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Public Perceptions of Marine Environmental Issues: A Review

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Abstract

In recent years, the importance of the marine environment has become prevalent, however it still faces many threats. One course of action for effective management of the marine environment requires the adoption of an ecosystem approach, as the top-down management strategy has often proved unsuccessful. The ecosystem based approach considers public perception and encourages agencies to consider the public when making decisions in order to have public participation or 'buy in' to the various policies/strategies for the management of the resources. A number of studies on public perceptions of the marine environment have been conducted in line with the ecosystem approach. This dissertation reviews the extensive literature on the public perception studies of the marine environment and provides recommendations for influencing environmentally conscious behaviour in society.

1. Introduction

Marine environments are vital for human wellbeing yet they face numerous threats which may have severe consequences. Humans rely on marine environments for food, recreation and economic opportunities but they are also essential for supporting and regulating services[1]. Despite this, human activities along with the rapid increase in population size and advancement in technology are increasingly exerting pressure on marine environments globally, both directly and indirectly (Halpern et al., 2008). Nationally and internationally, there have been several efforts aimed at conservation and the promotion of the sustainable use of marine environments. These efforts have consisted of strategies such as the Marine Strategy Framework Directive, the Habitats and Birds Directives, the Common Fisheries Policy, and the Global Partnership on Marine Litter, among others. It is usually the case that these strategies are implemented through expert working groups. However, implementing such policies without public consultation could be problematic as successful implementation of such policies requires them to be accepted by those they affect (Lorenzoni and Pidgeon, 2006). Understanding the public's awareness, values, concerns, attitudes and behaviour can therefore provide a database of knowledge which supports environmental reforms and policies (Gelcich et al., 2014; Jefferson et al., 2014; Potts et al., 2011).

A number of studies have been conducted to determine public perceptions of the marine environment. Some of the concerns relating to public perceptions of the marine environment include: the phenomenon that the public has little or no knowledge of the threats faced by the marine environment; the gap between scientific facts and public awareness; and the public not being concerned with environmental issues. This report examines the existing literature on public perceptions of the marine environment. Below we first briefly outlines the environmental and societal benefits of the marine environments and highlights the main threats they face. Section 2 then reviews previous research on public perceptions toward marine environments and summarizes the key findings from the different studies. In section 3 a number of public perception studies on the major marine industries - fishing, aquaculture, marine tourism, and marine shipping are reviewed. Finally, section 4 concludes by presenting a summary of the key principles for influencing society and bringing about behavioral change.

1.1 The Marine Environment

Life on earth is greatly supported by the sea. The ocean and their ecosystems are important for their provisioning services[2] like fisheries, oil, gas, minerals, sand and gravel. They are also essential for supporting and regulating services for example,

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[1] Supporting services are those that are necessary to produce other ecosystem services while regulating services are the benefits obtained from the regulation of ecosystem processes.

[2] Provisioning services are products used by humans that are obtained from ecosystems

inter alia, waste disposal, release of oxygen, carbon dioxide capture and storage, habitats, nutrient recycling, as well as climate regulation (Thurber et al., 2014). Marine related industries like fishing, tourism, energy, aquaculture and transport are also very important economically, by employing thousands of people and contributing billions to economies around the world. However, human activities have always impacted marine environments. The extent of the impact depends on the nature of human interface with the ocean and their surroundings. The main threats to the marine environment include pollution, climate change, habitat loss, over fishing and invasive species.

The ocean also plays a significant role in biogeochemical[3] cycles of carbon by absorbing about one-third of all carbon dioxide emissions in the atmosphere (Chen and Bolges, 2009). However, economic activities like shipping, oil and gas exploration, and tourism have caused the amount of carbon dioxide in the atmosphere to rise significantly (Dupont and Portner, 2013). Excess carbon dioxide causes the water pH to decrease leading to ocean acidification (Corner et al., 2014). Ocean acidification endangers marine organisms like fish, corals, brittlestars, etcetera, which may decrease marine biodiversity or even render some species extinct (Corner et al, 2014; Dupont and Portner, 2013).

