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Master Program in Statistics and Information Management

Awareness and Action: Coral Bleaching

Research study on changed behavior upon receiving information concerning coral bleaching effects

Linda Underwood

Dissertation presented as partial requirement for obtaining the Master's degree in Statistics and Information Management

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ABSTRACT

Coral reefs are living organisms that act as an important ecosystem for many different kinds of invertebrates and vertebrates. They are essential for marine life to survive yet also provide many benefits for human life as well. “Coral bleaching” is caused by climate change due to the increase in temperature in the ocean’s water which starves the organism and what remains is only its white skeleton. This is one of the biggest threats to coral reefs. This study aims to understand whether, when given information about coral bleaching specifically, people are more likely to participate in actions that prevent coral bleaching through global warming and if so, what their main motive is to do so. This is important for organizations whose goal is to protect the coral reef so that they can make more effective campaigns. A survey is conducted with questions specifically targeting these main goals and statistically analyzed before and after a passage containing facts regarding coral bleaching, to determine if there are any changes in people’s standpoint. Results showed a lack of knowledge of the importance of coral reefs for human life which increases likelihood to take action against coral bleaching once reading the passage, when considering all respondents. Previous belief in cause and existence of climate change influences the likelihood to take action overall. However, Gender and Age play a role in increased awareness and likelihood to take action against coral bleaching.

KEYWORDS

Coral bleaching, Coral Reefs, Global Warming, Climate Change

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LIST OF ABBREVIATIONS

WSRT	Wilcoxon Sign Rank Test
MWU	Mann Whitney U Test
KW	Kruskal Wallis
DTR	Do not take responsibility
TR	Take responsibility
NA	Not Active
AC	Active
M	Male
F	Female

1. INTRODUCTION

1.1. BACKGROUND

Coral reefs are the most diverse marine ecosystems providing home to 25% of all marine life, yet covering less than one percent of Earth's surface. Not only are they essential for the birth, growth, and survival of many marine species, but they are important for human life as well, providing food, jobs, and economic income. Therefore, the health of this ecosystem is crucial for the survival of life and its preservation should be of the utmost importance. However coral bleaching is threatening the survival of coral reefs around the globe. To best explain coral bleaching, it is necessary to know how coral reefs are structured.

Coral reefs have existed for as long as 400 million years, and while stony corals have evolved within the last 25 million years, the more established coral reefs we see today are between 5,000 to 10,000 years old. These coral reefs are made up of a myriad of groups of corals which are made up of many, many living organisms called polyps. "A polyp is a small invertebrate marine animal with tentacles that live within a hard cuplike skeleton that it secretes around itself" ("Coral Reef", n.d.). A coral polyp can reproduce sexually, excreting eggs and sperm which get carried away by ocean currents until landing on a hard surface and secrete their own calcium carbonate cups to form a new coral reef. They can also reproduce asexually by budding or forming new polyps attached to themselves by thin sheets of tissue and skeletal material which can also grow into a massive coral over time. The polyp secretes a white skeleton around itself made up of clusters of calcium carbonate by which it uses the assistance of the zooxanthellae, microscopic algae, which lives within the lining of the polyp's gut. The polyp provides the zooxanthellae with protection and when it secretes carbon dioxide, the zooxanthellae is able to photosynthesize and provide the polyp with nutrients, glucose, and amino acids. This then allows the polyp to create proteins, fats, carbohydrates, and calcium carbonate ("Coral Reef", n.d.). The zooxanthellae provides the polyp with 90% of its energy to stay alive while the polyp can also use its tentacles to catch plankton floating by during the nighttime (Orlowski, 2016). The polyp itself is clear, while the skeleton it produces is white; the bright colors that are generally thought of when imagining coral reefs come from the microscopic algae living with the lining of the polyp's gut. This is a symbiotic relationship between the polyp and zooxanthellae in which both are benefited and because of this unique relationship, coral reefs are able to survive and grow year after year. This process is as magnificent as it is delicate. A slight change in the amount of sunlight or in the temperature of the water can disturb this process and eventually stopping it completely.

Global warming[1] is the gradual increase in overall temperature in the atmosphere due to increased levels of carbon dioxide, CFCs, methane, and pollutants that create a barrier which traps in heat, also known as the greenhouse effect. This increase in temperature causes extreme and abnormal weather patterns which in turn effects living organisms all around the globe. Burning of fossil fuels is one of the largest contributors to global warming. The ocean is used as the earth's cooling system, absorbing 93% of the heat which otherwise would be in the air and felt by everyone (Knowlton, n.d.). Because it is absorbing

[1] Global warming and climate change are used interchangeably, as the focus is concerned on long term global warming as well as short term heat waves which are both a factor of climate change ("What's in a name? Weather, global warming, and climate change, n.d.)

the heat in the air, it is gradually changing the temperature of the water, which effects the organisms in it. As the coral reefs' process of receiving energy from zooxanthellae is so delicate and specific to a certain temperature of water, the effects of global warming in the ocean are interfering with this process leaving the coral reef without 90% of its energy source. When the temperature of the water is too warm, the coral begin to reject and evict the zooxanthellae within them leaving them without nutrients needed to survive. Since the zooxanthellae provide the color, only the white skeleton left behind. The coral reef is not dead quite yet, but is under a tremendous amount of stress and eventually will die due to lack of the majority of its nutrition ("Early Warning Signs of Global Warming: Coral Bleaching", 2003). This phenomenon is called coral bleaching and is caused by an increase in ocean water temperature, by both long term increases in ocean temperatures as well as short term extreme heat waves, which are irregular weather patterns.

Coral bleaching is being observed across the globe with large scale events occurring at an increasing rate. One study showed that out of 100 corals observed since 1980, 30% bleached in 2015 or 2016 alone. Also, the Great Barrier Reef saw a record breaking back to back bleaching event in 2016 and 2017 and the 2016 bleaching event killed more than two thirds of the corals along a northern part of the Great Barrier Reef (Greshko, 2018). The close proximity of these events do not allow the coral reefs a realistic chance to overcome the bleaching, and increases the risk of them dying exponentially.

The eventual death of coral reefs by coral bleaching have and will continue to impact marine life directly. Indeed, 25% of marine life will lose their homes, some fish may be become extinct due to lack of protection from predators. Some classes of fish will have no place to mate or protect their young. Not only does this affect marine life, but human life as well, as many populations around the world survive off of the fish found near coral reefs for food. Catching these fish usually found around the coral reef can have an impact on the economy as well: where there are no fish to catch, there are no fish to sell. Over 500 million people depend on coral reefs for food to survive or on the income fishing provides (Greshko, 2018).

Other jobs related to the ocean, such as tourism, will also disappear and negatively affect the economy. In 2017, a study revealed that coral reef tourism is worth up to $36 billion each year. Many island states have very few alternate sources of employment or income (Ullman, 2017). Coral reefs also act as a barrier, protecting beaches from strong waves which otherwise could damage shorelines and structures built close to the shorelines. These include business and peoples' homes. In one way or another, death of the coral reefs by coral bleaching will have a shocking and profound effect on life around the globe if positive action is not taken soon.

1.2. Problem Identification and Relevance

There is growing scientific research explaining coral bleaching, outlining climate change as the main cause, and highlighting the devastating impacts of the loss of this ecosystem. While studies examining the perceptions humans have of coral bleaching specifically are lacking, many studies have been done regarding the perceptions of climate change overall. Climate change can be a delicate and sensitive issue in regards to attitudes towards it due to people's confusion on the cause and its impact. Additionally, people are unaware, or do not acknowledge its threat, or ignore the negative impact of climate change. By combining information about perceptions of climate change and scientific literature related to coral

bleaching, a better understanding of how people feel about coral bleaching and whether those feelings affect their actions to fight against it can be discussed.

Organizations such as NOAA, National Oceanic and Atmospheric Administration, along with many others spend time, money, and resources to not only to protect the coral reef and better understand coral bleaching but to spread the word via campaigns, articles, and collaborations in documentaries. This is important so that people can be informed of the effects climate change has on coral reefs. The outcome of the spread of this knowledge may change habits and thus help to stop global warming to protect the coral reef. By determining why people would change their daily habits, for marine life or for human life, and what information aided in changing their view to stop coral bleaching, organizations can make their campaigns more effective. Thereby saving the organization's time, effort, and money but most importantly, effectively get this grave message across that without action, we are putting the ocean and ourselves, at risk.

1.3. OBJECTIVES

The study aims to improve the knowledge on whether **people who are more aware of the causes and effects of coral bleaching due to climate change, are more likely to intend to implement an action in their life to slow climate change's effect on coral reefs for marine life or human life, or both.** A survey is designed and implemented to address this research objective.

Several specific objectives emerge from this main objective, namely:

1. Understanding respondents' knowledge of benefits of coral reef for marine and human life;
2. Assessing the level of importance on whether deterioration of the coral reef as a threat to marine and human life;
3. Assessing the level of importance on protecting the coral reef for marine and human life; and
4. Understanding respondents' view on climate change

An initial pilot test of a questionnaire was conducted to address the first three specific objectives. A passage was included aiming to inform the respondents about climate change and its causes, how it affects coral reefs, and the effects of coral bleaching to marine and human life. Similar statements, referred to as "before" and "after" statements, were used to assess if there might be a change in behavior once people, after having read the passage, were better informed. The data collected through the pilot questionnaire was then statistically analyzed, and additional research was done on the complexity of opinions people have about climate change. Afterwards, changes were made to the questions and passage in order to design the "final" questionnaire, which addresses all specific objectives of the study. Statistical analysis was then conducted in order to determine any significant change in opinion regarding the main research objective.

1.4. DISSERTATION OUTLINE

The dissertation is organized in eight chapters and an appendix. The first chapter discusses the motivation and relevance of the research work, states the objectives, and briefly summarizes the methodological approach. This chapter ends with a brief overview of each of the main chapters.

The second chapter discusses previous studies about awareness of coral bleaching and its media coverage as well as studies on the perceptions of climate change. The topics discussed form ideas to be presented in the passage and questionnaire.

The third chapter discusses the sampling design, the reasoning behind the formation of the questionnaire, and an overview of descriptive and statistical analysis that are carried out.

The fourth chapter begins with a summary of the pilot results, both descriptive and statistical for all respondents. Then, the major changes implemented in the final questionnaire are reviewed with the corresponding reasoning.

The fifth chapter includes one section presenting the descriptive statistics for the first 8 questions, the second section analyzing the “before” and “after” statements for all of the respondents, and the following four sections analyzing the “before” and “after” statements separated in different groups. Within each of these sections, the groups are compared and interpretation of the results are discussed. Main results are presented in Figures and Tables, a complete output and supplementary tables used for interpreting results are located in the appendix.

The sixth chapter first summarizes the statistically significant results with the importance the information holds for organizations aimed to raise awareness of coral bleaching. The second section discusses the limitations and suggestions for future work.

The seventh chapter includes the list of references. The eighth chapter is separated into six appendices with corresponding outputs and tables used in the study.

2. LITERATURE REVIEW

This section contains previous studies from a scientific perspective of coral bleaching, as well as people's perspective and knowledge of both coral bleaching and climate change. By first understanding the delicacy in explaining these issues and aims to clarify any doubts people have on these subjects, a better survey and passage could be created.

2.1. CORAL BLEACHING

An assessment report from the Intergovernmental Panel on Climate Change (IPCC), reported that "mass coral bleaching and mortality, triggered by positive temperature anomalies is the most widespread and conspicuous impact of coral bleaching" (Gatusso, Hoegh-Guldberg & Portner, 2014). The notice of non-local bleaching events occurred during the 1980s, however the first major widespread and severe appearance of coral bleaching in was observed in 1998. This coincided with the warmest year of the century as well as the highest tropical sea surface temperatures recorded until that time ("Early Warning Signs of Global Warming: Coral Reef Bleaching", 2003). Since then, temperatures have continued to break record highs and more bleaching has been reported in shorter periods of time. In a recent study looking at the life of 100 coral reefs from 1980 to 2016, it has been noted that recent short spikes of extreme heat, a result of climate change, are doing more damage to the corals than longer exposure of gradual increase, although in tandem they make it worse. As a result, on average the time between massive bleaching events has been divided by a factor of five. This means that now, on average, there are massive bleaching events approximately every 6 years, far more than previously seen, due to climate change. The coral reefs do not have enough time to recover in such short time periods and therefore are more likely to die (Greshko, 2018).

In 2016, coral bleaching was the worst ever recorded in history for the Great Barrier Reef with 93% of the northern section already bleached and 22% of it dead. Later that year it was reported that almost two thirds of the entire reef had been bleached, raising grave concerns (Lewis & Mallela, 2017). Due to this widespread event, media coverage about coral bleaching increased significantly when compared to that of 2015. While the scientific research on climate change's effects on coral bleaching continues to grow and there are efforts by campaigns to spread the word, there is still little research on the effectiveness of this information and how people react to it. In international surveys 63% of respondents reported knowing at least "some" or "a little" about coral bleaching however only 40% knew that it was the result of global warming. Furthermore, when Americans were asked to describe the current condition of the Great Barrier Reef, 27% were unsure and 40% replied with "good" or "very good" (Swann & Campbell, 2016). This is representative of the lack of complete information people have of this subject and shows scientific based research ought to be included for the respondents to have an informed opinion. One study suggests the importance of the relationship between Australians and the Great Barrier Reef, where appreciating this ecosystem encouraged the feeling to protect it ("Climate change, the Great Barrier Reef and the responses of Australians", 2016). Therefore, the passage should emphasize the importance of coral reef for marine life, human life, and economic stability to build a connection between the respondent and the environmental icon. An effective passage should be written in order to raise awareness and intention to implement action by combining scientific research of coral bleaching to counteract the lack of knowledge of coral bleaching and coral reefs.

"Chasing Coral" is a documentary with more than 500 hours of underwater footage from over 30 countries capturing the process of coral bleaching while explaining the role climate change has on the corals and an explanation of what is to come if we do not take action. Its main mission was to " inspire a new wave of climate change champions in unexpected places" by using coral bleaching as a symbol for climate change, inspire actions for clean energy, and educate leaders about what is happening to our ecosystems. The combination of allowing viewers to experience this in a personal way, going underwater and seeing for themselves, along with detailed explanation of the science behind it including evidence of climate change, has impacted the world greatly even a few months after the documentary was released for the first time. It has been shown in over 60 countries with over 750 screenings[2] to groups of individuals as well as top influencers such as the United Nations, the United States Congress, Google, the World Bank, and more. The success of this documentary to implement action can be seen individually, where one woman threw a waste-free birthday party, as well as larger scale, where environmental organizers showed the film to American students gathering them together to show support at the climate negotiations in Germany. ("2017 Media Impact Festival Case Study: *Chasing Coral",* 2017). The success of this is documentary is a prime example, based on media reviews and stories of individual and group action, of how to express the information about coral bleaching and is important to take into consideration for future campaigns with similar goals.

While no studies were found on directly providing information about coral bleaching and assessing the influence it had on their awareness of the subject and intended action, the limited studies on recent opinions and the impact of the documentary "Chasing Coral" can be useful. Emphasis on an informational passage should be put on climate change's impacts on coral reefs, the scientific research on coral bleaching in general, along with building a connection or importance of the loss of coral reef.

2.2. Climate Change Awareness

Since the main cause of coral bleaching is climate change, opinions regarding this must be discussed. This includes overview of beliefs of the existence and cause of climate change, perceptions of overall threats, and attitudes towards it. While sufficient studies on perceptions and awareness of coral bleaching is lacking, understanding these topics on climate change overall helps better present the passage and explain results.

A 2016 study estimates that 69% of Americans believe that global warming is happening and 14% think the contrary with the rest unsure (Yale Climate Opinion Maps - U.S. 2016). A study in Australia found similar results with 82.8% of respondents believing that global warming is happening and 17.2% who do not (Leviston & Walker 2011). A third study shows that the level of certainty in their belief of whether global warming is happening or not differs, especially in those who do not believe where 47% responded that they are "somewhat sure that it isn't happening", just following 12% of responses saying they are "not at all sure" it is not happening. Another difference in opinion is whether global warming is caused by humans or is just a natural fluctuation in the Earth's climate. This is a surprising concern, as the majority of scientists do concur that global warming is mainly caused by humans and the 2014 U.S. National Climate Assessment stated "the global warming of the past 50 years is primarily due to human activities, predominantly the burning of fossil fuels. Many independent lines of evidence confirm that

[2] As of 2017

human activities are affecting climate in unprecedented ways." ("Climate Change in the American Mind", April 2014).

The above referenced studies reveal the lack the information people have regarding this issue's existence and cause. Most of the respondents trust information given by university scientists, yet one study shows that only 48% of American respondents believe that "[m]ost scientists believe that global warming is happening." ("Yale Climate Opinion Maps - U.S.", 2016). When in fact 97% of scientists have agreed, upon reviewing 12,000 related papers on climate change that, in fact, it is happening. ("Climate Change in the American Mind", April 2014). This may indicate a lack of an effective outlet to provide factual information regarding climate change and its causes.

People report many differing opinions on whether global warming is affecting them or their community negatively to an extreme extent. However there is a strong belief that global warming is currently and will continue to harm plants and animals as well as future generations. The majority of respondents increasingly agree that global warming will affect people other than themselves, (for example, people in developing countries or other people in the United States rather than themselves or their families). Questions were asked regarding illnesses and deaths caused by global warming worldwide where almost half responded to "Don't Know". One study shows that respondents believed that in 20 years if nothing has been done about climate change, there will be many more extreme weather patterns and environmental issues, where 57% of respondents claimed that global warming was already affecting weather in the US. ("Climate Change in the American Mind", April 2014). This further shows that although it may be becoming more obvious that there are abnormal weather patterns, people do not believe it is quite the threat to themselves than it is for other humans or animal life. This can play an important role in whether they choose to act on slowing global warming because they do not feel impacted personally, and they do not have enough information to know what is truly happening in the world and how detrimental climate change is already beginning to be.

