tool, program or lesson to accompany an environmental or science education curriculum.

Moving forward from this research and my Masters degree, I would like to continue working with the Youth climate report project and Shark Stewards to contribute my time to their many projects in marine conservation. I am particularly interested in their educational and film projects and opportunities, particularly with youth. I would like to continue traveling to places where conservation projects are taking place to learn more about filling gaps in ocean literacy education and marine conservation.

I would like to produce another documentary film in the future; however, rather than focusing on sharks specifically, I have become increasingly interested in turtle conservation in the Hawaiian islands and the implementation of marine protected areas. I am interested in engaging further with coastal and island communities and local knowledge, and how those experiences can be an example for the sharing and development of ocean literacy on a global scale. Some of my current work with the Shark Stewards non-profit focuses on the expansion of the Papahanaumokuakea Marine national monument off the coast of the northwestern Hawaiian islands. I believe a film focused on the cultural value and significance of sea turtles in the marine national monument to the native Hawaiian people would provide a valuable learning opportunity when showcased through film. Alternatively, a film about the local and native Hawaiian people working to conserve these sacred marine sites is also an interesting proposal for a film.

Nevertheless, if I do choose to create another film, I would again like it to be used as an educational tool for ocean literacy and be made available to schools and other academic settings. I would also like to write a book, possibly for children as a tool for ocean literacy in the future.

Moving forward in my career, I think I would be well suited for a science communications or program management role, ideally, in a non-profit or educational setting. I have grown quite fond of the nonprofit world and feel as if their work is the most fulfilling and engaging. I would be happy to work in a position where I could excel in improving both educational, conservation and policy outcomes, and I strongly believe that working with a variety of environmental programs, supporting companies that carry out conservation, and advocacy projects would be especially meaningful for me. I would also like to complete a PhD after working in the field for a few years.