Pollution is another major threat facing the marine environment today. It can be direct or indirect and results from activities such as agriculture, tourism, shipping, oil and gas exploration, aquaculture and other marine related industries. This results from actions such as dumping litter, untreated sewage, nutrient runoff, industrial chemicals, and fertilizers in to the sea (Chen and Bolges, 2009; Davenport and Davenport, 2006). Oil spills also cause pollution to the ocean which leads to damage of marine habitats, species mortality , adverse health effects and lost productivity. For example, the Exxon Valdez spill released 250,000 barrels of crude oil which resulted in the death of 250,000 birds, 2800 otters, over 250 seals and destroyed an unknown number of salmon and herring eggs (Kling et al., 2012).

Tourism is considered one of the most important economic sectors worldwide and coastal zones provide a very good environment for this activity (Moreno and Amuleng, 2009). However, tourist activities, the construction of tourism infrastructure, and cruise ship activity can contribute to habitat destruction. Finally, agriculture and fishing are important sources of food. However, the increase in demand for sea food and fish forage has led to over fishing creating a danger of extinction of some species (European Commission, 2011; Sporrong et al. 2005). In order to meet this increased demand there has been an increase in aquaculture. Aquaculture and agriculture nutrient run-off causes eutrophication[4] and results in death of other aquatic species like fish (Meyer et al., 2000; Smith et al., 1999; Selman et al., 2008). There is a need

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[3] A biogeochemical cycle of carbon is a cycle by which carbon is exchanged between the biosphere, hydrosphere, lithosphere and atmosphere of the earth.
[4] Eutrophication refers to the rapid growth of phytoplankton and algae which depletes water of oxygen

to address the threats to the marine environment to ensure it can provide ecosystem service benefits into the future. To address these threats however, we first need to understand society's attitudes toward the marine environment. The next section examines previous public perceptions studies on the marine environment with the aim of understanding what influences public values, attitudes, and behaviour toward the marine environment.

2. Public Perceptions on the Marine Environment

The deteriorating state of the ocean around the world and the ensuing social, health, and economic impacts have triggered a number of national and international efforts in the form of policies, legislations and directives aimed at returning ocean and seas to a healthy state (Gelcich et al., 2014). From the literature there appears to be a consensus that a top down approach may not be the most appropriate way to deal with the problem, making a collaborative approach the preferred option. There often appears to be a gap between what is known through research, and what policymakers and the public know and understand about the ocean and this may have consequences for the development and implementation of marine policies and measures. The objective of this section is to review the literature on public perceptions studies of the marine environment. The studies reviewed are split between those undertaken at an individual country level and also at cross-country levels. A review of a number of studies of perceptions towards the marine environment among young people is also presented.

2.1. Cross-country studies on public perceptions of the marine environment

This section reviews two studies conducted across a number of European countries and one which was conducted across a number of Baltic Sea countries. Europe's regional seas have suffered environmental degradation and yet previous efforts to solve the problem had not been successful. This led the European Union member states to adopt the Marine Strategy Framework Directive to find an adequate solution to their shared marine resources. This instrument relies on the ecosystem-based management approach, which comprehensively includes humans and the supporting ecosystem. The public perception studies enable the public position to be captured resulting in more effecting strategies.

The KnowSeas survey was conducted across seven European countries with the aim of eliciting public perceptions of Europe's Seas. The project was funded by the European Community's Seventh Framework Programme (FP7) and it involved the United Kingdom, France, Germany, Spain, Portugal, Italy, and Poland. The results of this study are outlined in the paper by Potts et al. (2011). The purpose of the study was collecting public views of the sea, its value to them as well as how important it was relative to other national and global issues. A sample of 7000 respondents, 1000 from each country was taken and questions were asked in order to determine the following:

- The importance of the sea to the individuals;

- The importance of marine health to individuals relative to other issues;
- The most important threats to the sea;
- Who was best suited to manage the sea; and
- Attitudes towards marine protected areas.

Regarding the importance of the sea to individuals, the respondents recognized its provisioning and regulating services with non-market ecosystem services like climate and weather coming across as the most important aspect of the ocean. The ocean was valued equally as a food source and for their scenic value with 65% of respondents ranking these attributes as important or very important. There was no significant difference in perceived importance of the socio-economic uses of the ocean. Between 51% and 55% of the respondents considered the sea to be important or very important for education, trade and shipping, energy, tourism and cultural identity. Among the aspects considered least important were employment and creativity values. Based on the above findings, it is important to consider the aesthetic, non-market value of the sea during the decision making process.