Although there are many who believe humans won't change their daily behavior, a majority believe that they will. However they are unsure they can do what is necessary. In addition, a study shows that the most popular feeling for respondents who do not believe in climate change as well as those who do but think it is natural, feel irritated when discussing the topic (Leviston & Walker 2011). This means that any information received about global warming may instantly be discarded, and where knowledge is not learned there is no possibility of intention of action that could be taken. Presenting facts about climate change should be handled delicately.

Actions to slow global warming can include every day activities such as using less water, using less electricity, or using a reusable bag. Other more drastic actions can include buying an electric car or changing to solar power which may not be in the respondent's price range. Another upcoming action that can be done, is signing a petition with a certain number of signatures and aim it towards the government to show support for a concern in hopes that they take it into account and implement a large scale decision. This option should be explored as many people believe that one person cannot make a drastic enough impact to stop global warming, although a majority of people support policies that aim to reduce CO2 and use renewable resources ("Climate Change in the American Mind", April 2014). Many programs use petitions to raise awareness to change a law or to bring attention to an issue. Websites online such as change.org allow you to easily make a petition and send them out over the internet. The

UK even has a part of the governmental website where citizens can create petitions and sign them. Parliament is required to entertain any petition that receives a certain number of signatures.

Since obtaining information is the first step towards the possibility of initiating action, the studies discussed above are concerning and many aspects must be taken into account when conducting a survey regarding coral bleaching. Therefore, a passage is written to inform respondents based on information presented in this chapter. Along with an explanation of coral bleaching, it must be made as clear as possible that climate change is real, it is mainly caused by human activity, and is negatively affecting coral reefs which in turn effects marine life and human life. Emphasis should be put on the urgency of the situation, with supporting facts from scientists and professionals, and building a connection between the respondent and the coral reef to encourage the likelihood that action is taken to save it. By clarifying any doubts and enlightening the reader of this phenomenon of coral bleaching, respondents can make a more informed decision about taking action and effectiveness of the passage can be studied.

3. METHODOLOGY

In order to understand what motives, if any, could changes the intention of people's actions to slow coral bleaching, quantitative research was used. A survey was designed and implemented to collect data based on the research objectives. This section outlines information on selecting a sample, a replica of the questionnaire, how and why the questions are included, and procedures implemented in both descriptive and statistical analysis. Descriptive analysis was used in order to better understand the respondents' knowledge and beliefs in order to best gain information from statistical analysis. Statistical analysis was conducted in order to determine any significant change in opinion for the main problem objective.

3.1. SURVEY DESIGN

3.1.1. Sampling Design

The target population for this survey is any individual over 18 years of age with access to internet who can speak English. There is no limitation as to nationality since climate change affects everyone around the world and initial information regarding opinions of coral bleaching is desired. It is impossible to have an exhaustive list of everyone in the world, in which case there is no sampling frame. However, answers from respondents were bought through Survey Monkey's Contribute Program. The Survey Monkey's: Buying Responses Section, states that "Contribute members take surveys for charity and a chance to win a sweepstakes prize. We believe that by offering these non-cash incentives, we limit problems such as satisficing and encourage respondents to provide honest, thoughtful opinions." In this case, convenience sampling, a non-probabilistic method, is used on the respondents of the Contribute Panel that Survey Monkey provides. Although many studies[3] regarding climate change have sample sizes of 1,000 or more, due to cost restrictions, the sample size is set to a 100. As this is a non-probabilistic sampling method, a specific number of respondents could not be determined based on confidence interval.

Errors can be separated into two main categories: Sampling error and Non-sampling error. Sampling error occurs because the sample is not representative of the entire target population, while non-sampling errors occur because of factors that are independent of the survey plan. The main non-sampling errors in this survey are thought to be non-response and measurement error. For item non-response error, Survey Monkey will automatically exclude surveys that are incomplete and the researcher will exclude surveys after the passage if the respondent chooses "I did not read the passage" since it is necessary to complete and continue the survey. Measurement error is one of the most concerning errors, especially for those who lie in saying they did read the passage when they actually did not. This cannot be known. However, the passage has been limited as much as possible and the respondents are warned beforehand that there is a passage to be read in hopes that they accept this fact, do read it, and respond truthfully. Another measurement error that may occur is due to the sensitivity of the subject and how "politically correct" they should be in helping the environment and therefore lie. For this reason, a statement before the passage is included ensuring that questionnaires are anonymous.

[3] This refers to the many studies mentioned in the Literature Review

3.1.2. Questionaire

A questionnaire containing 19 questions was created using the tool “Survey Monkey”. Survey Monkey allows the researcher to create a survey using their own questions and responses on an online platform. Questions are shown one at a time and responses are instantly recorded without the possibility of returning to a previous question.

An initial pilot test of a questionnaire with 15 questions was conducted based on the same study objectives (except for the fourth study objective of climate change) using similar questions, methodology, and passage as the “final” questionnaire, which is tested in this paper. After analyzing the descriptive statistics and results of statistical testing for the pilot survey, it was concluded that there must have been confusion due to the knowledge of the respondents and/or the questions providing inconclusive results. Additional research was done on the views of climate change and once understanding the complexity of opinions people have about it, changes were made to the questions and passage, and a specific research question was added (Understanding respondents’ view on climate change).

The questionnaire of the pilot survey is presented in Appendix A. A summary of pilot survey results, limitations, and general changes due to these limitations can be seen in “4. Results Pilot” section. The detailed improvements due to limitations of the pilot survey are discussed in detail throughout section “3.1.3. Rational of Questionnaire”.

The following is a replica of the Final Questionnaire conducted on Survey Monkey including the introductory statement, 19 questions, and the informational passage:

This is a research survey for opinions regarding the coral reef used for a Masters Dissertation. Please answer all of the questions to the best of your knowledge and truthfully as the responses to the survey will be anonymous. A passage is included and it is mandatory to read the entire passage in order to continue with the survey. Thank you for your time!

1. What is your gender?

A. Male
B. Female

2. Please select your age group:

A. 18-29

B. 30-44

C. 45-60

D. 60 or over

3. What are some benefits of coral reefs? (can choose more than one)

A. home for marine life

B. mating areas

C. protection

D. feeding areas

4. How many people rely on coral reefs for their livelihoods and food?

A. 50 million

B. 500 million

C. 5 billion

D. I don't know

5. To your best knowledge, how much of the coral reef system will be destroyed by 2050?

A. 30%

B. 60%

C. 90%

D. I don't know

6. Do you specifically do anything to prevent climate change?

A. Yes
B. No

7. I believe that climate change:

A. is happening

B. is not happening

C. I don't know

8. I believe that climate change

A. is caused by humans

B. is a natural fluctuation in Earth's temperature

C. is not happening

D. I don't know

Please select level of agreement to the following statements where 1 is Strongly Disagree, 5 is Somewhat Disagree, 6 is Somewhat Agree and 10 is Strongly Agree:

9. I think that a deterioration of the coral reef is a threat to **marine life**:

Strongly Disagree- 1 2 3 4 5 6 7 8 9 10 -Strongly Agree

10. I think that a deterioration of the coral reef is a threat to **human life**:

Strongly Disagree- 1 2 3 4 5 6 7 8 9 10 -Strongly Agree

11. I think it is important to take action in protecting the coral reef for **marine life**.

Strongly Disagree- 1 2 3 4 5 6 7 8 9 10 -Strongly Agree

12. I think it is important to take action in protecting the coral reef for **human life**.

Strongly Disagree- 1 2 3 4 5 6 7 8 9 10 -Strongly Agree

Please read the **entire** passage and proceed to the next questions:

Coral polyps, which make up coral reefs, are invertebrates that have survived for over 400 million years, where today's corals are anywhere from 5,000-10,000 years old. These invertebrates secrete calcium carbonate to build protective white skeletons which grow to take on beautiful and bright colors which many people know them for thanks to a symbiotic relationship with algae that live within their tissues. This algae provides them with over 90% of their energy to survive and flourishes due to a delicate process, specific to a certain amount of sunlight and temperature of water. EPA (USA Environmental Protection Agency) has calculated an increasing rise in average sea temperature in the last 3 decades along with temporary spikes in temperature due to climate change. Temperature increase of just 1.8 to 3.6 degrees Fahrenheit forces the coral to expel the colorful algae, leaving behind only a white skeleton and the coral without its major food source. The process is known as "coral bleaching" and is the last warning before death. When this happens it affects marine life, human life, and even economies. The world has lost roughly half of its coral reef in the past 30 years and it is predicted that by 2050 more than 90% will die. "This isn't something that's going to happen 100 years from now. We're losing them right now," said marine biologist Julia Baum from Canada's University of Victoria. Coral reefs are home to 25% of marine life with the most biodiversity in the ocean whether they live there or come for other reasons such as feeding and mating, although only covering 1% of the area of the ocean. Without them the number of species will greatly decrease because prey, and even their offspring, have no protection from their predators, leading to likelihood of extinction which causes a crash in the food chain due to entire classes of fish becoming extinct. Fish that for many years have been studied by both scientists and past generations for mere enjoyment can be lost forever, simply a memory or old photos in a science book studied by our children. Over 500 million people around the world depend on these areas of densely packed fish to survive for food alone as well as income, where fisherman and other jobs and industries related to marine life, even tourism, are at risk. Lack of jobs in turn results in a fall in the economic income, first locally and then globally. On top of that, corals can provide protection to coasts, to limit damage due to flooding and structural damage. **Consequently, coral bleaching affects us all in one way or another.** When reviewing 12,000 peer-reviewed papers in the climate science literature, scientists found that of those papers that stated a position on the reality of human-caused global warming, 97% said it is happening (Climate Change in the American Mind – April 2014) confirming that our daily actions are contributing to coral bleaching if we continue to not fight against actions that cause climate change. However, with a few changes in lifestyle or adjustments it is possible to slow this

process and reverse its effects as “Researchers emphasize that there’s still time…to prevent existential damage to the world’s reefs—but only if sweeping action is taken now” (Michael Greshko, National Geographic 2016).

A. I have read this passage
B. I have not read this passage

13. I feel that I have learned more after reading this passage:

Strongly Disagree- 1 2 3 4 5 6 7 8 9 10 -Strongly Agree

14. After reading the passage, I think that coral bleaching is a threat to **marine life**:

Strongly Disagree- 1 2 3 4 5 6 7 8 9 10 -Strongly Agree

15. After reading the passage, I think that coral bleaching is threat to **human life**:

Strongly Disagree- 1 2 3 4 5 6 7 8 9 10 -Strongly Agree

16. I am more likely to adjust something in my lifestyle in order to slow climate change **knowing the effects it has on coral bleaching for <u>marine life</u>:**

Strongly Disagree- 1 2 3 4 5 6 7 8 9 10 -Strongly Agree

17. I am more likely to adjust something in my lifestyle in order to slow climate change **knowing the effects it has on coral bleaching for <u>human life</u>:**

Strongly Disagree- 1 2 3 4 5 6 7 8 9 10 -Strongly Agree

18. After reading this article I would be more likely to sign a petition to raise awareness to encourage lawmakers to implement policies regarding cleaner energy:

Strongly Disagree- 1 2 3 4 5 6 7 8 9 10 -Strongly Agree

19. After reading this article I am more likely to take action by altering daily lifestyle behavior on climate change: (ex: using less water, less electricity, using more renewable energy resources)

Strongly Disagree- 1 2 3 4 5 6 7 8 9 10 -Strongly Agree

3.1.3. Rationale of Questionairre

An introductory passage was included to discuss why the survey was being conducted and that the completion in both reading the passage and answering all questions was mandatory. Questions in this questionnaire were chosen to obtain information about the respondents' knowledge of coral reefs, beliefs in climate change, and opinions on climate change's effect on coral reefs. Also, four similar statements referred to as "before" and "after" statements, are used to assess if there was a change in level of agreement for threat levels for marine and human population as well as level of agreement of the importance and intention of changing behavior after reading an informational passage. Finally, specific situations on how much more likely they are to participate in specific situations against climate change after reading the passage. This section aims to provide insight on the process of formatting and creating the questionnaire including changes made from pilot survey.

The content of the passage separating the "before" and "after" statements was a crucial part of the questionnaire because it provides a variety of information aimed to affect the respondents' levels of agreement to given statements. The passage was written by the author after a great amount of research on coral reefs as well as climate change and then checked by a Marine Biologist for accuracy. The passage includes the major benefits and the importance of coral reefs for marine and human life, information about climate change and coral bleaching, and connects this information to the effect it will have on marine and human life if no action against climate change is taken. As discussed in the Literature review, many people have a lack of true information on whether climate change exists and if it is caused by humans. Therefore, quotes from scientists were included to validate that it is happening and it is in fact mostly caused by humans. Quotes by scientific intellectuals on this subject were included because the same study as mentioned above, show that people trust scientists' opinions the most when compared with other sources (Leviston & Walker, 2011). Quotes emphasizing that climate change it is happening now and not a distant consequence were included because studies showed that people did not believe it is affecting them now but think it will affect future generations. Although many people have indicated

that they believe that it is a problem for animal and plant life now ("Climate Change in the American Mind", April 2014), a connection was made to the effects of coral bleaching for human life regarding basic survival as well as economic consequences, which is another form of survival, and one that people all over the world can relate to. An optimistic ending was added due to the fact that even those who do believe that climate change is caused by humans think that they cannot make a big enough impact and have very low hopeful feelings towards this subject (Leviston & Walker 2011). Graphics were provided after the passage to make the situation more apparent by showing how quickly coral bleaching kills the coral reef and what it actually looks like. This is crucial to build a connection between the respondent and the lives that are affected by a dying coral reef. These are all important points to include in the passage to provide clarification, through trustworthy sources, that our actions directly affect climate change which is now causing coral bleaching so that the respondents feel the urgency to act now in order to protect the coral reef for marine and human life. This resulted in a longer than desired passage, but all information included was necessary to make an informed opinion.

Questions 1 and 2 provide demographic information.

Questions 3, 4, and 5 provide information on whether the respondents know of the importance of coral reefs for marine life, human life, and its deterioration rate before they read these exact facts in the passage. It is important to understand that these questions refer to a group of information that is presented in the passage, in addition to the correct answers asked, as well as connecting their importance to each other. By having a general idea of what the respondent is previously aware of, we can better determine what new information, or on which subject, influenced a change in level of agreement, if one exists. These questions also provide evidence on whether they did or did not learn something in the passage, the importance of this will be discussed later in this section.

Questions 6, 7, and 8 provide information on the respondent's standpoint on climate change. Question 6 provides insight on whether the respondents currently do something to stop climate change. It is impossible to tell whether the respondent answers truthfully, however anonymous answered are insured in hopes to reduce this measurement error. This can be useful for grouping in statistical analysis. Question 7 is very similar to question 8, with the difference being between existence and cause, and may be questioned to remove one of them as it would make the survey shorter. However, as studies show that respondents show uncertainty on their beliefs in climate change ("Climate Change in the American Mind", April 2014) by comparing the two, it may provide a more complete understanding of what the respondent believes. Also, by understanding initial beliefs on climate change, data can be grouped on these beliefs during statistical analysis in order to better determine what information in the passage had an impact on results or on which group.

Statements 9, 10, 11, and 12 are considered "before" statements and after reading the passage compared with 14, 15, 16, and 17, the "after" statements, forming pairs (where 9 was compared with 14, 10 was compared with 15, 11 was compared with 16, and 12 was compared with 17). These statements can be broken into two groups based on information to be assed: 1. Threat and 2. Action, where each one is repeated specifically for marine life and for human life. For the "Threat" statements[4], it hopes to assess whether the respondent sees deterioration, and then referred to afterwards as coral bleaching given that it is a specific type of deterioration, as a threat to marine/human life. Being aware of coral bleaching as a

[4] Threat statement pairs are Q9 & Q14 for marine life, and Q10 & Q15 for human life

threat is seen as agreeing to these statements, because they could read the information in the passage however not agree that it is true, and without this then there would be no push to take action. For the "Action" statements[5], there is more variability in the wording from before and after, but the main concept remains the same. It assesses level of importance for personal action to protect the coral reef but with emphasis on relating it to the information in the passage, including coral bleaching as a deterioration, and stopping climate change as the personal action due to the fact that this is the cause of coral bleaching. The statements after the passage specify the likelihood to adjust their lifestyle based on information in the passage to better understand if they do intend to do something. This was important to include to best interpret results because a study showed that there is a gap between awareness and action (McKercher, Prideaux, Cheung, & Law, 2010). This emphasizes the importance of the information in the passage, to increase awareness across different uncertainties and use this as motivation to take action while directly questioning the intention of changed behavior. The "before" and "after" statements almost mimic each other's wording in aims to control variation with the "after" statements only providing more detail relevant to the passage and study objectives.