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Figures

Figure 7.1: United Nations Sustainable Development Goals #14 *Life Below Water*

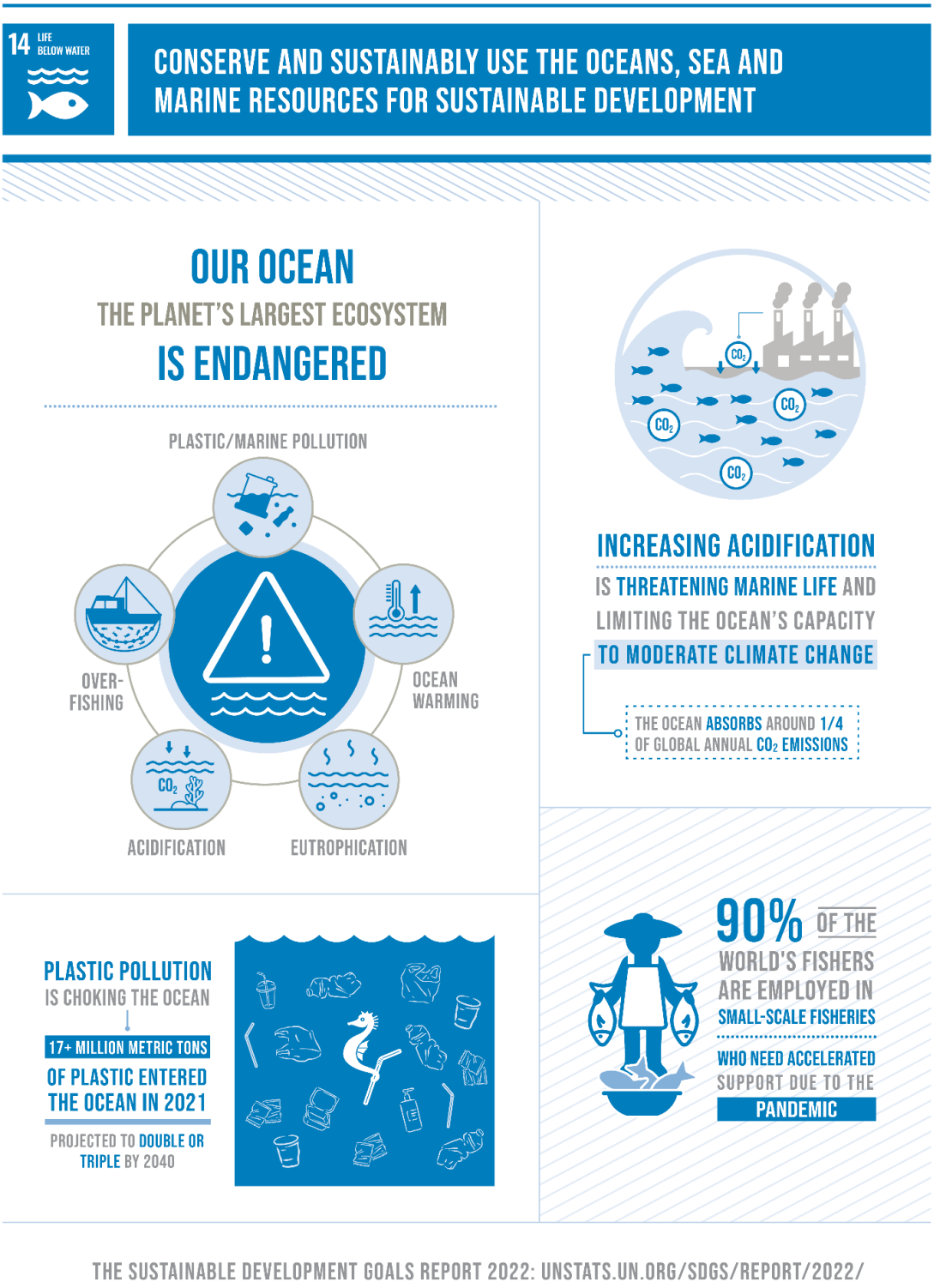


Figure 7.2: Canadian Ocean Literacy Coalition Survey- How Canadians Learn About the Ocean

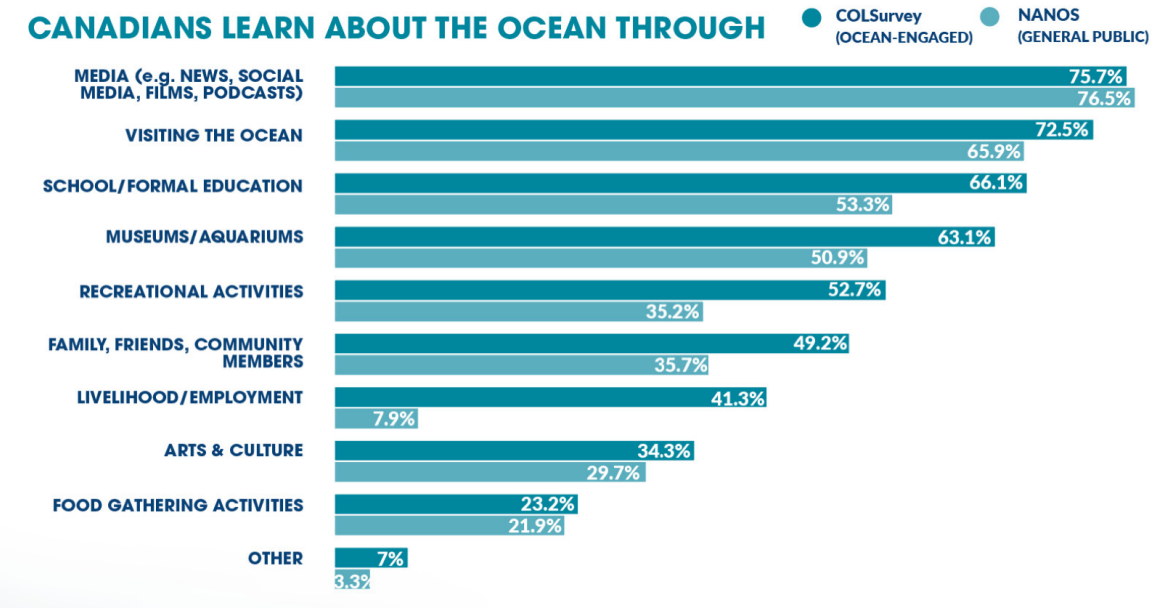


Figure 7.3: Canadian Ocean Literacy Coalition Study- How Youth Engage with Ocean Literacy