The results also suggested that ocean health was a low priority for the public with only 46% raking it as important. Issues like the cost of living, health, education, terrorism, the economy, pollution, and poverty were considered more important than ocean health. When asked to rank how much of a threat certain issues were to the marine environment, the results indicated a strong difference in what scientists believed to be the biggest concerns regarding marine health (climate change, eutrophication and destructive fishing) and what the public perceived them to be. The public perceived pollution, litter and large scale industrialization to be the most important threats. Less than half of the respondents ranked marine issues such as species loss, shipping, invasive species, fisheries, aquaculture and marine renewables as important. This suggests a communication deficiency of scientific findings to the public.

When asked who they thought was best suited to manage marine resources, the majority of the respondents believed that environmental groups and scientists were the most competent, while private industry was believed to be least competent. The public had little trust in government institutions, but of the existing institutions the EU was ranked the most competent. This lack of trust could have been a result of failure of government policies to prevent environmental problems. The majority of respondents greatly supported marine protection. This was the case especially in countries that expressed ocean health as an important issue and/or have a high consumption of seafood.

The authors concluded by highlighting the need for consideration of public views in the decision making process as it is a key step of ecosystem based management and it would ensure the success of management initiatives.

The second major cross-country study reviewed here that examined public perceptions towards the marine environment had a particular interest in climate change. The results of the FP7 project CLAMER (Climate Change and European Marine Ecosystem Research) were reported in Buckley et al. (2011). While there had been previous studies about public perceptions on climate change, studies particularly

focused on marine climate change were lacking and not much attention had been paid to marine environmental issues in general. For this reason the CLAMER project was focused on determining the public's perception towards marine climate change issues and finding out the public's awareness and concern for marine environmental issues in general.

A survey was conducted involving 10,000 European citizens selected from ten countries namely; Norway, Netherlands, United Kingdom, Germany, Estonia, France, Iceland, Czech Republic, Spain and Italy. The choice of countries depended on geographic location and ethnic diversity of the nations with many having a coastline with regional seas. Respondents to the study were asked questions relating to their general perceptions of major global risks, climate change and marine environmental matters.

The results of the survey suggested that climate change was a concern to the European public and they ranked it the second most important global issue. Up to 46% of the respondents believed climate change was solely a result of human activity, while 42% believed that it was caused by both natural processes and human activity. This was an important finding in that if the adverse change is caused by human activity, then there is a possibility of stopping it by countering those activities. Regarding marine issues, pollution, over-fishing and habitat destruction were of most concern to the citizens while the two most important concerns relating to marine climate change were sea level rise and flooding. The survey revealed differences across socio-demographic groups. "Females although less informed, expressed more concern than males, coastal dwellers more than those living inland, and older people (55-64 age bracket) more than younger people (18-34 year olds)" Buckley et al. (2011). These differences across socio-demographic groups were similar to those reported in Ahtiainen et al. (2013) and the Special Eurobarometer 322 (European Commission, 2009).
Respondents were asked a number of questions relating to sea temperature change and sea level rise. Approximately two thirds of the public's estimates for rates of sea level rise and temperature change were in line with the scientific facts, suggesting success of public awareness efforts.

Another important aspect of the 2011 FP7 CLAMER report was to determine the public's sources of information on climate change and their associated level of trust. It was clear that the citizens trusted scientists working for research institutes, universities and environmental NGOs more than those working for government and industry. Also, television channels were the main source of information and were trusted by 60 per cent of the respondents. The most trustworthy source of information was scientific journals with 29% of respondents getting their information from this source.

The research by Gelcich et al. (2014) concerning public awareness, concerns, and priorities about anthropogenic impacts [5]on marine environments formed part of the CLAMER project. Findings in the report by Buckley et al. (2011) and Gelcich et al. (2014) noted that respondents felt that they lacked individual effectiveness in tackling marine impacts, with 57% of them believing that individual citizens' actions were

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[5] This includes impacts on biophysical environments, biodiversity, and other resources, resulting from human activity.

ineffective. The authors note that there is little that can be done regarding behavioural change if individuals believe that their actions are insignificant compared to the weight of the problem. They further highlight a need to empower the public with information as one of the ways to improve their perceptions and actions towards the marine environment.