Data analysis was done on these statements to determine significant differences in level of agreement and discussed in Statistical analysis section. The aim of these questions was to understand the level of agreement towards coral deterioration for both marine and human life as well as if they are more likelihood to change behavior for either one. For each question the respondents can choose their level of agreement on a 10 point Likert scale with anchors on each side, 1 being Strongly Disagree to 10 being Strongly Agree; in this case responses 1-5 represents a level of disagreement and 6-10 represents a level of agreement. By choosing a 10 point scale instead of a lower point scale, such as 4, the respondent has a broader range of agreement to choose from which is useful so that the respondent has options closer to what they truly believe and we can determine even a small difference in opinion before and after the passage. The 10 point scale involves no neutral response, as to say the respondent is forced to choose between disagreeing and agreeing, increasing in how strongly they feel the closer the respondent chooses to the anchors. This was chosen over a scale allowing a neutral option, such as an 11 point scale, based on the details of the study. A neutral response can be seen as a "dumping ground" and may not represent the midpoint as a "neither agree nor disagree" or "neutral" response (Worcester, Burns, Kulas, 2008). This "dumping ground" may be due to uncertainty in facts of climate change as well as the confidence that they have in their beliefs about it ("Climate Change in the American Mind", April 2014) or the respondents "may use the midpoint to avoid reporting what they see as a socially acceptable answer" (Johns, 2010). The main data analysis includes whether there is a change in agreement level to the statements, however if there is a significant change in agreement and the majority changes to a neutral response after reading the passage, then it is difficult to determine how the passage impacted the respondent in gaining meaningful results as it could be multiple different options, and not a neutral response. Opinions on climate change can be somewhat uncertain, but because the passage provides facts that aim to clarify this, it is useful to force the respondents to make an opinion based on the knowledge they knew initially and compare it to the knowledge they have learned.

After reading the passage, the respondent will have qualifying questions for the statistical analysis which include asking if they did or did not read the passage. If they didn't read it, they will not be considered for descriptive or statistical analysis because there is no knowledge learned to influence their

[5] Action statement pairs are Q11 &Q16 for marine life and Q12 & Q17 for human life

opinion. Question 13 provides information on whether the respondents feel that they have learned more using a 10 point Linkert scale where 1 is Strongly Disagree and 10 is Strongly Agree, maintaining directions given before the passage and to continue the survey with the ease. If a respondent chooses some level of disagreement, a number between 1 and 5, their answers to 3, 4, and 5 are reviewed. In this case, if the respondent answered those questions correctly and still disagrees on some level, then they will be disqualified from the survey as they did not learn anything.

Statements 18 and 19 are additional information on if a person would be more likely to sign a petition or alter their lifestyle and offer examples for altering lifestyle, since some studies suggested people didn't know how they could help (Leviston & Walker 2011). A 10 point Linkert scale is used on these questions to allow variation in the answer closer to what they truly believe and to continue with the ease of the survey. This points out two ways of action, action by yourself in daily life and action to encourage response on a larger political scale. This could be even more interesting for future campaigns. As seen in previous studies even those who do not believe that climate change is caused by humans believe that governments have a responsibility in changing it (Climate Change in the American Mind – April 2014), a contradicting statement but can provide some insight on what action is most likely to take place if they intend to change their behavior. These questions can also justify or explain results.

While the questions used show importance to the objectives, the format and wording were considered as well. The use of the word "alter" was specifically used against the word "change" to not make the effort seem so extreme in the after statements. The term "climate change" was used instead of "global warming" as a study showed that there was a higher level of belief that climate change is happening rather than global warming (Schuldt, Konrath, & Schwarz, 2011). In this case, it was presented in the passage to better influence the opinions of respondents as well as throughout the survey. This is appropriate as well as when reviewing the definition of climate change from NASA, as it includes the increased temperature trends predominately caused by humans burning fossil fuels as well as irregular heat waves. These minor changes in wording were taken into consideration in order to best limit variation of outside factors, including emotions that may arise when reading the questionnaire and influence opinions that cannot be calculated.

3.1.4. Cleaning, Preparing, and Exporting Data

Once all 100 questionnaires were completed, all responses were uploaded into SPSS and no transformation of the responses were necessary. Questionnaires of those who selected "I did not read the passage" were deleted. Those who answered to some level of disagreement on "I feel that I have learned more after reading this passage" were selected and based on whether they answered incorrectly to questions 3, 4, or 5 were left in the sample based on the fact that they did learn from the passage. After this, the descriptive and statistical analysis was proceeded in SPSS.

3.2 DATA ANALYSIS

3.2.1 Descriptive Research

Descriptive research is used throughout the study to gain an initial understanding as well as interpret results. First, questions 1-8 deal with categorical variables and therfore are shown by frequencies and/or percentages for all respondents in tables, pie charts, or bar charts. Groups that will be

analyzed statistically are outlined in the first section of “5.1. Descriptive Overview”. The following five sections focus on the same “before” and “after” statements, first for all of the respondents as well as separated by groups. Boxplots for these “before” and “after” statements are presented for all respondents as well as each group to gain an initial understanding of differences and changes. Throughout the sections, references are made to questions 1-8, however tables are referenced in the Appendix. Bar charts or boxplots are presented for spread of agreement level for statements 18 and 19.

3.2.2. Mann Whitney U Test

Mann-Whitney U test is a non-parametric test that is used to test whether two sample medians are equal or not. As it is non-parametric, it can be used to compare two independent nominal groups when the dependent variable is not normally distributed, at least of ordinal scale, and observations in the groups do not need to be equal. The distribution of both groups must also be compared to determine whether they are similar or different in shape in order to interpret the results accordingly (“Conduct and Interpret a Mann-Whitney U Test”). This is tested on the “before”. In the case that the two distributions have the same distribution, the median can be compared under the following hypothesis:

H_0: the medians of the two groups are equal

H_A: the medians of the two groups are not equal

A significance level of 5% or less will be used to reject the null hypothesis, unless stated otherwise. This is useful to determine whether it is valuable for the sample to be separated into groups as well as interpret differences in changed levels of agreement for one group but not another.

3.2.3. Kruskal Wallis Test

The Kruskal Wallis Test uses one nominal variable, the grouping variable, and a measurement variable to determine if the mean rank for groups are the same. This is tested on the “before” statements. The measured observations are transformed into overall ranked measurements for the entire sample, from 1 being the smallest, 2 the second smallest, and so on; then the mean ranks are taken for each group (McDonald, n.d.). When the groups have differently shaped distributions or variances, the Kruskal Wallis tests makes no assumption and uses the following hypothesis:

H_0: The mean ranks of the groups are the same

H_A: The mean ranks of the groups are not the same

If the null hypothesis is rejected, based on a 5% significance level unless otherwise stated, then at least one mean ranks differ but it is unsure which group or groups differ from each other. This is used to understand whether the groups should be separated into groups as well as interpret differences in changed levels of agreement for one group but not another.

3.2.4. Wilcoxon Sign Rank Test

A Wilcoxon Sign Rank Test is a non-parametric statistical test that uses ordinal data to compare two sets of scores from the same participants using the ranks and magnitude of differences. The four paired “before” and “after” statements are used to determine if the information in the passage had a significant difference in level of agreement. The assumptions of the Wilcoxon Sign Rank Test are the use

of ordinal data, that the data are paired, and that the samples were chosen randomly. When the non-zero differences are large (n>10), then the W statistic approximates a normal distribution under the following hypothesis:

H_0: The difference between the medians of the two levels of agreement is zero

H_A: The difference between the medians of the two levels of agreement is not zero

A significance level of 5% or less will be used to reject the null hypothesis, unless otherwise stated. This test is conducted for all respondents as well as subgroups of the respondents, in order to compare results and interpret other factors that may influence a difference in level of agreement.

4. RESULTS OF PILOT

A pilot test was conducted with the same study objective, to understand awareness of coral bleaching and intention to change behavior based on additional information, however emphasis on climate change was not as prominent as it was for the final questionnaire, both in the questions as well as the passage. Below is a short summary of the exploratory analysis, explaining the background of the respondents, and statistical analysis, conducting a Wilcoxon Sign Rank Test to determine if there was a change in level of agreement to statements before and after reading an informational passage. Finally, a short summary is presented on the limitations of the analysis and how the Final Questionnaire was improved based on these discoveries.

The questions and responses were uploaded to Survey Monkey and shared through the authors social media accounts by providing a link to the survey. 136 surveys were collected, however 23 respondents answered that they had not read the passage and therefore were not considered in the study. The 113 who responded that they had read the passage were then analyzed. The questions in the survey can be seen in Appendix A.

4.1. EXPLORATORY ANALYSIS

This sample had slightly more females (56.6%) than males (43.4%). The largest age group were those 50 or over (40.7%), followed by 18-29 (30.1%), 30-39 (18.6%), and the smallest being 40-49 (10.6%). The majority (83.2%) were aware of some kind of deterioration of the coral reef, but it is unsure what they are referring to. When asked "Do you do anything now specifically to prevent global warming?" The majority responded Yes (67.3%) and the rest No (32.7%).

The charts below show the percentage of respondents who answered either Strongly Disagree, Disagree, Agree, or Strongly Agree, to the "before" and "after" statements:

Table 1: Percentage of respondents for Q4 and Q11 Pilot Test

	Q11: After	Q4: Before
Disagree	1.8%	-
Agree	23.9%	26.5%
Strongly Agree	74.3%	73.5%
Total	100.0%	100.0%

Table 2: Percentage of respondents for Q5 and Q12 Pilot Test

	Q12: After	Q5: Before
Disagree	3.5%	8.8%
Agree	37.2%	38.1%
Strongly Agree	59.3%	53.1%
Total	100.0%	100.0%

Table 1 shows that the majority "Strongly Agree" that deterioration/coral bleaching is a threat to marine life before (73.5%) as well as after (74.3%) however no major difference can be seen. Table 2 shows that the majority "Strongly Agree" that deterioration/coral bleaching is a threat to human life both before (53.1%), and increasing after (59.3%).

Table 3: Percentage of respondents for Q6 and Q13 Pilot Test

	Q13: After	Q6: Before
Disagree	3.5%	8.8%
Agree	37.2%	40.7%
Strongly Agree	59.3%	50.4%
Total	100.0%	100.0%

Table 4: Percentage of respondents for Q7 and Q14 Pilot Test

	Q14:After	Q7: Before
Strongly Disagree	-	0.9%
Disagree	7.1%	8.8%
Agree	48.7%	38.9%
Strongly Agree	44.2%	51.3%
Total	100.0%	100.0%

Table 3 shows the agreement level for the statement "I am more likely to change something in my lifestyle, make an additional change, or feel stronger about what I am already doing, in order to stop global warming knowing the effects it has on coral bleaching for marine life" has the a slight increase after reading the passage (59.3%) than before (50.4%). Table 4 shows the agreement level for the statement "I am more likely to change something in my lifestyle, make an additional change, or feel stronger about what I am already doing, in order to stop global warming knowing the effects it has on coral bleaching for human life" is the only statement where someone answered to "Strongly Disagree" (.9%) however after the passage they chose differently. There is an increase proportion of those responding as "Agree" after (48.7%), however a decrease in proportion of "Strongly Agree" from before (51.3%) to after (44.2%).

Overall there seems to be no major change in proportions, anything greater than 10%, of agreement level before and after reading the passage, however when asked to respond to the statement "I feel that I have become more informed regarding the effects of coral bleaching after reading this passage" 55.8% said they "Strongly Agree" and 44.2% said they "Agree", meaning they felt that they did learn more.

4.2. WILCOXON SIGN RANK TEST

A Wilcoxon Sign Rank Test is conducted on the four "before" and "after" statements to determine whether there is a significant difference in level of agreement. In order to proceed with this test, these values were converted into numbers where "Strongly Disagree" =1, "Disagree"=2, "Agree"=3, and "Strongly Agree"=4. The following output from SPSS, Table 5, is shown below:

Table 5: WSRT Sum of Ranks for Pilot Test

		N	Mean Rank	Sum of Ranks
Q11: After reading the passage, I think that coral bleaching is a threat to marine life: - **Q4**: I think that a deterioration of the coral reef is a threat to marine life:	Negative Ranks	12	12.00	144.00
	Positive Ranks	11	12.00	132.00
	Ties	90		
	Total	113		

Q12: After reading the passage, I think that coral bleaching is threat to human life: - **Q5:** I think that a deterioration of the coral reef is a threat to human life:	Negative Ranks	14	20.00	280.00
	Positive Ranks	26	20.77	540.00
	Ties	73		
	Total	113		
Q13: I am more likely to change something in my lifestyle, make an additional change, or feel stronger about what I am already doing, in order to stop global warming knowing the effects it has on coral bleaching for marine life: - **Q6:**I think it is important that I take action in protecting the deterioration of the coral reef for marine life.	Negative Ranks	33	28.86	952.50
	Positive Ranks	24	29.19	700.50
	Ties	56		
	Total	113		
Q14: I am more likely to change something in my lifestyle, make an additional change, or feel stronger about what I am already doing, in order to stop global warming knowing the effects it has on coral bleaching for human life: - **Q7:** I think it is important to take action in protecting the deterioration of the coral reef for human life.	Negative Ranks	30	24.85	745.50
	Positive Ranks	22	28.75	632.50
	Ties	61		
	Total	113		

A Negative rank means that the respondent decreased their agreement level after the passage, while a positive rank means that that the respondent increased their level of agreement, after the passage. This does not necessarily mean that the respondent changed from agreement to disagreement, but may indicate that there was a change in how strongly they agree or disagree. A tied rank signifies no change in level of agreement.

When analyzing the first two statements' number of ranks, there is confusion because the respondents agreed to learn more after reading the passage, yet there is still a number of people who lower their agreement level that coral bleaching is a threat to marine life (n=12) and human life (n=24). When given scientific facts in a passage, with almost the exact same question, there should only be ties

or more agreement, when considering such a straightforward and few number of responses to choose from.

This lead the author to ask what these negative ranks could be due to, as coral bleaching is in fact the leading cause of coral reefs deteriorating, it was concluded that further information on people's opinions regarding climate change should be studied. By having initial confusion on how the respondents viewed climate change due to negative ranks in the threat of coral bleaching for marine and human life, this could impact the interpretation of results for action and posed the main problem for this analysis. For statements regarding whether action would be taken for marine and human life, there are more negative ranks than positive; this also may be an effect of respondent's views on climate change. Another important factor is due to the large number of tied ranks in all of the statements, this may be due to a lack of important information in the passage, either due to climate change or effects of coral bleaching, or not enough available variation in responses. The final statistical significance test was conducted to see if there are any significant changes in opinion after reading the passage. Table 6 shows the results of the Wilcoxon sign rank test for each comparison.

Table 6: WSRT Test Statistics for Pilot Test

	Q11-Q4	Q12-Q5	Q13-Q6	Q14-Q7
Z	-.209	-1.982	-1.133	-.568
p-value	.835	.047	.257	.570

The only significant result is the before and after statement pertaining to whether deterioration/coral bleaching is a threat to human life (Q12-Q5, p=.047). This suggests that the information in the passage impacted their level of agreement with 26 respondents agreeing more. However, this new perceived threat did not provide significant evidence that the respondents impact their action for human life (Q14-Q7, p=.570). There is no evidence that the passage had any impact on level of agreement for statements regarding marine life.

4.3. CONCLUSION OF PILOT STUDY

With the added confusion on how respondents can agree less when receiving facts, looking at the negative ranks, further research was conducted in all aspects to better understand these results. It was then understood that opinions of climate change were complex and uncertain, both in existence and cause. This is surprising as it was assumed, due to great amount of scientific evidence which can be easily accessed, that people understood the cause and existence of climate change and at least general knowledge its effects of increasing global temperatures. Another interesting fact was that a majority of the respondents are aware of a deterioration of the coral reefs, however it is unsure what they think it is caused by. This information as well as limitations seen in the pilot survey were used in altering and enhancing the Final Questionnaire.

Changes to the Introduction and Literature review after this survey included information about climate change. The main objective and study objective now included an emphasis on understanding respondents view on climate change and what information could be gained. Literature review included information on previous studies researching how people view climate change, the cause of it, whether it exists, who or what is affected by climate change, who holds most responsibility on climate change, and more. Most changes were made in the Methodology Section, and although specifics were given in

“Rational of Questionnaire”, the passage below explains the major limitations that the Pilot Survey had which influenced these changes.

First, although respondents could answer whether they had or had not learned information in the pilot survey, it is unsure what exactly they learned. Therefore, questions about coral reefs were added in the Final Questionnaire before the passage to better understand what exactly they would learn in the passage. Second, the Pilot survey only asked whether the respondents do anything to prevent climate change but not their beliefs. Therefore, questions were asked to understand their view on the existence and the cause of climate change before receiving facts in the passage. These questions would help better interpret final results in the analysis section. Third, the passage in the Final Questionnaire took information presented in the Literature review to better explain and present climate change. It also included correct answers to the questions mentioned above, on what they would learn exactly, as well as additional information relating to those subjects. Fourth, while the point initially was to gain an easier understanding of how they felt based off of simply disagree and agree using a 4 point Likert scale, there was not much variation in responses and it proved difficult in detecting a change in level of agreement. Therefore, the Final Questionnaire increased the options for level of agreement, using a Likert scale of 10 rather than 4. Lastly, while more questions were added, questions asking about whether the respondent is aware of deterioration and where they get most of their news from were excluded from the final questionnaire in order to shorten it, as they did not add significant value to interpret the results.

5. FINAL RESULTS

The aim of this study is to understand if people who are more aware of causes and effects of coral bleaching, due to climate change, are more likely to implement an action in their own life to slow climate change and for what motive. First, descriptive statistics of questions 1-8 are provided to gain initial information about the demographics, knowledge, and beliefs of the respondents and outline groups that will be studied. Then, the "before" and "after" statements are analyzed both overall as well as by groups. These sections include descriptive statistics of the "before" and "after" statements, statistical analysis, and interpretation of the results found.