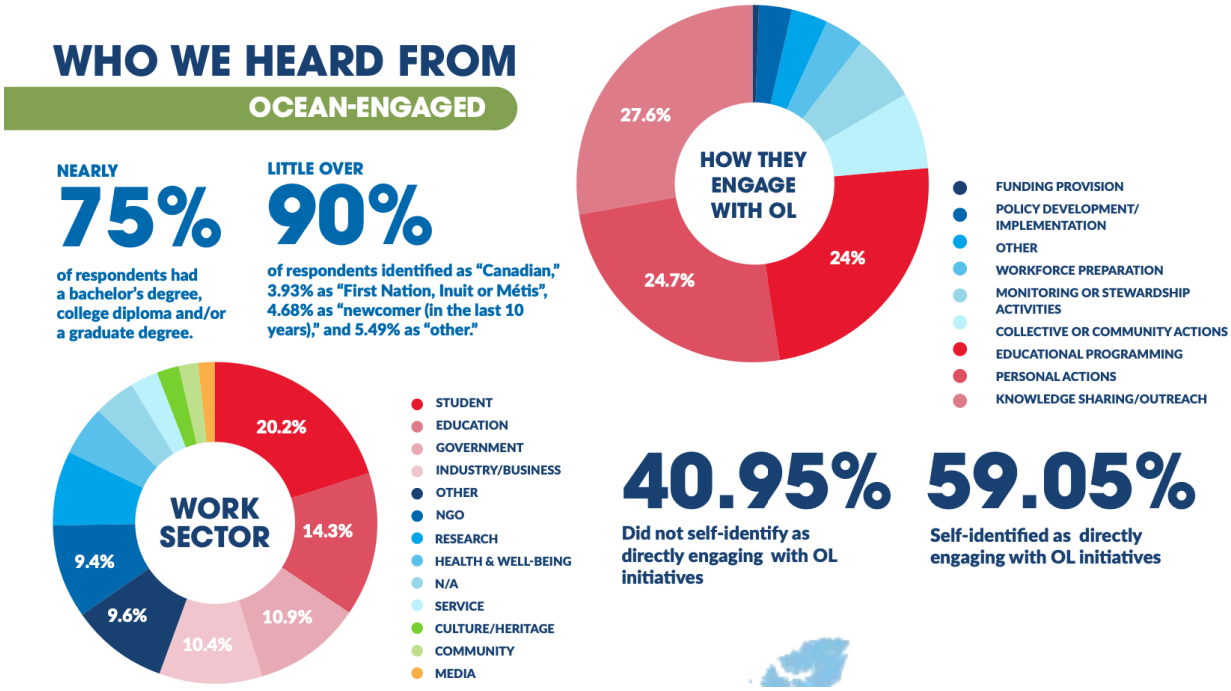
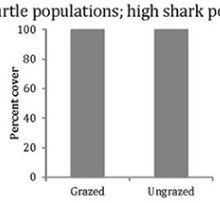
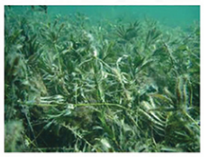
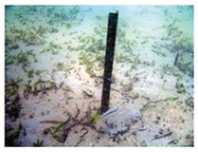
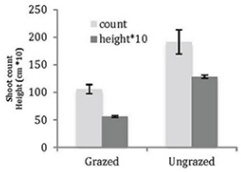
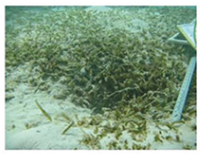
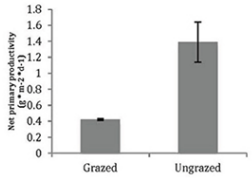
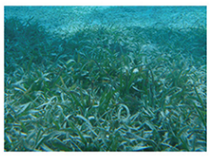
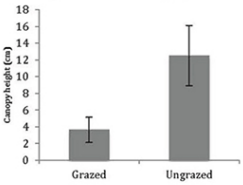
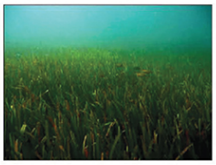
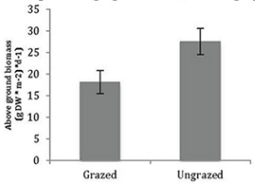