Elsewhere, Ahtiainen et al. (2013) undertook a study of the public's recreational use and perceptions of the Baltic Sea. The Baltic Sea is very important to a number of countries yet it is under threat, with eutrophication being a major problem. The study involved a random sample survey of the public in the nine states surrounding Baltic namely; Denmark, Germany, Finland, Lithuania, Sweden, Latvia, Estonia, Poland and Russia. The first objective of the study was getting an understanding of the scope and variety of the public's recreational use of the Baltic Sea and how water quality affected it. The second objective was to find out how the public in the nine states assessed the present condition of the sea and to determine their attitudes towards its improvement.

In this study, respondents were first asked about the frequency of visits to the Baltic Sea, the kinds of recreation undertaken there and how the water quality affected them. The respondents enjoyed a variety of activities including; beach recreation, swimming, boating, cruises, non-winter fishing, diving, ice sports, and water sports among others. The water quality was not considered a major issue and did not restrict their activities and experience. The condition of the sea was considered to be neither 'good' nor 'bad' even though it was an issue of concern. However, there were significant differences in opinions across countries, with those from the east of the Baltic considering its condition worse than those from the west. The eastern sub-region of the Baltic Sea is affected the most by eutrophication compared to all other regions. This shows that the public has some knowledge about the current state of affairs. The Russians and Poles in particular held the view that it was restricting to their recreational opportunity, with the Russians (least frequent visitors) believing that they would visit more if the water quality improved.

Respondents were also asked about their individual impact on the sea and if they were willing to make a financial contribution towards its improvement. The results suggested that generally the respondents did not consider themselves accountable for its state and were unwilling to pay towards its improvement. However, the expressed level of concern, and acceptance of accountability for their actions were positively related to willingness to pay with the Swedes, Finns, Poles and Danes most willing to make financial contributions. The level of concern and willingness to make a financial contribution towards a healthier sea also varied across socio-demographic groupings. Older people and larger households were less willing to contribute financially towards improvement of the sea. On the other hand, those with a higher level of education, higher income, younger people, and respondents who frequently visited the sea showed more concern about its state and were willing to contribute to this cause.

Countrywide, population size and average income were positively related to willingness to contribute to sea improvement, with Poland (large population), Denmark, Sweden and Finland (higher average incomes) leading in this area. These variations in responses across socio-demographic groups were similar to those noted by in the Special Eurobarometer (European Commission, 2009), briefly reviewed below, which was specifically about the public's attitude towards climate change.

The Special Eurobarometer involved a survey of the public across the 27 member states of the EU, with the aim of eliciting their perceptions on the seriousness of climate change, possible actions to combat it, and willingness to pay more for greener energy. The results suggested that staying longer in education, being female, and being younger were related to higher concern about climate change; while having a better financial status increased willingness to pay for cleaner energy (European Commission, 2009).

2.2   Country specific public perception studies of the marine environment

The current literature on public perceptions of the marine environment includes country specific studies. This section reviews some of these studies from a number of countries namely, the UK, Ireland, USA and New Zealand.
The studies reviewed for the UK and Ireland include findings from Cobham Research Consultants (1997), Fletcher et al. (2009), Hynes et al. (2013) and Jefferson et al. (2014) on what the public knew about the coastal and marine environment. Corner et al. (2014) focused on public's knowledge on ocean acidification. Details of these studies are outlined below.

The research by Cobham Resource Consultants (1997) on public perceptions towards the marine environment in Scotland appears to be one of the earliest studies in this area. The research was prompted by the need to have a knowledge base of what influenced the public's marine awareness, values and attitudes in order to enhance development of effective marine environment plans. The purpose of the study was to elicit the attitudes and aspirations of the public towards their marine environment. Questions asked during the study were related to the use, controls and conservation importance of the marine environment. The results of the study suggested that the majority of the public (67%) considered the seas and coasts as very important to them. The public valued wild life features of the sea and its scenic aspect as the most important followed by its provisioning services. No importance was attached to the sea regarding waste disposal. However, despite being considered very important, other natural features like forests and rivers tended to be ranked more highly than the marine environment.