5.1. DESCRIPTIVE OVERVIEW

100 completed final questionnaires were collected. Out of the 100, 5 respondents admitted to not reading the passage[6] and therefore were omitted from the analysis. 6 respondents answered in some level of disagreement on whether they felt they learned more after reading the passage[7]. However, reviewing their answers to question 3, 4, and 5, which tested their knowledge about coral reefs, all respondents answered incorrectly on at least one of the questions. This proves that they in fact did learn at least one thing and therefore were included in the study. The following section outlines information collected from the 95 respondents on the first 8 question which were studied to gain demographics, knowledge of coral reefs, and beliefs on climate change.

Figure 1 and 2 show the proportions of respondents by gender and age. The sample consists of a slightly higher proportion of females (56.8%) than males (43.2%). The sample consists of similar proportions for the three different age groups of "18-29", "30-44", and "45-60", ranging between 20.0% and 25.0%; however, those aged over 60 years of age make up a larger proportion of 35.8% of the sample. Both Gender and Age are used as groups to compare differences between the "before" and "after" statements.

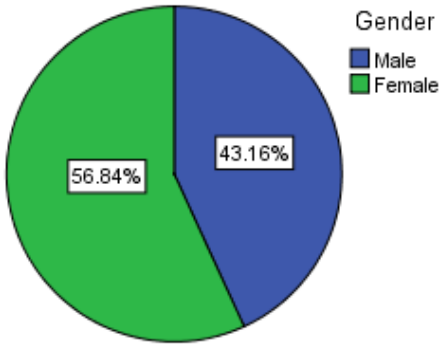

Figure 1: Gender

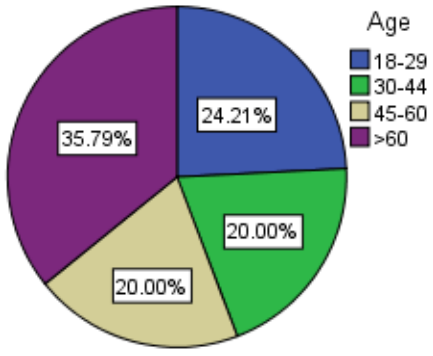

Figure 2: Age

Three questions were asked in order to understand how much the respondents knew about benefits of the coral reef for marine and human life as well as rate of destruction that the coral reef

[6] Collected from a question placed at the end of the passage in Survey Monkey, no number was assigned to this
[7] Collected from question 13, where responses "1"-"5" represented some level of disagreement

currently faces, before reading the passage. The tables below show the count and proportion of responses for each question.

Table 7: Count and Percentage of Q3

Q3: What are some benefits of the coral reef? (Please select all that apply)		
	Count	Percentage
A: Home for marine life	89	93.70%
B: Mating Areas	68	71.60%
C: Protection of shore	73	76.80%
D: Feeding areas	72	75.80%

Table 8: Count and Percentage of Q4

Q4: How many people rely on coral reefs for their livelihoods and food?		
	Count	Percentage
A: 50 million	13	13.70%
B: 500 million	13	13.70%
C: 5 billion	6	6.30%
D: I don't know	63	6.30%

Table 9: Count and Percentage of Q5

To your best knowledge, how much of the coral reef system will be destroyed by 2050?		
	Count	Percentage
A: 30%	16	16.80%
B: 60%	20	21.10%
C: 90%	30	31.60%
D: I don't know	29	30.50%

Table 7 shows responses regarding benefits of the coral reef; the most known benefit was “home for marine life” (93.7%) while the least known benefit was “mating areas ” (71.6%). All possibilities given for this question were benefits of the coral reef with the first, second, and fourth responses benefiting marine life. Table 8 shows that the majority of the respondents (66.3%) do not know how many people around the world rely on coral reefs for their livelihood and food, when in fact only a small percentage (13.0%) correctly know that 500 million do. Table 9 shows that roughly the same amount of respondents answered correctly to the proportion of the coral reef system that will be destroyed by 2050 (31.6%) as those who do not know (30.5%).

Three questions were asked in order to understand the respondents' views on climate change before reading the passage. The tables below show the counts and proportions of the chosen responses for each question.

Table 10: Count and Percentage of Q6

Q6: Do you specifically do anything to stop climate change?		
	Count	Percentage
Yes	60	63.20%
No	35	36.80%
Total	95	100.00%

Table 11: Count and Percentage of Q7

Q7: I believe that climate change:		
	Count	Percentage
is happening	77	81.10%
is not happening	11	11.60%
I don't know	7	7.40%
Total	95	100.00%

Table 12: Count and Percentage of Q8

Q8: I believe that climate change:		
	Count	Percentage
is caused by humans	64	67.40%
is a natural fluctuation in Earth's temperature	21	22.10%
is not happening	5	5.30%
I don't know	5	5.30%
Total	95	100.00%

While the majority separately respond to taking action against climate change (63.2%), that climate change is happening (81.1%), and that climate change is caused by humans (67.4%), below is a more in depth look of how responses show varying beliefs.

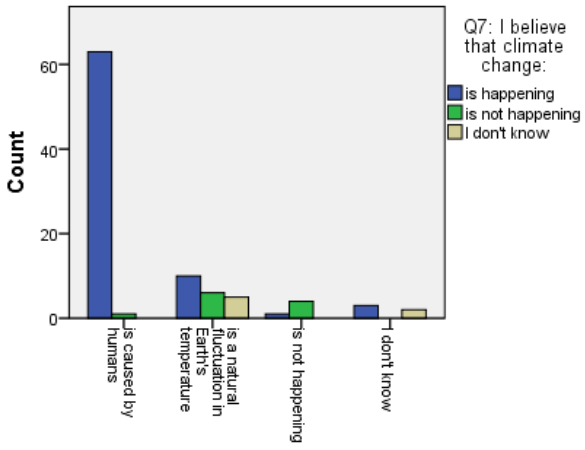

Figure 3: Clustered bar chart of Q8 by Q7

Figure 3 shows the groups of responses in question 7, which refers to the existence of climate change, that make up the responses in question 8, which refers to the beliefs on whether their actions cause climate change. The majority (66.32%) of all respondents realize that climate change is happening now and know that it is caused by humans, while other respondents have a differing belief of the existence of climate change. Those who believe that climate change is a natural fluctuation in Earth's temperatures, have the most varied responses previously answering in all three categories about its existence. It is difficult to assess what each group truly believes, whether they notice a change in climate patterns but are unaware of the causes of it, are not aware of it (leaving there to be no cause for anything), or just simply confused on the definition of climate change. All, but one individual, who believe that climate change is caused by humans know that it is happening now, sharing the same beliefs as the majority of scientists, while others have differing beliefs of cause and therefore are not accountable for their actions. Therefore, responses to Question 8 best represents those who are aware of the true cause and existence of climate change versus those who are mistaken in one way or another, and will be used for further statistical analysis, rather than responses to Question 7. Two groups will be comprised of those who believe that climate change is caused by humans and those who answered that it "is a natural fluctuation in earth's temperature", "is not happening", or "I don't know". Essentially, the first group, of 64 respondents, is aware that their actions affect the climate and therefore take responsibility for their actions, and will be referred to as "Take responsibility". The other 31 respondents do not believe that their actions have any impact on the climate and will be referred to as "Do not take responsibility".

Figure 4 shows the groups of responses in question 8, which refers to the cause of climate change, that make up the responses in question 6, whether or not they specifically do anything to stop climate change. It would seem that only those who believe that their actions affect climate change respond "yes", but again, we can see uncertainty in their beliefs where respondents believing that it is natural (n=11) and those who are unsure of the cause (n=2) responded that they do actively do something to stop climate change. These groups are used for further statistical analysis where the 60 respondents who responded "yes" are referred to as "Active" and the 35 respondents who responded "no" are referred to as "Not Active" (n=35).

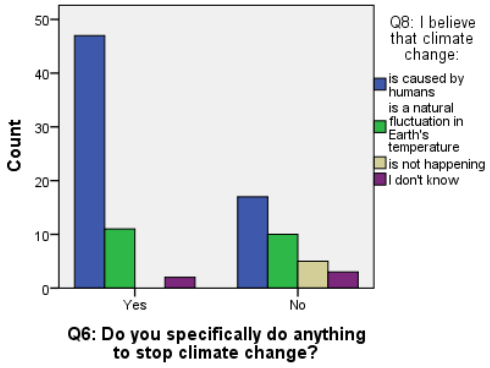

Figure 4: Clustered bar chart of Q8 and Q6

Finally, Figure 5 shows the count of level agreement to the statement "I feel that I have learned more after reading this passage". The most chosen response to this statement was "Strongly Agree" with

34 people choosing this, while 89 respondents in total agreed on some level that they did learn more, answering 6 or higher.

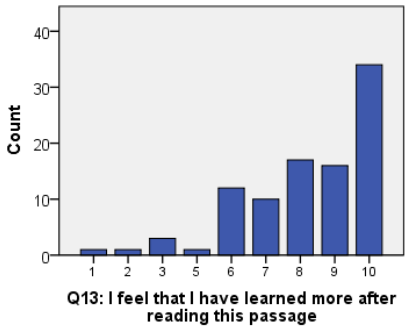

Figure 5: Bar Chart of Q13

According to these results, there was information that was previously unknown or uncertain that the passage effectively covered. However, this alone does not give insight into whether this newly learned and/or confirmed information raised awareness of threat of coral bleaching. For this reason, the “before” and “after” statements are studied.

5.2. ALL RESPONDENTS

5.2.1. Descriptive Statistics

Figure 6 shows the boxplots for the “before” and “after” statements for all 95 respondents. For statements regarding the threat of coral bleaching for marine life (Q9 and Q14) as well as likelihood to take action against coral bleaching for marine life (Q11 and Q16), there seem to be no changes in median or distribution of the responses after reading the passage. However, for statements regarding the threat of coral bleaching for human life (Q10 and Q15) there is an increase in median and less varied interquartile range. For the statement regarding likelihood to take action against coral bleaching for human life (Q12 and Q17) there is also an increase in median, however responses seem to vary more after reading the passage.

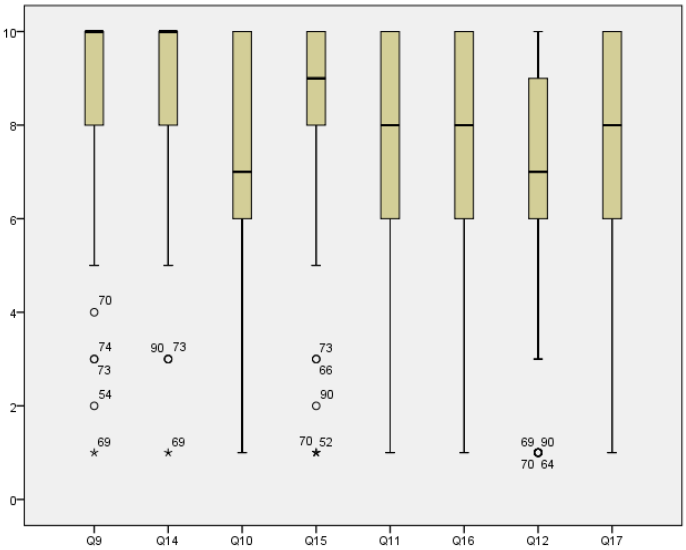

Figure 6: "Before" and "After" Boxplots for "All"

5.2.2. Wilcoxon Sign Rank Test

The aim of this study is to determine if more aware people are more likely to take action against the effects of coral bleaching and for what motive. Therefore, the Wilcoxon Sign Rank test was conducted to determine whether there is evidence of significant differences in the level of agreement for the "before" and "after" statements for all of the respondents (n=95).

Results in Table 13 shows that there is evidence of significant differences in the level of agreement before and after the passage regarding the perception of threat to human life caused by the deterioration of the coral reef (Q10 and Q15; p-value = 0.000). There is also evidence of significant differences regarding taking action in protecting the coral reef for human life (Q12 and Q17; p-value = 0.012). According to the descriptive analysis and table 14, these results indicate that there were significant increases in the medians of both statements regarding human life. On the other hand, as expected from the descriptive analysis, there is no evidence of significant differences for both analogous questions referring to marine life (Q9 and Q14; Q11 and Q16), with a significance level of 5%.

Table 13: WSRT Test Statistics for "All"

	Q9 and Q14	Q11 and Q16	Q10 and Q15	Q12 and Q17
Z	-0.059	-0.943	-4.920	-2.526
p-value	0.953	0.345	0.000	0.012

Table 14: "After" Medians for "All"

	Median	*+/-*
Q14	10	0
Q16	8	0
Q15	9	+2
Q17	8	+1

Although there are significant increases in median level of agreement for statements regarding human life, the threat of a deteriorating coral reef is slightly less important than that for marine life still after reading the passage. However when considering taking action to protect the coral reef, respondents after the passage have the same level of agreement to action against climate change for marine and human life.

It is not surprising that there was no evidence of significant differences for the threat of marine life because descriptive overview analysis showed that the majority knew the benefits of coral reef for marine life[8] and studies show that respondents believe that climate change is affecting plant and animal life right now. Also, the lack of knowledge of the importance of coral reefs for mankind[9] allowed information to be gained in the passage, increasing awareness of the threat of coral bleaching and

[8] Question 3, Table 7
[9] Question 4, Table 8

likelihood to take action to protect it. Therefore, this suggests that increasing knowledge of effects of coral bleaching for human life may be important to increase likelihood to act against climate change to save the coral reef where knowledge about impacts of a dying coral reef would have for marine life is already known.

While significant differences before and after the passage were discussed in this section for the responses overall, comparing groups that make up the respondents can provide further insight to impacts of the passage for different groups of people.

5.3. "TAKE RESPONSIBILITY" VS "DO NOT TAKE RESPONSIBILITY"

5.3.1. Descriptive

The respondents are separated into two groups based on their beliefs of cause of climate change, "Take responsibility" and "Do not take responsibility". As discussed in the descriptive overview analysis regarding Question 8, the "Take responsibility" consists of 64 respondents who believe that climate change is caused by humans, while "Do not take responsibility" consists of 31 respondents who do not believe that their actions effect climate change. Figure 7 shows the boxplots for the "before" and "after" statements to gain an initial understanding of each group. "Take responsibility" have higher medians and interquartile ranges for all "before" as well as "after" statements when compared to "Do not take responsibility". An increase in median can be seen for both groups for perception of threat to human life caused by the deterioration of the coral reef (Q10 and Q15), however "Take Responsibility" responses vary less after reading the passage where "Do not take responsibility" responses vary more. After reading the passage, "Take Responsibility" increases their median and inner quartile range regarding taking action in protecting the coral reef for human life (Q12 and Q17) while "Do not take responsibility" shows no change. According to medians after reading the passage, the perceived threat of coral bleaching and likelihood to take action is the same for marine and human life, for each separate group.

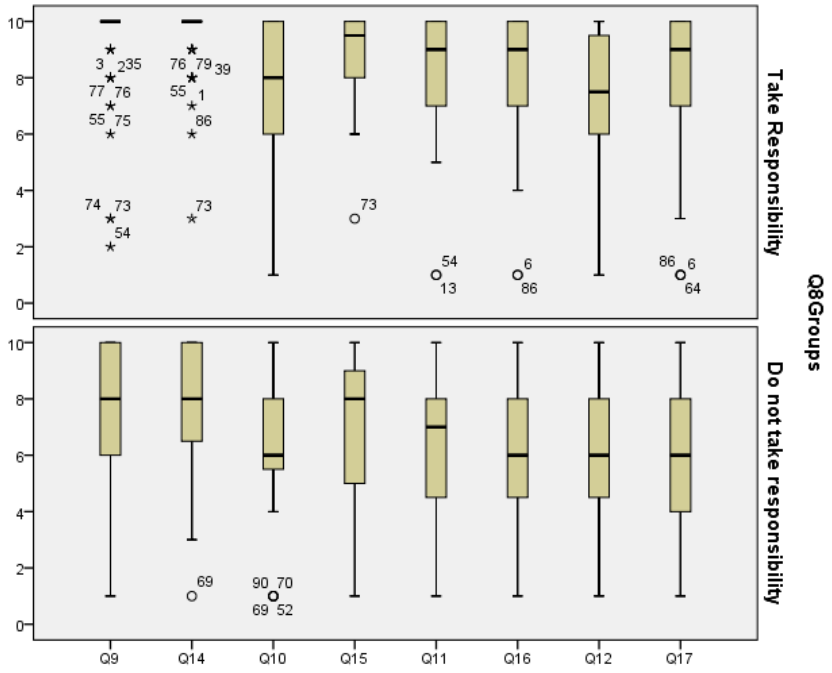

Figure 7: "Before" and "After" boxplots for "TR" and "DTR"

5.3.2. Statistical

5.3.2.1. Mann Whitney U

A Mann Whitney U test is conducted on all four "before" statements to determine if the median levels of agreement for the two groups, "Take responsibility" and "Do not take responsibility", are significantly different. Results in Table 15 show that there is evidence of significant differences in median level of agreement between "Take Responsibility" and "Do not take responsibility" for all four "before" statements at a significance level of 5%. According to Table 16, and descriptive analysis, these results indicate that "Take Responsibility" respondents have a higher median than "Do not take responsibility" respondents.

Table 15: MWU Test Statistics for "DTR" and "TR"

	Q9	Q10	Q11	Q12
Z	-3.893	-2.273	-3.565	-1.972
p-value	0.000	0.023	0.000	0.049

Table 16: "Before" medians for "DTR" and "TR"

	Q9	Q10	Q11	Q12
Do not take responsibility	8	6	7	6
Take responsibility	10	8	9	7

Reasons for separating the respondents into two groups is due to their responses to beliefs in climate change before the passage, and the significant evidence of difference in medians for the "before" statements between the groups further justifies this separation. "Take responsibility" are more informed about the cause of climate change, but also seem to be more informed about the urgency of the climate change's impact on coral reefs. This can be seen in responses to question 5, which asks about the percentage of coral reef system that will be destroyed by 2050, where 42.2% of "Take Responsibility" respondents knew that 90% would be destroyed by 2050; however only 9.7% of "Do not take responsibility" were aware of this (See Appendix C, Table 3). Already we can see that enhanced knowledge and awareness of issues caused by climate change even before the passage, leads to higher level of agreement to the threat of coral bleaching and personal importance to take action for both marine and human life compared to "Do not take responsibility". By separating them into more similar groups, additional tests can be conducted in order to gain more useful interpretations based on each group.