Table 7.4: How Sharks Affect Carbon Sinks Study- Heithaus et al, 2014

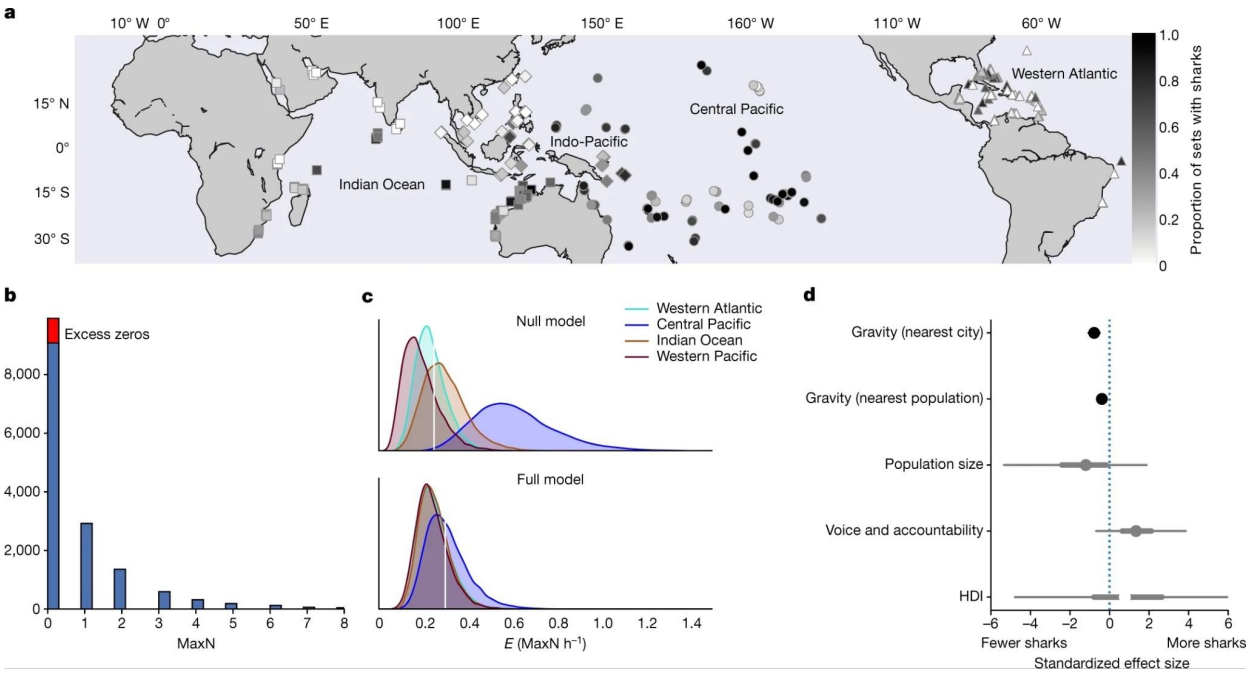
Many turtles*		Few/No turtles	Method (significance)
Western Australia: stable turtle populations; high shark populations; high risk habitat			
			600 day exclosure (NS)
Western Australia: stable turtle populations; high shark populations; low risk habitat			
			600 day exclosure (count: p<0.05) (height: p < 0.01)
Bermuda: high and rapidly increasing turtle populations; shark populations reduced			
			730 day exclosure (p <0.01)
Lakshadweep, India: rebounded to high, stable turtle populations; shark populations likely reduced			
			Long-term natural exclosures (p < 0.0001),
Derawan, Indonesia: increasing turtle populations; shark populations likely reduced			
			90 day exclosure (p < 0.05)

Comparison between seagrass meadows with presence of sharks and sea turtles

Figure 7.5: Tiger Shark Impacts in Seagrass Ecosystems Study- Gallagher et al.

The regulation and monitoring of seagrass ecosystems by researchers and tiger sharks

Figure 7.6: Global Finprint Project- Distribution of Reef Sharks



Distribution of reef sharks captured on film through BRUVS, baited video cameras

Part 8: Appendices

8.1: Appendix 1: Interview Questions

1. Please introduce yourself with your name and title.

2. How does pollution affect marine predators and how does that affect the balance in marine ecosystems?

2. What protection measures are in place to sustainably manage marine ecosystems, and what more can be done to improve ocean and community health on a global scale?

3. Specifically, how does ocean acidification and warming affect marine predators and how is it related to the trophic level of marine ecosystems. (ie. Sensory impacts on marine predators paired with habitat change and loss causing increased disruption within the ocean food web)

4. How does the fishing industry affect sharks, what are some alternatives that can be adopted to promote shark health and conservation? (combating IUU and overfishing)

5. How do Marine protected area's benefit and promote marine conservation and how can people engage with marine policy and stewardship through MPAs?

6. What are some things that can be done to help end fisheries subsidies that may contribute to this? How can fishing operations be better monitored and fishing laws enforced to mitigate harmful practices?

7. What benefits are there for developing nations especially coastal and island nations to utilize marine resources and tourism activities for socio-economic development? How can the blue economy help endangered species such as sharks?

8. Why is scientific knowledge, environmental education and ocean literacy so important for conservation, especially among youth? How can the general public contribute to marine science, technology and research even if they are not scientists, through either programs or general practices.

9. How can we support local and artisanal fishers and how can we push legal and governing bodies to recognize and protect small scale fishers?

10. Where are we as a global community on the success of SDG #14 *Life Below Water* and the conservation and sustainable use of marine resources and where are improvements most needed to achieve this sustainable development goal? How can we as a global community reach conservation goals and work together with governments and NGOs to save the oceans and their biodiversity?

8.2: Appendix 2: Film Link

https://youtu.be/jQOzR3YxUKk