When asked about the issues facing the marine environments, respondents identified coastal zone management as the most pressing issue, while others included water pollution, beach sewage pollution, oil pollution, and over fishing. More respondents

were in favour of strong statutory controls over the marine environment than voluntary management measures; however the majority (80%) supported integration of marine management. Regarding publicity, the majority of the respondents felt that marine environmental matters did not get enough media attention, and when they did, it was mainly negative. When asked about marine protection levels, the respondents identified the fish stocks and water quality as the main 'under protected' marine aspects, while others included marine habitats and marine archaeology.

A number of recommendations were suggested including increased all round media coverage of marine environmental issues and integration of marine management measures to include the local perspectives.

In another study by Fletcher et al. (2009), a survey "to elicit public awareness of the coastal and marine environmental issues in the UK specifically within the context of the UK's National Maritime Museum's (NMM) Planet Ocean Initiative" was carried out. The Planet Ocean Initiative was aimed at promoting public awareness of the oceans. It consisted of two phases, with the first being concerned with the promotion of the Museum's profile in the marine environment subject area. The second phase focused on enhancing public awareness, promoting marine education, participation and increased outreach activities. The survey further focused on offshore renewable energy based on the fact that the UK has an outstanding wind resource in Europe.

A total of 138 face-to-face interviews were conducted with members of the public visiting the NMM. Respondents were asked to name the marine environment issues that they found interesting, the most serious issues facing the ocean, and whether they would revisit the NMM if issues of interest were made part of the interpretive material. Among the top marine environmental issues of interest were pollution, marine life, climate change, fishing stocks and overfishing. The most serious issues facing the ocean included; pollution (40.8%), climate change (17.3%), and overfishing and stock depletion (16.8%). Sea-level rise, marine litter, sewage disposal, shipping and tourism were perceived to be of less concern. The majority of the respondents (94.9%) believed that the NMM was a credible and well-suited place for raising marine environmental issues. In addition, 45% of respondents indicated that they would revisit the NMM if their topics of interest were made part of the interpretive material. Based on this strong support, the authors concluded that the NMM provides a very good avenue for increasing public awareness of marine issues and should be made a comprehensive knowledge centre with online access to material and resources.

The next area of interest of the study involved eliciting the public's knowledge about offshore renewable energy and its effects on the marine environment. When asked whether they were aware of offshore renewable energy production, up to 76.8% of the respondents responded in the affirmative especially mentioning 'wind farms with tidal power', and 'wave and wind power'. Respondents' general knowledge of offshore energy was impressive with 37% aware and able to elaborate on the related UK government policy. The majority of the respondents (86.2%) were in favor of

development of an offshore renewable energy exhibition in the NMM. Their interest was focused on provision of information on how offshore renewable energy production takes place, related facts and figures, as well as its impact on the environment and ecosystems. The interest in the effects of offshore renewable energy illustrates the concern of the public for their marine environment. This interest and demonstration of knowledge by the public lays a foundation for further enhancement of knowledge through the development of comprehensive interpretational materials.

Another study by Jefferson et al. (2014) focused on the public perceptions of the UK marine environment in line with the national and international drive of understanding the social values, attitudes and knowledge about the marine environment. The study involved a survey of 1047 members of the public with the aim of answering questions related to marine species and marine health. It sought to determine whether there was potential to develop a more optimistic association between the UK public and the sea, despite the previous studies which noted a pessimistic association. Species related questions were asked with the aim of eliciting public knowledge of marine species. Ecosystem health questions were asked to identify the criteria the public used to judge the sea as healthy or unhealthy.

Respondents were shown pictures and the names of twelve species. They were then asked three questions about the species. The results suggested that respondents were most familiar with colorful or impressive-looking species like puffins, sea horses, seals and cod. The least familiar species were the invertebrates like the oyster and lobster. However, the results showed that the more familiar respondents were with the species; the less they thought it was found in the UK seas. On the other hand, those species respondents were less familiar with were believed to be found in the UK seas. These findings indicate a knowledge gap amongst the UK public in relation to the biodiversity in the seas around them. Similar to Ahtiainen et al. (2013), frequency of visits to the coast was positively related to knowledge about marine species which could be interpreted as the importance of physical engagement in influencing ocean literacy.