5.3.2.2. Wilcoxon Sign Rank Test

The aim of the passage was to inform the respondents about climate change and its causes, how it affects coral reefs, and the effects of coral bleaching to marine and human life. By separating the respondents into two groups, "Take Responsibility" and "Do not take responsibility", we know what each group has the potential of understanding, and accepting as true, when reading the passage. The respondents in "Take Responsibility" already recognize that their actions have consequences for climate

change, and therefore information about coral bleaching and its effects for both marine and human life may be new information that could change their level of agreement to the “after” statements. “Do not take responsibility” respondents will also be presented with this information, however they must first be convinced by the facts that climate change is happening and that it is caused by humans.

A Wilcoxon Sign Rank test is conducted for all of the “before” and “after” statements for the two groups separately, “Take Responsibility” and “Do not take responsibility”, in order to determine if there is evidence of significant difference in the level of agreement. The results of the two groups for the same “before” and “after” statements in a total of 8 tests, first discussing statements for marine life followed by human life. The results are compared and analyzed to discuss the effectiveness of the information in the passage in raising awareness and encouraging action.

Results in table 17 shows that there is no evidence in significant differences in level of agreement before and after the passage regarding the perception of threat to marine life caused by deterioration of coral bleaching (Q9 and Q14; “Do not take responsibility p-value=.565 and “Take responsibility” p-value=.617) as well as taking action in protecting coral reef for marine life (Q11 and Q16; “Do not take responsibility p-value=.439 and “Take responsibility” p-value=.713) for either group. In which case, no significant change can be seen in medians, as shown in table 18, as expected in descriptive analysis.

Table 17: Marine life WSRT Test Statistics for "DTR" and "TR"

	Q9 and Q14		**Q11 and Q16**	
	Do not take responsibility	*Take Responsibility*	*Do not take responsibility*	*Take responsibility*
Z	-0.575	-0.500	-0.774	-0.381
p-value	0.565	0.617	0.439	0.703

Table 18: Marine life "After" Medians for "DTR" and "TR"

	Do not take responsibility		*Take responsibility*	
	Median	**+/-**	**Median**	**+/-**
Q14	8	0	10	0
Q16	6	-1	9	0

Results in Table 19 show that there is evidence of significant differences in the level of agreement after the passage regarding the perception of threat to human life caused by the deterioration of the coral reef (Q10 and Q15) for “Take Responsibility” (p-value = 0.000). There is also evidence of significant differences regarding taking action in protecting coral reef for human life (Q12 and Q17) for “Take responsibility” (p-value=.003). According to table 20, and descriptive analysis, these results indicate an increase in median for both statements for “Take responsibility” respondents. There is evidence of significant differences in the level of agreement after the passage regarding the perception of threat to

human life caused by the deterioration of the coral reef (Q10 and Q15), when considering a significance level of 10%, for “Do not take responsibility” (p-value=.071) but no evidence of difference for likelihood to take action (Q12 and Q17; p-value=.734) for a significance level of 10%. Table 20 indicates that this significant difference resulted in an increased median for the statement regarding threat of coral bleaching for human life (Q10 and Q15).

Table 19: Human life WSRT for "DTR" and "TR"

	Q10 and Q15		**Q12 and Q17**	
	Do not take responsibility	*Take Responsibility*	*Do not take responsibility*	*Take responsibility*
Z	-1.806	-4.313	-0.34	-2.981
p-value	0.071	0.000	0.734	0.003

Table 20: Human life "After" medians for "DTR" and "TR"

	Do not take responsibility		*Take responsibility*	
	Median	**+/-**	**Median**	**+/-**
Q15	8	+2	9	+1
Q17	6	0	9	+2

Information in the passage had an impact on those who already believe that climate change is caused by humans, in that they agree more that coral bleaching is a threat to human life and are more likely to take action to fight against it. It is important to note that 87.5% of “Take responsibility” respondents were unaware of how many people survive off of coral reefs (See Appendix C, Table 4) and may represent a lack of knowledge concerning other benefits the coral reef has for human life that were presented in the passage. These facts, along with how coral reefs are dying because of climate change, are effective in triggering action for this group, they are more accepting of these facts, which lead to action, and because they already know that their actions can negatively impact climate change.

Those who do not believe that climate change is caused by humans, became more aware of the threat of a dying coral reef for human life only when considering a significance level of 10%, but not the more widely used 5%; in which case caution should be taken into consideration when expressing a result. While 11 respondents do increase their level of agreement and only 5 decrease it (See Appendix C, Table 5), resulting in the same median level of agreement of threat to marine life both before and after the passage, it does not impact them overall to increase likelihood to take action. In fact, the median for likelihood to take action for human life is 6, equivalent to only “Slightly Agree”. Therefore, it is likely that this raised awareness after reading the passage may simply be due to lack of knowledge of the importance of coral reef for human life and therefore the effects that a dying coral reef would have; however they were not completely convinced that their actions are the cause of coral bleaching.

It is important to outline the many differences between these two groups in order to grasp a better understanding of the group as a whole. Because of the obvious difference in the belief of cause of climate change, as well as significant differences, explained both before and after the passage, these groups are referred to throughout the study to interpret results.

5.4. "ACTIVE" AND "NOT ACTIVE"

5.4.1. Descriptive

Two groups are formed regarding their responses to question 6: "Do you specifically do anything to prevent climate change?". The 60 respondents who answered "yes" are referred to as "Active" while the 35 respondents who answered "no" are refered to as "Not Active". Figure 8 shows the boxplots for the "before" and "after" statements to gain an initial understanding of each group. "Active" respondents have no major changes levels of agreement after reading the passage for statements regarding marine life (Q9 and Q14; Q11 and Q16). However, "Not Active" respondents have a slight decrease in median level of agreement to the statement regarding likelihood to take action against climate change for marine life (Q11 and Q16). Both "Active" and "Not Active" respondents increase their median level of agreement and interquartile range for the threat of coral bleaching for human life (Q10 and Q15) as well as likelihood to take action against coral bleaching for human life (Q12 and Q17). "Active" respondents agree more the statements both before and after reading the passage compared to "Not Active" respondents.

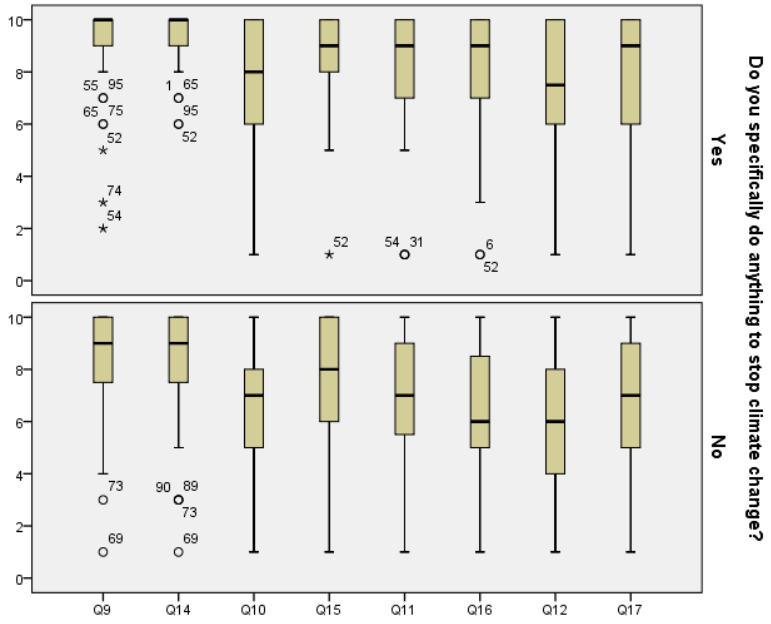

Figure 8: "Before" and "After" Boxplots for "Active" and "Not Active"

5.4.2. Statistical

5.4.2.1. Mann Whitney U

A Mann Whitney U test is conducted on all four "before" statements to determine if the median level of agreement for the two groups, "Active" and "Not Active", are significantly different. Results in Table 21 show that there is evidence of significant differences in median level of agreement between the two groups for all four "before" statements, at a significance level of 5%. This difference, as discussed in the Section 5.4.1., refers to "Active" respondents having a higher median than "Not Active" respondents.

Table 21: MWU Test Statistics for "Not Active" and "Active"

	Q9	Q10	Q11	Q12
Z	-2.314	-2.331	-3.032	-2.374
p-value	0.021	0.02	0.002	0.018

Table 22: "Before" Medians for "Not Active" and "Active"

	Q9	Q10	Q11	Q12
Not Active	9	7	7	6
Active	10	8	9	7.5

It is not surprising that “Active” respondents agree more to the “before” statements than “Not Active” respondents, given that the 78.3% of “Active” respondents are those who believe that climate change is caused by humans and findings in Section 5.3. revealed that “Take responsibility” respondents agree more to these statements. However, knowledge of cause of climate change alone does not automatically mean that the person will take action, as 26.6% of “Take responsibility” respondents currently do not do anything to stop climate change, making up 48.6% of the “Not Active” respondents, (See Appendix D, Table 1). Awareness of cause of climate change as well as importance to take action has lead to significantly higher medians for “Active” versus “Not Active” respondents even before reading the passage. By separating these two groups, and keeping in mind the their beliefs on cause of climate change, we can gain a better understanding of what, if anything, can increase liklihood to take action against coral bleaching, especially for “Not Active” respondents.

5.4.2.2. Wilcoxon Sign Rank Test

While the aim of this study is to determine if people who are more aware of the current situation are more likely to take action against the effects of coral bleaching, it is necessary to compare those who currently take action to stop climate change versus those who do not . A Wilcoxon Sign Rank Test is conducted to determine if there is evidence of significant differences in level of agreement for both “Active” and “Not Active” respondents. The results of the two groups for the same “before” and “after” statements are then compared in a total of 8 tests, first discussing statements for marine life followed by human life. The results are compared and analyzed to discuss the effectiveness of the information in the passage in raising awareness and encouraging action.

Results in Table 23 show that there is no evidence of significant differences in the level of agreement before and after the passage for either statement regarding marine life for “Active” and “Not Active” groups. As expected from the descriptive analysis, Table 24 shows no significant change in medians.

Table 23: Marine life WSRT Test Statistics for "Not Active" and "Active"

	Q9 and Q14		Q11 and Q16	
	Not Active	*Active*	*Not Active*	*Active*
Z	-1.037	-1.09	-0.996	-0.327
p-value	0.3	0.276	0.319	0.743

Table 24: Marine life "After" Medians for "Not Active" and "Active"

	Not Active		*Active*	
	Median	**+/-**	**Median**	**+/-**
Q14	9	0	10	0
Q16	6	-1	9	0

Results in Table 25 shows evidence of significant differences in the level of agreement before and after the passage regarding perception of threat to human life caused by the deterioration of the coral reef (Q10 and Q15) for “Not Active” (p-value=.004) and “Active” (p-value=.000) respondents. There is also evidence of significant differences in the level of agreement before and after the passage regarding taking action in protecting the coral reef for human life (Q12 and Q17) only for “Active” (p-value = 0.042) respondents; but not for “Not Active” (p-value=.129). According to Table 26, and discussed in the descriptive analysis, these significant differences increased the median level of agreement.

Table 25: Human life WSRT for "Not Active" and "Active"

	Q10 and Q15		Q12 and Q17	
	Not Active	*Active*	*Not Active*	*Active*
Z	-2.901	-4.007	-1.52	-2.032
p-value	0.004	0	0.129	0.042

Table 26: Human life "After" Medians for "Not Active" and "Active"

	Not Active		*Active*	
	Median	**+/-**	**Median**	**+/-**
Q15	8	+1	9	+1
Q17	7	+1	9	+1.5

While the respondents were separated to determine directly whether the passage had an impact on action, beliefs in cause of climate change continue to play a large role in both groups. Information in the passage had an impact on those who already do something to stop climate change in that they agree more that coral bleaching is a threat to human life and are more likely to take action to fight against it for

this reason, similar to results in Section 5.3.2.2. While it is important spread the knowledge of the coral bleaching to those who do take action against climate change to encourage even more activity, the main aim is to encourage those who do not currently take action against climate change to do so. The information in the passage did increase awareness of the threat of coral bleaching, however it did not impact a significant change in intention to take action for those who do not do anything to stop climate change. Specifically observing those who do not currently take any action, the information in the passage seemed to mainly impact those who believe that climate change is caused by humans where 62.5% (10/16) (See Appendix D, Table 4) agreed more and had an overall median of 9, however only 37.5% (6/10) of those who believe the contrary agreed more and had an overall median of 5, equivalent to "Slightly Disagree" (See Appendix D, Table 6). This shows continuing differences between the two groups on whether they currently do something to stop climate change or not. It still holds true that more effort is needed to convince respondents that our actions cause climate change, which has dangerous results for marine and human life.

5.5. MALE VS FEMALE

5.5.1. Descriptive

Two groups are formed based on gender, with 41 "Male" respondents and 64 "Female" respondents. Figure 9 represents the distribution of responses for "before" and "after" statements by gender. Responses for Males vary more than Females both before and after the statements. This may be due to Females having a larger proportion of "Take responsibility" (75.9%) respondents where Males have similar proportions of "Take responsibility" (56.1%) as "Do not take responsbility" (43.9%) respondents. As discussed throughout Section 5.2., "Do not take responsibility" respondents tend to have lower level of agreements which may influence the variation of responses when observing Females. Therefore, the boxplots are separated by gender and beliefs in cause of climate change, as seen in Figure 10. "Male/Do not take responsibility" have a larger proportion of lower level of agreements and medians than "Male/Take responsibility" both before and after the passage. The major difference observed is that "Male/Do not take responsibility" decrease their level of agreement after reading the passage regarding liklihood to take action against climate change to stop coral bleaching for both marine(Q11 and Q16) and human life (Q12 and Q17), where the other groups increased their level of agreement. "Female/Do not take responsibility" have a larger proportion with lower agreement levels before the passage, compared to "Female/Take responsibility", however after reading the passage they increase their level of agreement for all statements except coral bleaching as a threat to marine life (Q9 and Q14), having similar medians to "Female/Take responsibility". Although "Female/Do not take responsibility" increase their median level of agreement for after statements regarding liklihood to take action against climate change to stop coral bleaching for both marine(Q11 and Q16) and human life (Q12 and Q17), the responses vary much more than before suggesting that some Female respondents agreed much less to the statement.

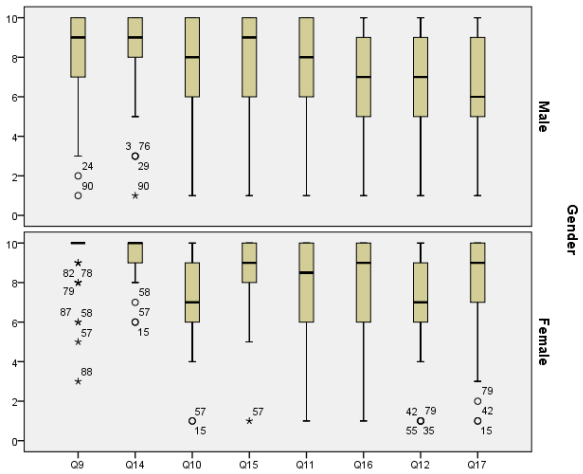

Figure 9:"Before" and "After" Boxplots for "Gender"

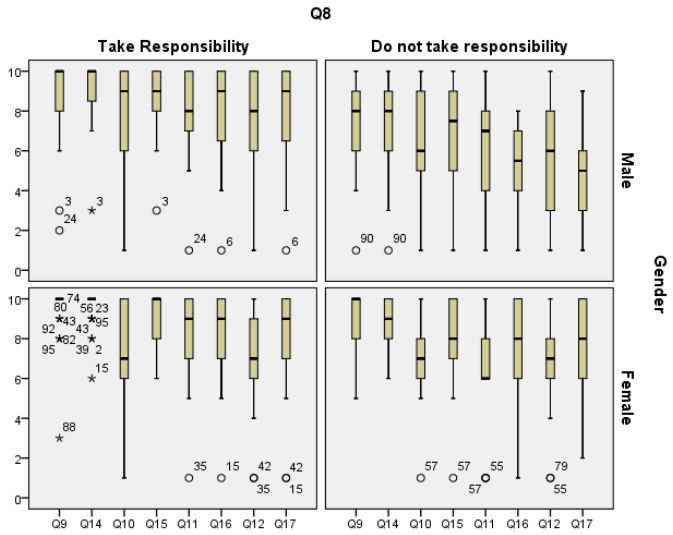

Figure 10: "Before" and "After" Boxplots for "Gender" and "DTR"/"TR"

5.5.2. Statistical

5.5.2.1. Mann Whitney U

A Mann Whitney U test is conducted on all four “before” statements to determine if the median levels of agreement for Male and Female are significantly different.

Table 27 shows evidence of significantly different levels of agreement for Male and Female respondents only for the statement regarding perception of threat of deterioration of coral reef for marine life (Q9; p-value=.002). According to Table 28, as well as descriptive analysis, indicates that Females agree more and responses vary considerably less than Males for this statement. Otherwise, there is no evidence of difference in median agreement levels for the other “before” statements.

Table 27: MWU Test Statistics for "Gender"

	Q9	Q10	Q11	Q12
Z	-3.150	-0.176	-0.839	-0.488
p-value	0.002	0.860	0.402	0.626

Table 28: "Before" Medians for "Gender"

	Q9	Q10	Q11	Q12
Male	9	8	8	7
Female	10	7	8.5	7

While there seems to be no major difference between Male and Female before the passage, further statistical analysis is conducted to see if they respond differently to the passage.

5.5.2.2. Wilcoxon Sign Rank Test

While the aim of this study is to determine if people who are more aware of the impact of climate change are more likely to take action against the effects of coral bleaching, it is useful to study whether gender is a contributing factor in increasing liklihood to take action. A Wilcoxon Sign Rank Test is conducted to determine if there is evidence of significant differences in level of agreement for both Male and Female respondents for the "before" and "after" statements in a total of 8 tests; first discussing statements for marine life followed by human life. The results are compared and analyzed to discuss the effectiveness of the information in the passage in raising awareness and encouraging action.

Table 29 shows no evidence of significant differences of level of agreement before and after the passage for both statements regarding marine life (Q9 and Q14; Q11 and Q16) for both Male and Female at a significance level of 5%. Table 30, shows no significant changes in medians.

Table 29: Marine life WSRT Test Statistics for "Gender"

	Q9 and Q14		**Q11 and Q16**	
	Male	*Female*	*Male*	*Female*
Z	-0.334	-0.513	-1.606	-0.384
p-value	0.739	0.608	0.108	0.701

Table 30: Marine life "After" Medians for "Gender"

	Male		*Female*	
	Median	**+/-**	**Median**	**+/-**
Q14	9	0	10	0
Q16	7	-1	9	+0.5

Table 31 shows evidence of significant difference in level of agreement after the passage regarding the perception of threat to human life caused by the deterioration of the coral reef (Q10 and Q15) for both Male (p-value=.041) and Female (p-value=.000) respondents. These results indicate that there were significant increase in medians, as shown in table 32, for both genders. However, when regarding level of agreement toward taking action to protect the coral reef for human life (Q12 and Q17), only Female respondents showed evidence of a significant difference (p-value=.004). Table 32 indicates that this significant difference increased "Female" respondents' median level of agreement.

Table 31: Human life WSRT Test Statistics for "Gender"

	Q10 and Q15		**Q12 and Q17**	
	Male	*Female*	*Male*	*Female*
Z	-2.04	-4.371	-0.233	-2.872
p-value	0.041	0.000	0.816	0.004

Table 32: Human life "After" Medians for "Gender"

	Male		*Female*	
	Median	**+/-**	**Median**	**+/-**
Q15	9	+1	9	+2
Q17	6	-1	9	+2

According to the results, increased awareness of the threat of coral bleaching for human life increased the liklihood to take action for Females. This can be attributed to Females regardless of their belief, where 63.23% of "Female/Do not take responsibility" and 53.65% of "Female/Take responsibility" increase their response (See Appendix E, Table 7). In fact, Figure 12 below shows that after reading the passage, the most commonly chosen response was "Strongly Agree" (10) in altering daily behavior. However, Figure 11 shows that most "Female/Take responsibility" "Strongly Agree" (10) that they would take action by signing a petition to raise awareness and encourage lawmakers to invest in clean energy where most "Female/Do not take responsibility" only "Slightly Agree" (6) to take action in this way. Therefore, it would be beneficial to reach out to women about this issue with information similar to the passage written, and encourage them to take action.

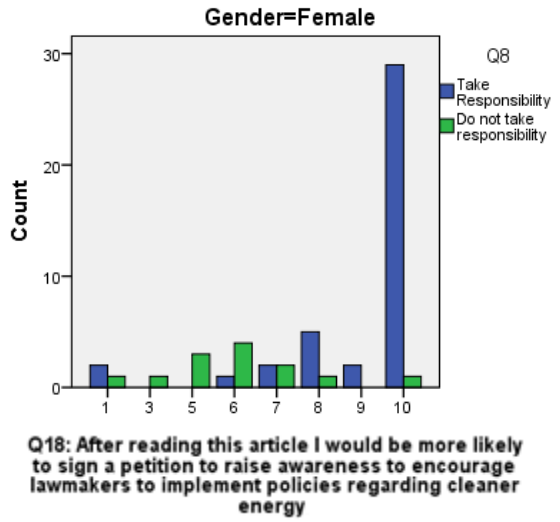

Figure 11: Clustered Bar Chart Q18 by Q8 for Female

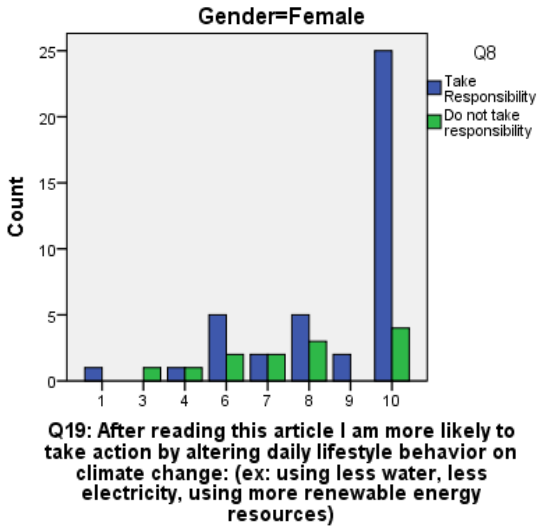

Figure 12: Clustered Bar Chart Q19 by Q8 for Female

Although awareness of threat of coral bleaching for human life is increased for Males and equal to that of Females, based on medians, it did not increase liklihood to take action against coral bleaching for human life. This is mainly due to differing beliefs on cause of climate change for Males. Table 33 takes a closer look at those who agreed less (Negative Rank) and those who agreed more (Positive Rank) to the statement in question after reading the passage. While overall there are almost an equal number of respondents who agree more as there are who agree less, which does not lead to significant results, 64.28% (9/14) of Negative Ranks are "Male/Do not take responsibility" while 85.61% (11/13) of the Positive Ranks are "Male/Take responsibility". In fact, at least 44.4% of "Male/Do not take responsibility"

agree less after reading the passage for every statement (See Appendix E, Table 7), which differentiates them from all other groups. While belief in cause of climate change was already studied in Section 5.3., by studying Male respondents, we can gain a better understanding of them as a whole and can effectively compare these differences with Females.

Table 33: Q12 and Q17 Ranks for "M/DTR" and "M/TR"

	Q12 and Q17		
	Total	*Male/Do not take responsibility*	*Male/ Take responsibility*
Negative Rank	14	9	5
Positive Rank	13	2	11
Tie	14	7	7

Therefore, an additional Wilcoxon Sign Rank test was conducted to determine if there is evidence of significant differences in level of agreement for for “Male/Take responsibility” and “Male/Do not take responsibility” respondents for the “before” and “after” statements in a total of 8 tests.

Table 34 shows no evidence of significant difference in level of agreement after the passage regarding the perception of threat of the deterioration of the coral reef for marine life (Q9 and Q14) or human life (Q10 and Q15) for “Male/Do not ake responsibility” for a significance level of 5% or 10%. However, there is evidence of significant difference in level of agreement for likelihood to take action in protecting the coral reef for marine life (p-value=.062) as well as human life (p-value=.029), for a significance level of 10%. According to descriptive analysis, this lead to decrease in median for both statements.

Regarding “Male/Take responsibility”, Table 34 shows evidence of significant difference in level of agreement after the passage regarding the perception of threat of the deterioration of the coral reef for human life (Q10 and Q15; p-value=.032), however there was no evidence of significant differences in level of agreement toward the liklihood to take action to protect the coral reef for human life (Q12 and Q17; p-value=.152). As discussed in descriptive analysis, this significant difference lead to an increase in median level of agreement. There is no evidence of significant differences for both analogous questions referring to marine life (Q9 and Q14; Q11 and Q16), with a significance level of 5% or 10%.

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Table 34: WSRT Test Statistics for "M/DTR" and "M/TR"

		Q9 and Q14	Q11 and Q16	Q10 and Q15	Q12 and Q17
"Male/Do not take responsibility"	**Z**	-1.137	-1.864	-0.666	-2.178
	p-value	0.256	0.062	0.506	0.029
"Male/Take responsibility"	**Z**	-0.574	-0.316	-2.139	-1.433
	p-value	0.566	0.752	0.032	0.152

No major changes were seen in the agreement level to coral bleaching as a threat for “Male/Do not take responsibility”, however agreement level of liklihood to take action for both marine and human life decreased after reading the passage, indicating their strong disagreement with information in the passage and lack of beneficial impact. Although there was increased awareness of coral bleaching as a threat to human life, this had no effect on taking action against it for “Male/Take responsibility”. Figure 13 and figure 14 below show the difference between the Males based on belief and their responses on liklihood to take action in two distinct ways ways. Figure 13 displays an obvious difference on liklihood to sign a petition to raise awareness for cleaner energy between the groups. Figure 14 shows a mixture of levels of agreement for adjusting lifestyle for each group.

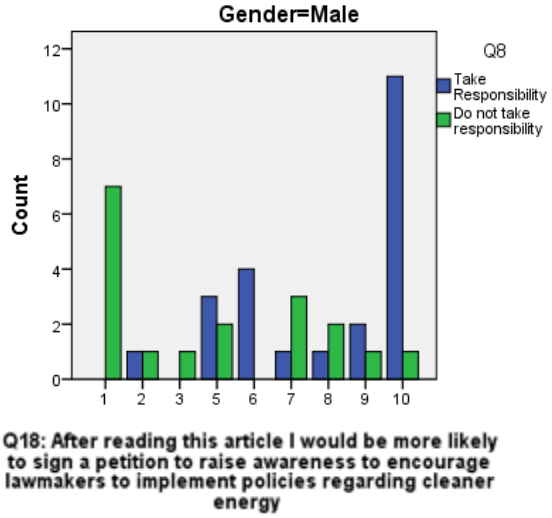

Figure 13: Clustered bar chart Q18 by Q8 for Male

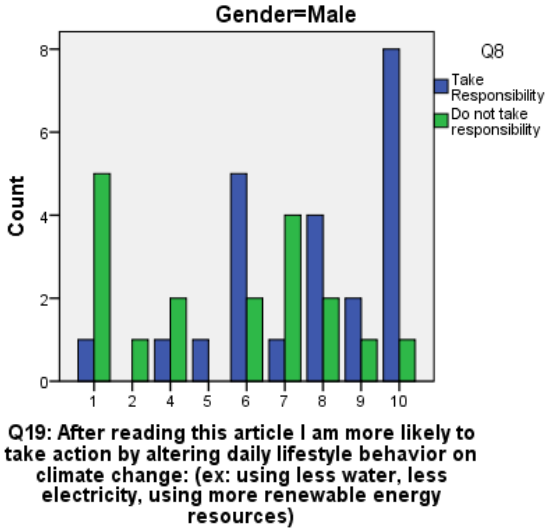

Figure 14: Clustered bar chart Q19 by Q8 for Male

In summary, the information in the passage was effective in increasing action for Females but not Males, even when considering beliefs in cause of climate change, with the same liklihood to act for marine and human life. It would be beneficial to target women with this information and the importance to take action themselves as well as begin a conversation with the men in their life. This may be a better approach to encourage men to take action, given the backlash in opinion or indifference Males had to passage with scientific facts.

5.6. AGE

5.6.1. Descriptive Statistics

Respondents are separated into four age groups “18-29” (n=23), “30-44” (n=19), “45-60” (n=19), and “>60” (n=34). Figure 15 represents the distribution of responses for “before” and “after” statements by age in order to gain an initial understanding of the differences between the groups. For statements regarding threat of coral bleaching to marine life (Q9 and Q14), medians stay the same or increase after reading the passage to “Strongly Agree” (10) for all ages. For statements regarding threat of coral bleaching to human life (Q10 and Q15), median level of agreement increase in all ages and variation of responses decrease, except for those aged “45-60”. For statements regarding liklihood to take action

against climate change to stop coral bleaching for marine life (Q11 and Q16),medians remain the same or increase for all age groups except those aged “18-29”, who not only have a lower median but also have more varying responses. For statements regarding liklihood to take action against climate change to stop coral bleaching for human life (Q12 and Q17), medians for all age groups increase but response levels vary from “Strongly Disagree” (1) to “Strongly Agree” (10) for all age groups. Those aged “18-29” and “30-44” have a larger proportion of “Take responsibility” respondents where the older age groups have almost equal proportions (Appendix F), however it does not seem to impact the changes in age.

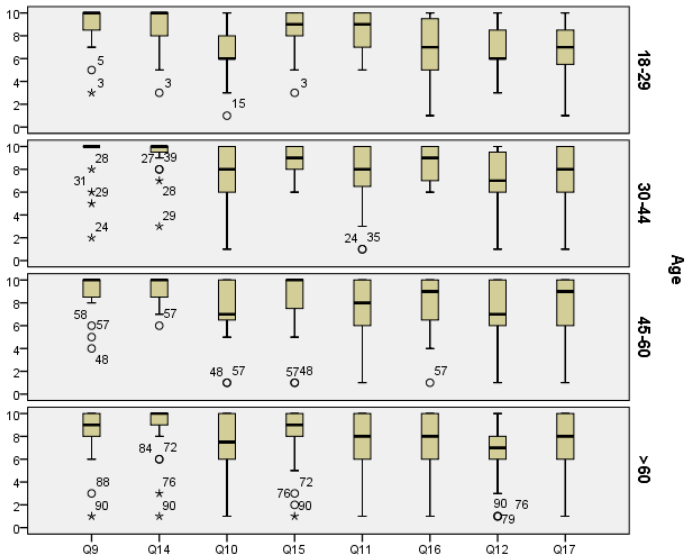

Figure 15: "Before" and "After" Boxplots for "Age"

5.6.2. Statistical

5.6.2.1. Kruskal Wallis

Table 35 shows the medians for the “before” statements for each age group. A Kruskal Wallis test was conducted on all four “before” statements for to determine if there is a significant difference in mean ranks for the four age groups. Results in Table 36 show no evidence of significant differences between at least one pair of groups for any of the four “before” statements with a significance level of 5%.

Table 35: "Before" Medians for "Age"

	Q9	Q10	Q11	Q12
"18-29"	10	6	9	6
"30-44"	10	8	8	7
"45-60"	10	7	8	7
">60"	9	7.5	8	7

Table 36: KW Test Statistics for "Age"

	Q9	Q10	Q11	Q12
Chi-Square	3.674	1.281	1.652	0.917
p-value	0.299	0.734	0.648	0.821

This suggests that there are no obvious differences between the agreement level of the statements before reading the passage, with the only difference being age. However, different age groups could react differently to the passage than other age groups.

5.6.2.2. Wilcoxon Sign Rank Test

While the aim of this study is to determine if the more aware people are of climate change the more likely they are to take action against the effects of coral bleaching, it is useful to study whether different age groups are impacted by the passage differently. A Wilcoxon Sign Rank Test is conducted to determine if there is evidence of significant differences in level of agreement for all four age groups on the "before" and "after" statements in a total of 16 tests. The results are compared and analyzed to discuss the effectiveness of the information in the passage in raising awareness and encouraging action.

Table 38 shows evidence of significant differences in the level of agreement before and after the passage regarding the perception of threat to human life caused by coral bleaching (Q10 and 15) for age groups "18-29"(p-value=.005), "45-60" (p-value=.049), ">60" (p-value=.003) regarding a 5% significance level, and those aged "30-44" when considering a 10% significance level. According to table 37, these results indicate that there were significant increases in medians for all groups. Those aged ">60" were the only age group to show evidence for significant differences in level of agreement regarding taking action to protect the coral reef against climate change for human life (Q12 and 17). Table 37 shows that this significant difference increased median for this group. Age group "18-29" was the only group to show evidence of a significant difference in level of agreement after the passage regarding perceived threat of coral bleaching for marine life (Q11 and Q16). Table 37 indicates that there was a decrease in median level of agreement for this statement.

Table 37: "After" Medians for "Age"

	"18-29"		***"30-44"***		***"45-60"***		***">60"***	
	Median	+/-	Median	+/-	Median	+/-	Median	+/-
Q14	10	0	10	0	10	0	10	+1
Q16	7	-2	9	+1	9	+1	8	0
Q15	9	+3	9	+1	10	+3	9	+1.5
Q17	7	+1	8	+1	9	+2	8	+1

Table 38: WSRT Test Statistics for "Age"

		Q9 and Q14	Q11 and Q16	Q10 and Q15	Q12 and Q17
"18-29"	**Z**	-1.403	-2.189	-2.836	-0.056
	p-value	0.161	0.029	0.005	0.955
"30-44"	**Z**	-0.171	-0.718	-1.774	-1.292
	p-value	0.865	0.473	0.076	0.196
"45-60"	**Z**	-0.586	-0.679	-1.972	-1.516
	p-value	0.558	0.497	0.049	0.129
">60"	**Z**	-1.113	-0.523	-2.993	-2.389
	p-value	0.266	0.601	0.003	0.017

Information in the passage was successful in increasing awareness of the threat of coral bleaching for human life for all age groups, however only those aged “>60” increased their liklihood to take action to protect the coral reef for human life against climate change’s effects on coral bleaching. Furthermore, Figure 15 and 16 show that over half of the respondents “Strongly Agree”, more than any other age group, that they are more likely to take action by signing a petition to raise awareness and encourage lawmakers to invest in clean energy as well as to alter daily lifestyle behavior after reading the passage. Therefore, it is beneficial to use information similar to that in the passage to raise awareness of the threat coral bleaching has on humans, for this age group.

After reading the passage, respondents aged “18-29” have the least level of agreement of likelihood to take action for marine or human life, with median responses only one level higher than “Slightly Agree” (6), despite having similar level of agreements about the threat of coral bleaching for marine and human life, with the median being either “Strongly Agree” (10) or close to this (9), compared to other age groups. In fact, they were significantly less likely to take action against coral bleaching for the benefit of marine life. There was no decrease in perception of threat of coral bleaching for marine life, and while 76% of the “18-29” year old respondents believe that climate change is caused by human action (See Appendix F, Table 12) the decrease should not be an issue with convincing what is the cause of climate change. Figure 15 and 16 reveals that they feel equally likely, according to median and the spread of responses, to take action by signing a petition to raise awareness and encourage lawmakers to implement policies regarding clean energy as they do altering daily lifestyle.

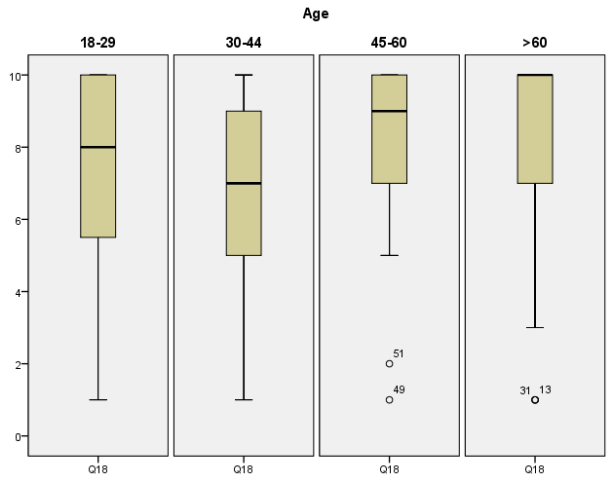

Figure 16: Boxplots for Q18 by "Age"

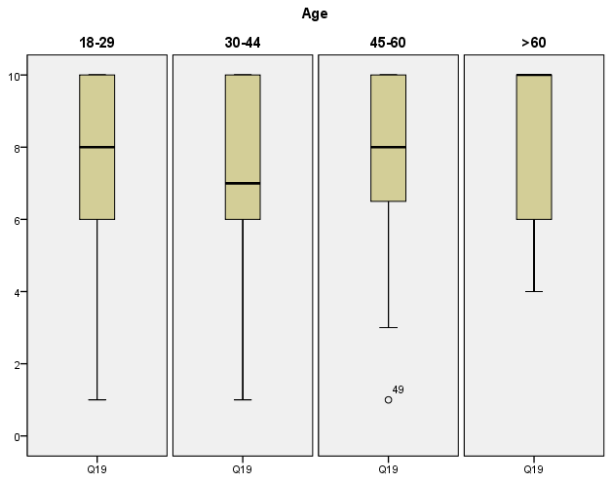

Figure 17: Boxplots for Q19 by "Age"

The passage had no significant impact intention of likelihood to take action for those aged “30-44” and “45-60”. However, when observing the Figures 15 and 16, those aged “30-44” respond more similarly to “18-29” while “45-60” respond more similarly to “>60”. A study “Aging, Climate, and Legacy Thinking” suggests that older generations may be more susceptible to information of climate change and likeliness to take action due to their “sense of legacy-their impulse to care for those who come after” (Frumkin, Fried, & Moody, 2012). This may explain the difference between the anchors of the age groups studied and the difference in likelihood to take action. In this case, coral bleaching articles should emphasize the urgency for younger generations to take action because they are more likely to see its effects in their lifetime. It may be useful to encourage older generations to talk to their younger family members about coral bleaching and what actions can be taken to fight against it.

6. CONCLUSION

Coral bleaching is an effect of climate change that is currently starving the coral reef of nutrition and will be the reason that this incredibly important ecosystem will die. This will impact not only marine life but humans as well. There is still a chance to stop the effects of climate change and reverse some of the resultant damage to coral reefs, however immediate action is necessary. The aim of the study was to understand if people who are more aware of the causes and impacts of coral bleaching due to climate change, are more likely to intend to implement an action in their life to slow climate change's effect on coral reefs for marine life, human life, or both. A passage was written informing the survey respondents about coral bleaching, including educational information that it is caused by climate change which is largely caused by humans, as well as the effects that the dying coral reef will have for marine and human life. Similar statements were used before and after the passage to study whether the information provided impacted the respondents. Further information was included in the survey to best study and interpret results. Major findings are summarized with the usefulness it can hold for future campaigns regarding coral bleaching as well as personal incentives.

The before and after statements regarding the threat of deterioration of coral reef and importance/likelihood to implement action to stop climate change's affects on coral bleaching for human life were the only statements that the showed significant increases in level of agreement overall, afterwards having similar or equal levels of agreement as the same statements for marine life. While the majority of respondents knew the importance of coral reefs for marine life, there seems to be a lack of knowledge of the importance it has for humans and this should be highlighted to increase likelihood to take action.

Previous knowledge of the cause of climate change plays a very large role throughout the study, where coral bleaching and its effects are used as motivation, one cannot be convinced to take action if one does not believe that their own actions cause it in the first place. Those who already knew that climate change is caused by humans were more concerned about a deterioration of the coral reef than those who didn't, and were more likely to take action against coral bleaching. However, using coral bleaching as an example of climate change impacts to those who don't believe that it is caused by humans was not effective. Therefore, a more in depth explanation about climate change and its causes should be used and then examples about the different effects it has can be included.

Knowledge of the cause of climate change played differing roles when considering gender. While before the passage there were no significant differences between Male and Female, they responded differently when considering this position. Females became more aware of coral bleaching and its effects and were more likely to take action, both every day and involving lawmakers and policies. The passage did not motivate Males to take action, where those uninformed about the causes of climate change were significantly less likely to take action. It is extremely important that this information is publicized in campaigns and implemented in everyday life. A study about recycling activities found that because of women's traditional gender roles with household work they were more likely to recycle goods (Arcury, Scollay, & Johnson, 2017). A study on "Gender perspectives on climate change" shares this view that women are more likely to take into account the benefit energy efficiency appliances have on the environment (Mignaquy, n.d.) when making a purchasing decision. These studies, along with the author's results, can inform and empower women to first start not only with their personal actions, but incorporate

these actions in their households whether they are a mother, daughter, girlfriend, sister, or roommate. By first incorporating action in the household such as recycling or buying energy efficient appliances, a dialogue can begin with males in the household- whether that be with father, brother, or friend. Information in the passage contained scientific facts to convince the cause and urgency to stop climate change, but did not show any impacts on Males' awareness and behavior. However, one study found that after trusting scientists and professors about the facts of climate change, they trust family and friends the most. Coral bleaching campaigns can take this information to target women, providing them with scientific facts to present to a male family member or friend, and begin a movement.

Age was also studied as a contributing factor of the effectiveness of the passage, but was only effective for those aged ">60", with "18-29" year olds having the lowest likelihood to take action. It is suggested that it is because older generations have a sense of legacy, of what they leave behind. Coral bleaching campaigns could target older generations highlighting the urgency of the situation and effects that will be left not to future generations, but to their kids and grandchildren as another self-interest incentive (Frumkin, Fried, Moody). Of course it would also be beneficial to include the importance of speaking to their family members and friends, especially younger generations considering that they will see more of the effects. It would also be beneficial to target younger generations with information more focused on the negative impact it will have for them that they will see in their lifetime, considering they have a larger percentage who are more aware about the cause and existence of climate change.

Climate change is a terrible consequence caused by humans that will eventually affect us all if we do not come together to fight against it, and coral bleaching is an example of how it is happening now, already affecting marine life and soon humans. Many variables can affect whether we do take action such as cost, time, sense of urgency, but awareness of the issue must first be clear. This includes explaining that humans are the cause of it, that it is happening now, the many effects that it will have on nature, animals, and humans, and what we can do to stop it. By understanding these facts first and foremost ourselves, and sharing it with others, each individual will be able to find their own personal motivation to take action whether it is to have less smog in the air, protect the coastlines from flooding, or save the coral reef from coral bleaching, a habitat for so much of marine life which benefits us all. By spreading information about coral bleaching, highlighting the importance not only for marine life but human life as well, and focusing on women and older generations first, a movement can be started to fight climate change together.

6.1. LIMITATIONS AND SUGGESTIONS

The main limitation was the length of the passage. This limited the number of questions in the survey so that respondents would respond based on what they truly believed and not rush through them. It is also unknown if the respondent truly read the passage or merely skimmed over it after seeing how long it was, thereby influencing the results. For future works, a video explaining the same concepts may be more helpful to keep the attention of the respondent, better explain the cause and effects of coral bleaching, include different ways that a respondent can take action. That method could insure that the respondent watches the entire video instead of skimming over a written passage, and allow more questions to be asked to better understand differences between respondents and their motives. Many variables can contribute to whether a person takes action against climate change, therefore more questions might better explain what in the passage was and wasn't effective, and for whom.

Another limitation was the cost involved in increasing the number of respondents. Most studies that research people's perceptions of climate change and action involve significantly more respondents than this one, however due to cost 100 respondents was the maximum possible.

It would be interesting to compare, on a larger scale, how different effects of climate change affect different people using the same questions or structure for each example and the same structure of the passage (or video). It would continue to include explanation of climate change, how this phenomena is happening, proof from scientists and professors that this particular phenomena is not natural, and highlighting the multiple negative effects it will have. This could explain whether certain effects pose as a larger motivation to take action for others using an actual example rather than understanding threats of climate change over all.

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APPENDIX

Appendix A: Pilot Survey

1. What is your gender?

    A. Male
    B. Female

2. Please select your age group:

    A. 18-29

    B. 30-39

    C. 40-49

    D. 50 or over

3. Are you aware of any deterioration of the coral reef?

    A. Yes

    B. No

4. I think that a deterioration of the coral reef is a threat to marine life:

    Strongly Disagree, Disagree, Agree, Strongly Agree

5. I think that a deterioration of the coral reef is a threat to human life:

    Strongly Disagree, Disagree, Agree, Strongly Agree

6. I think it is important that I take action in protecting the deterioration of the coral reef for marine life.

    Strongly Disagree, Disagree, Agree, Strongly Agree

7. I think it is important to take action in protecting the deterioration of the coral reef for human life.

    Strongly Disagree, Disagree, Agree, Strongly Agree

8. Do you do anything now specifically to prevent global warming?

    A. Yes

    B. No

9. Passage: Reefs are made up of groups of corals and corals are made up of many living organisms called polyps. These polyps have a skeleton, digestive and reproductive tissues. Inside each mature polyp, many single celled algae live, providing 98% of the polyp's energy to survive through photosynthesis. This is a delicate process, specific to a certain amount of sunlight and temperature of water. Due to global warming, the average temperature of the ocean is increasing which interferes with this process. Therefore, the coral polyp is not getting nutrition and begins to deteriorate leaving nothing but its white calcium carbonate skeleton. This is referred to as coral bleaching, and is the last sign before death. When this happens it effects marine life, human life, and even economies. As coral reefs are home to 25% of marine life and most biodiversity in the ocean, although only covering 1% of the area of the ocean, without them the number of species will greatly decease. Without corals, prey of larger fish have no protection from their predators and are more likely to become extinct which will eventually cause a crash in the food chain due to entire classes of fish becoming extinct. Successful reproduction is also effected as the marine life that live there do not have a place to protect their young ones from predators or outside factors or simply to find a place to encounter a mate. Populations around the world depend on these areas of densely packed fish in order to survive. Survival from the fish can be explained by simply not having any food to eat or jobs for fisherman and other jobs related to marine life. Lack of jobs in turn results in a fall in the economy. Areas where the tourism relies on the fish and coral reef for economic income will also be affected greatly. Because of the reasons mentioned above, coral bleaching affects us all in one way or another however our daily actions are contributing to this whether we realize it or not. Simple actions to stop global warming to protect this delicate and essential ecosystem include but are not limited to: taking public transportation/biking/or walking, using solar energy, using less electricity or energy efficient appliances, and eat less meat.

C. I have read this article

B. I have not read this article

10. I feel that I have become more informed regarding the effects of coral bleaching after reading this passage:

Strongly Disagree, Disagree, Agree, Strongly Agree

11. After reading the passage, I think that coral bleaching of the coral reef is a threat to marine life:

Strongly Disagree, Disagree, Agree, Strongly Agree

12. After reading the passage, I think that coral bleaching of the coral reef is threat to human life:

Strongly Disagree, Disagree, Agree, Strongly Agree

13. I am more likely to change something in my lifestyle, make an additional change, or feel stronger about what I am already doing, in order to stop global warming knowing the effects it has on coral bleaching for marine life:

Strongly Disagree, Disagree, Agree, Strongly Agree

14. I am more likely to change something in my lifestyle, make an additional change, or feel stronger about what I am already doing, in order to stop global warming knowing the effects it has on coral bleaching for human life:

Strongly Disagree, Disagree, Agree, Strongly Agree

15. Where do you get most of your news from?

A. TV

B. Online or Mobile Apps

C. Social Media

D. Newspaper/Magazine

Appendix B: All Respondents

Table 1: WSRT Sum of Ranks, All

Ranks

All		N	Mean Rank	Sum of Ranks
Q14 - Q9	Negative Ranks	17	18.32	311.50
	Positive Ranks	18	17.69	318.50
	Ties	60		
	Total	95		
Q15 - Q10	Negative Ranks	10	19.95	199.50
	Positive Ranks	46	30.36	1396.50
	Ties	39		
	Total	95		
Q16 - Q11	Negative Ranks	33	34.67	1144.00
	Positive Ranks	30	29.07	872.00
	Ties	32		
	Total	95		
Q17 - Q12	Negative Ranks	24	31.83	764.00
	Positive Ranks	44	35.95	1582.00
	Ties	27		
	Total	95		

Table 2: WSRT Test Statistics, All

Test Statistics

	Q14 - Q9	Q15 - Q10	Q16 - Q11	Q17 - Q12
Z	-.059	-4.920	-.943	-2.526
Asymp. Sig. (2-tailed)	.953	.000	.345	.012

Appendix C: “Take responsibility” vs “Do not take responsibility”

Table 1: MWU Ranks, TR vs DTR

Ranks

	Q8	N	Mean Rank	Sum of Ranks
Q9	Take Responsibility	64	54.62	3495.50
	Do not take responsibility	31	34.34	1064.50
	Total	95		
Q10	Take Responsibility	64	52.38	3352.50
	Do not take responsibility	31	38.95	1207.50
	Total	95		
Q11	Take Responsibility	64	54.82	3508.50
	Do not take responsibility	31	33.92	1051.50
	Total	95		
Q12	Take Responsibility	64	51.83	3317.00
	Do not take responsibility	31	40.10	1243.00
	Total	95		

Table 2: MWU Test Statistics, TR vs DTR

Test Statistics

	Q9	Q10	Q11	Q12
Mann-Whitney U	568.500	711.500	555.500	747.000
Wilcoxon W	1064.500	1207.500	1051.500	1243.000
Z	-3.893	-2.273	-3.565	-1.972
Asymp. Sig. (2-tailed)	.000	.023	.000	.049

a. Grouping Variable: Q8

Table 3: Crosstabs, Q5 vs Q8

To your best knowledge, how much of the coral reef system will be destroyed by 2050? * Q8Groups Crosstabulation

			Q8Groups		
			Take Responsibility	Do not take responsibility	Total
To your best knowledge, how much of the coral reef system will be destroyed by 2050?	30%	Count	11	5	16
		% within Q8Groups	17.2%	16.1%	16.8%
	60%	Count	12	8	20
		% within Q8Groups	18.8%	25.8%	21.1%

	90%	Count	27	3	30
		% within Q8Groups	42.2%	9.7%	31.6%
	I don't know	Count	14	15	29
		% within Q8Groups	21.9%	48.4%	30.5%
Total		Count	64	31	95
		% within Q8Groups	100.0%	100.0%	100.0%

Table 4: Crosstabs, Q4 vs Q8

How many people rely on coral reefs for their livelihoods and food? * Q8Groups Crosstabulation

			Q8Groups		
			Take Responsibility	Do not take responsibility	Total
How many people rely on coral reefs for their livelihoods and food?	50 million	Count	9	4	13
		% within Q8Groups	14.1%	12.9%	13.7%
	500 million	Count	8	5	13
		% within Q8Groups	12.5%	16.1%	13.7%
	5 billion	Count	3	3	6
		% within Q8Groups	4.7%	9.7%	6.3%
	I don't know	Count	44	19	63
		% within Q8Groups	68.8%	61.3%	66.3%
Total		Count	64	31	95
		% within Q8Groups	100.0%	100.0%	100.0%

Table 5: WSRT Sum of Ranks, DTR

Ranks

Do Not Take Responsibility		N	Mean Rank	Sum of Ranks
Q14 - Q9	Negative Ranks	8	6.69	53.50
	Positive Ranks	5	7.50	37.50
	Ties	18		
	Total	31		
Q15 - Q10	Negative Ranks	5	6.70	33.50
	Positive Ranks	11	9.32	102.50
	Ties	15		
	Total	31		
Q16 - Q11	Negative Ranks	13	12.54	163.00
	Positive Ranks	10	11.30	113.00

	Ties	8		
	Total	31		
Q17 - Q12	Negative Ranks	10	10.60	106.00
	Positive Ranks	11	11.36	125.00
	Ties	10		
	Total	31		

Table 6: WSRT Test Statistics, DTR

Test Statistics

	Q14 - Q9	Q15-Q10	Q16-Q11	Q17-Q12
Z	-.575	-1.806	-.774	-.340
Asymp. Sig. (2-tailed)	.565	.071	.439	.734

Table 7: WSRT Sum of Ranks, TR

Ranks

Take Responsibility		N	Mean Rank	Sum of Ranks
Q14 - Q9	Negative Ranks	9	12.39	111.50
	Positive Ranks	13	10.88	141.50
	Ties	42		
	Total	64		
Q15 - Q10	Negative Ranks	6	16.67	100.00
	Positive Ranks	35	21.74	761.00
	Ties	23		
	Total	64		
Q16 - Q11	Negative Ranks	20	22.98	459.50
	Positive Ranks	21	19.12	401.50
	Ties	23		
	Total	64		
Q17 - Q12	Negative Ranks	14	20.32	284.50
	Positive Ranks	33	25.56	843.50
	Ties	17		
	Total	64		

Table 8: WSRT Test Statistics, TR

Test Statistics

	Q14 - Q9	Q15-Q10	Q16-Q11	Q17-Q12
Z	-.500	-4.313	-.381	-2.981
Asymp. Sig. (2-tailed)	.617	.000	.703	.003

Appendix D: “Active” vs “Not Active”

Table 1: Crosstabes, Q8*Q6

Q8Groups * Q6Groups Crosstabulation

			Q6 Groups		
			Yes	No	Total
Q8Groups	Take Responsibility	Count	47	17	64
		% within Q6	78.3%	48.6%	67.4%
	Do not take responsibility	Count	13	18	31
		% within Q6	21.7%	51.4%	32.6%
Total		Count	60	35	95
		% within Q6	100.0%	100.0%	100.0%

Table 2: MWU Ranks, AC vs NA

Ranks

	Q6 Groups	N	Mean Rank	Sum of Ranks
Q9	Active	60	52.32	3139.00
	Not Active	35	40.60	1421.00
	Total	95		
Q10	Active	60	52.93	3176.00
	Not Active	35	39.54	1384.00
	Total	95		
Q11	Active	60	54.37	3262.00
	Not Active	35	37.09	1298.00
	Total	95		
Q12	Active	60	53.06	3183.50
	Not Active	35	39.33	1376.50
	Total	95		

Table 3: MWU Test Statistics, AC vs NA

Test Statistics

	Q14 - Q9	Q15-Q10	Q16-Q11	Q17-Q12
Z	-2.314	-2.331	-3.032	-2.374
Asymp. Sig. (2-tailed)	.021	.020	.002	.018

Table 4: WSRT Sum of Ranks, AC

Ranks

Active		N	Mean Rank	Sum of Ranks
Q14 - Q9	Negative Ranks	8	9.63	77.00
	Positive Ranks	12	11.08	133.00
	Ties	40		
	Total	60		
Q15 - Q10	Negative Ranks	7	11.43	80.00
	Positive Ranks	29	20.21	586.00
	Ties	24		
	Total	60		
Q16 - Q11	Negative Ranks	17	20.79	353.50
	Positive Ranks	19	16.45	312.50
	Ties	24		
	Total	60		
Q17 - Q12	Negative Ranks	14	20.75	290.50
	Positive Ranks	28	21.88	612.50
	Ties	18		
	Total	60		

Table 5: WSRT Test Statistics, AC

Test Statistics[a]

	Q14 - Q9	Q15-Q10	Q16-Q11	Q17-Q12
Z	-1.090	-4.007	-.327	-2.032
Asymp. Sig. (2-tailed)	.276	.000	.743	.042

Table 6: WSRT Sum of Ranks, NA

Ranks

Not Active		N	Mean Rank	Sum of Ranks
Q14 - Q9	Negative Ranks	9	8.67	78.00
	Positive Ranks	6	7.00	42.00
	Ties	20		
	Total	35		
Q15 - Q10	Negative Ranks	3	9.33	28.00
	Positive Ranks	17	10.71	182.00
	Ties	15		
	Total	35		

Q16 - Q11	Negative Ranks	16	14.38	230.00
	Positive Ranks	11	13.45	148.00
	Ties	8		
	Total	35		
Q17 - Q12	Negative Ranks	10	11.65	116.50
	Positive Ranks	16	14.66	234.50
	Ties	9		
	Total	35		

Table 7: WSRT Test Statistics, NA

Test Statistics[a]

	Q14 - Q9	Q15-Q10	Q16-Q11	Q17-Q12
Z	-1.037	-2.901	-.996	-1.520
Asymp. Sig. (2-tailed)	.300	.004	.319	.129

Table 8: Rank Counts, AC vs NA

	Active			Not Active			Grand Total
Q14-Q9	TR	DTR	Total	TR	DTR	Total	
Tie	33	7	40	9	11	20	60
Neg	4	4	8	5	4	9	17
Pos	10	2	12	3	3	6	18
Grand Total	47	13	60	17	18	35	95
	Active			Not Active			Grand Total
Q15-Q10	TR	DTR	Total	TR	DTR	Total	
Tie	17	7	24	7	8	15	39
Neg	4	3	7	1	2	3	10
Pos	26	3	29	9	8	17	46
Grand Total	47	13	60	17	18	35	95
	Active			Not Active			Grand Total
Q16-Q11	TR	DTR	Total	TR	DTR	Total	
Tie	19	5	24	4	4	8	32

Neg	13	4	17	7	9	16	33
Pos	15	4	19	6	5	11	30
Grand Total	47	13	60	17	18	35	95

	Active			Not Active			Grand Total
Q17-Q12	TR	DTR	Total	TR	DTR	Total	
Tie	14	4	18	3	6	9	27
Neg	10	4	14	4	6	10	24
Pos	23	5	28	10	6	16	44
Grand Total	47	13	60	17	18	35	95

Appendix E: Gender

Table 1: MWU Ranks, Gender

Ranks

	Gender	N	Mean Rank	Sum of Ranks
Q9	Male	41	39.17	1606.00
	Female	54	54.70	2954.00
	Total	95		
Q10	Male	41	48.56	1991.00
	Female	54	47.57	2569.00
	Total	95		
Q11	Male	41	45.35	1859.50
	Female	54	50.01	2700.50
	Total	95		
Q12	Male	41	46.44	1904.00
	Female	54	49.19	2656.00
	Total	95		

Table 2: MWU Test Statistics, Gender

Test Statistics

	Q9	Q10	Q11	Q12
Mann-Whitney U	745.000	1084.000	998.500	1043.000
Wilcoxon W	1606.000	2569.000	1859.500	1904.000
Z	-3.150	-.176	-.839	-.488
Asymp. Sig. (2-tailed)	.002	.860	.402	.626

Table 3: WSRT Sum of Ranks, Male

Ranks

Male		N	Mean Rank	Sum of Ranks
Q14-Q9	Negative Ranks	10	9.30	93.00
	Positive Ranks	8	9.75	78.00
	Ties	23		
	Total	41		
Q15-Q10	Negative Ranks	6	7.58	45.50
	Positive Ranks	13	11.12	144.50
	Ties	22		

	Total	41		
Q16-Q11	Negative Ranks	19	14.37	273.00
	Positive Ranks	9	14.78	133.00
	Ties	13		
	Total	41		
Q17-Q12	Negative Ranks	14	12.82	179.50
	Positive Ranks	13	15.27	198.50
	Ties	14		
	Total	41		

Table 4: WSRT Test Statistics, Male

Test Statistics

	Q14 - Q9	Q15 - Q10	Q16 - Q11	Q17 - Q12
Z	-.334	-2.040	-1.606	-.233
Asymp. Sig. (2-tailed)	.739	.041	.108	.816

Table 5: WSRT Sum of Ranks, Female

Ranks

Female		N	Mean Rank	Sum of Ranks
Q14-Q9	Negative Ranks	7	9.43	66.00
	Positive Ranks	10	8.70	87.00
	Ties	37		
	Total	54		
Q15-Q10	Negative Ranks	4	16.13	64.50
	Positive Ranks	33	19.35	638.50
	Ties	17		
	Total	54		
Q16-Q11	Negative Ranks	14	20.86	292.00
	Positive Ranks	21	16.10	338.00
	Ties	19		
	Total	54		
Q17-Q12	Negative Ranks	10	21.05	210.50
	Positive Ranks	31	20.98	650.50
	Ties	13		
	Total	54		

Table 6: WSRT Test Statistics, Female

Test Statistics

	Q14 - Q9	Q15 - Q10	Q16 - Q11	Q17 - Q12
Z	-.513	-4.371	-.384	-2.872
Asymp. Sig. (2-tailed)	.608	.000	.701	.004

Table 7: Rank Counts, Gender and TR/DTR

	Male			Female			Grand Total
Q14-Q9	TR	DTR	Total	TR	DTR	Total	
Tie	13	10	23	29	8	37	60
Neg	4	6	10	5	2	7	17
Pos	6	2	8	7	3	10	18
Grand Total	23	18	41	41	13	54	95
	Male			Female			Grand Total
Q15-Q10	TR	DTR	Total	TR	DTR	Total	
Tie	13	9	22	11	6	17	39
Neg	2	4	6	3	1	4	10
Pos	8	5	13	27	6	33	46
Grand Total	23	18	41	41	13	54	95
	Male			Female			Grand Total
Q16-Q11	TR	DTR	Total	TR	DTR	Total	
Tie	8	5	13	15	4	19	32
Neg	8	11	19	12	2	14	33
Pos	7	2	9	14	7	21	30
Grand Total	23	18	41	41	13	54	95
	Male			Female			Grand Total
Q17-Q12	TR	DTR	Total	TR	DTR	Total	
Tie	7	7	14	10	3	13	27
Neg	5	9	14	9	1	10	24
Pos	11	2	13	22	9	31	44

Grand Total	23	18	41	41	13	54	95

Table 8: WSRT Sum of Ranks, Male TR

Ranks

Male/Take Responsibility		N	Mean Rank	Sum of Ranks
Q14-Q9	Negative Ranks	4	5.50	22.00
	Positive Ranks	6	5.50	33.00
	Ties	13		
	Total	23		
Q15-Q10	Negative Ranks	2	3.50	7.00
	Positive Ranks	8	6.00	48.00
	Ties	13		
	Total	23		
Q16-Q11	Negative Ranks	8	8.19	65.50
	Positive Ranks	7	7.79	54.50
	Ties	8		
	Total	23		
Q17-Q12	Negative Ranks	5	8.10	40.50
	Positive Ranks	11	8.68	95.50
	Ties	7		
	Total	23		

Table 9: WSRT Test Statistics, Male TR

Test Statistics

	Q14 - Q9	Q15 - Q10	Q16 - Q11	Q17 - Q12
Z	-.574	-2.139	-.316	-1.433
Asymp. Sig. (2-tailed)	.566	.032	.752	.152

Table 10: WSRT Sum of Ranks, Male DTR

Ranks

Male/Do Not Take Responsibility		N	Mean Rank	Sum of Ranks
Q14-Q9	Negative Ranks	6	4.33	26.00
	Positive Ranks	2	5.00	10.00
	Ties	10		
	Total	18		
Q15-Q10	Negative Ranks	4	4.25	17.00

	Positive Ranks	5	5.60	28.00
	Ties	9		
	Total	18		
Q16-Q11	Negative Ranks	11	6.55	72.00
	Positive Ranks	2	9.50	19.00
	Ties	5		
	Total	18		
Q17-Q12	Negative Ranks	9	6.22	56.00
	Positive Ranks	2	5.00	10.00
	Ties	7		
	Total	18		

Table 11: WSRT Test Statistics, Male DTR

Test Statistics

	Q14 - Q9	Q15 - Q10	Q16 - Q11	Q17 - Q12
Z	-1.137	-.666	-1.864	-2.178
Asymp. Sig. (2-tailed)	.256	.506	.062	.029

Appendix F: Age Outputs

Table 1: Kruskal Wallis Ranks, Age

Ranks

	Age	N	Mean Rank
Q9	18-29	23	50.30
	30-44	19	53.92
	45-60	19	50.00
	>60	34	42.01
	Total	95	
Q10	18-29	23	42.76
	30-44	19	51.16
	45-60	19	50.37
	>60	34	48.46
	Total	95	
Q11	18-29	23	52.22
	30-44	19	51.61
	45-60	19	44.21
	>60	34	45.25
	Total	95	
Q12	18-29	23	44.78
	30-44	19	49.84
	45-60	19	52.16
	>60	34	46.82
	Total	95	

Table 2: Kruskal Wallis Test Statistics, Age

Test Statistics

	Q9	Q10	Q11	Q12
Chi-Square	3.674	1.281	1.652	.917
df	3	3	3	3
Asymp. Sig.	.299	.734	.648	.821

Table 3: WSRT Sum of Ranks, 18-29

Ranks

Age: 18-29	N	Mean Rank	Sum of Ranks

Q14-Q9	Negative Ranks	5	4.40	22.00
	Positive Ranks	2	3.00	6.00
	Ties	16		
	Total	23		
Q15-Q10	Negative Ranks	3	7.00	21.00
	Positive Ranks	15	10.00	150.00
	Ties	5		
	Total	23		
Q16-Q11	Negative Ranks	12	11.29	135.50
	Positive Ranks	6	5.92	35.50
	Ties	5		
	Total	23		
Q17-Q12	Negative Ranks	9	11.50	103.50
	Positive Ranks	11	9.68	106.50
	Ties	3		
	Total	23		

Table 4: WSRT Test Statistics, 18-29

Test Statistics

	Q14 - Q9	Q15 - Q10	Q16 - Q11	Q17 - Q12
Z	-1.403	-2.836	-2.189	-.056
Asymp. Sig. (2-tailed)	.161	.005	.029	.955

Table 5: WSRT Sum of Ranks, 30-44

Ranks

Age: 30-44		N	Mean Rank	Sum of Ranks
Q14-Q9	Negative Ranks	5	3.00	15.00
	Positive Ranks	2	6.50	13.00
	Ties	12		
	Total	19		
Q15-Q10	Negative Ranks	1	5.50	5.50
	Positive Ranks	7	4.36	30.50
	Ties	11		
	Total	19		
Q16-Q11	Negative Ranks	4	4.13	16.50

	Positive Ranks	5	5.70	28.50
	Ties	10		
	Total	19		
Q17-Q12	Negative Ranks	4	3.75	15.00
	Positive Ranks	6	6.67	40.00
	Ties	9		
	Total	19		

Table 6: WSRT Test Statistics, 30-44

Test Statistics

	Q14-Q9	Q15-Q10	Q16-Q11	Q17-Q12
Z	-.171	-1.774	-.718	-1.292
Asymp. Sig. (2-tailed)	.865	.076	.473	.196

Table 7: WSRT Sum of Ranks, 45-60

Ranks

Age: 45-60		N	Mean Rank	Sum of Ranks
Q14-Q9	Negative Ranks	3	4.67	14.00
	Positive Ranks	5	4.40	22.00
	Ties	11		
	Total	19		
Q15-Q10	Negative Ranks	3	3.67	11.00
	Positive Ranks	8	6.88	55.00
	Ties	8		
	Total	19		
Q16-Q11	Negative Ranks	5	5.10	25.50
	Positive Ranks	6	6.75	40.50
	Ties	8		
	Total	19		
Q17-Q12	Negative Ranks	5	4.80	24.00
	Positive Ranks	8	8.38	67.00
	Ties	6		
	Total	19		

Table 8: WSRT Test Statistics, 45-60

Test Statistics

	Q14 - Q9	Q15 - Q10	Q16 - Q11	Q17 - Q12
Z	-.586	-1.972	-.679	-1.516
Asymp. Sig. (2-tailed)	.558	.049	.497	.129

Table 9: WSRT Sum of Ranks, >60

Ranks

Age: >60		N	Mean Rank	Sum of Ranks
Q14-Q9	Negative Ranks	4	7.50	30.00
	Positive Ranks	9	6.78	61.00
	Ties	21		
	Total	34		
Q15-Q10	Negative Ranks	3	7.17	21.50
	Positive Ranks	16	10.53	168.50
	Ties	15		
	Total	34		
Q16-Q11	Negative Ranks	12	15.13	181.50
	Positive Ranks	13	11.04	143.50
	Ties	9		
	Total	34		
Q17-Q12	Negative Ranks	6	12.50	75.00
	Positive Ranks	19	13.16	250.00
	Ties	9		
	Total	34		

Table 10: WSRT Test Statistics, >60

Test Statistics

	Q14-Q9	Q15-Q10	Q16-Q11	Q17-Q12
Z	-1.113	-2.993	-.523	-2.389
Asymp. Sig. (2-tailed)	.266	.003	.601	.017

Table 11: Crosstabs, Age*Q8

Age * Q8 Crosstabulation

	Q8	Total

			Take Responsibility	Do not take responsibility	
Age	18-29	Count	18	5	23
		% within Age	78.3%	21.7%	100.0%
	30-44	Count	16	3	19
		% within Age	84.2%	15.8%	100.0%
	45-60	Count	11	8	19
		% within Age	57.9%	42.1%	100.0%
	>60	Count	19	15	34
		% within Age	55.9%	44.1%	100.0%
Total		Count	64	31	95
		% within Age	67.4%	32.6%	100.0%

Table 12: Crosstabs, Age*Gender

Age * Gender Crosstabulation

			Gender		
			Male	Female	Total
Age	18-29	Count	10	13	23
		% within Age	43.5%	56.5%	100.0%
	30-44	Count	8	11	19
		% within Age	42.1%	57.9%	100.0%
	45-60	Count	9	10	19
		% within Age	47.4%	52.6%	100.0%
	>60	Count	14	20	34
		% within Age	41.2%	58.8%	100.0%
Total		Count	41	54	95
		% within Age	43.2%	56.8%	100.0%