In relation to the ocean health, contaminated sea food as well as beach and sea cleanliness were chosen by 60% of respondents as indicators of a healthy or unhealthy marine environment. These two indicators were classified under human related impacts. The highest ranking ecological indicators of an unhealthy sea included damaged habitat and low diversity. The people who were the first to settle near the sea (pioneers) were more knowledgeable and concerned about marine environment issues than those who were likely to settle there in the future (prospectors) or those who had settled after the pioneers (settlers). Females were also more concerned about the marine environment than males. The frequency of visits to the sea was positively related to ocean knowledge and concern. This suggested once again that marine experience plays a key role in shaping individual attitudes, concerns and behaviour.

These findings provide intuition of what matters when it comes to the public relationship with its sea and should be made part of the possible course of action in order to achieve marine conservation.

Ocean acidification is another recognized major threat to oceans around the world and has attracted increasing interest from scientists in an effort to understand it. Public understanding of ocean acidification however is still very low and could be frustrating efforts aimed at improving ocean health. Corner et al. (2014) conducted a survey to find out public perceptions of ocean acidification in the UK. The online survey involved 2501 respondents and was funded as part of the UK Ocean Acidification Research Programme. Every seven years the Intergovernmental Panel on Climate Change (IPCC) issues assessment reports aimed at presenting policy relevant highlights on updates relating to climate change issues. The survey by Corner et al. (2014) was performed in two phases with the first being before the release of the IPCC 5th Assessment Report (September 2013), and the second phase taking place after the release of the report (May 2014). This was done in order to identify whether the report which had specific information on ocean acidification had had any significant influence on public perceptions of the issue.

The results suggested that most people were not concerned about ocean acidification with only 19.6% of respondents responding positively to the question inquiring whether they had heard of ocean acidification before the survey. Of those, only half claimed to have come across information about ocean acidification since the beginning of 2014 and less than 3% of respondents knew a fair amount or a great deal about the issue. When asked if they were concerned about the issue 56.5% responded that they did not know or had no opinion.

When asked how much of a threat certain environmental issues were to the marine environment; industrial pollution was considered the most serious threat, while over fishing, sewage, litter, climate change, and ocean acidification were believed to pose a similar magnitude of threat to the marine environment. The study also sought to obtain information on the public's perception of the causes and consequences of ocean acidification. Despite the low level of knowledge about ocean acidification, when provided with some basic information about the subject, many respondents believed anthropogenic carbon emissions and shipping pollution to be the major causes of ocean acidification. Their level of concern about ocean acidification also significantly increased. Regarding consequences of ocean acidification, respondents strongly agreed that it resulted in damaged coral reefs, unfavorable conditions for marine animals and reduced ability by the ocean to absorb carbon dioxide.

The study also sought to elicit perceptions of scientific findings in the area of ocean acidification. Most respondents believed that the majority of science experts were of the view that ocean acidification was a result of human activities and that it had harmful effects on the marine environment and ecosystems. They believed however

that scientists agreed more on ocean acidification effects than on its causes. The perceived disagreement among scientists on the causes was divergent from the current state of knowledge (carbon emissions are the major cause of the ongoing ocean acidification); indicating a knowledge gap. Lastly, much as the respondents believed that ocean acidification had consequences for them, the majority felt that they could not do much about the issue. This suggested that there was a need to empower people with the relevant information so as to address some of the issues noted in the study.

When asked about the level of trust in the different sources of ocean acidification information, independent scientists, environmental groups and ocean scientists were trusted the most, while government, media and industry were least trusted. These information credibility ratings were similar to what was noted by Potts et al. (2011), Buckley et al. (2011) and Hynes et al. (2014). In addition, there was no significant difference in the level of public awareness of ocean acidification before (phase one) and after (phase two) the IPCC 5th assessment report. This necessitates coming up with effective ways of communicating to the public about ocean acidification and, perhaps climate change issues in general, where they can find the relevant information. Following the shift of the European marine environment policy agenda towards an ecosystem based approach there was a need for participatory governance rather than a top down approach. This prompted the study by Hynes et al. (2014) aimed at eliciting the values, concerns and preferences of Irish individuals towards their marine environment. The survey involved quota controlled sampling of 182 individuals in Ireland aged 18 years and above. Respondents were asked a series of questions to elicit their personal opinions and attitudes towards the environment. The first question required respondents to give their view on the state of the ocean around Ireland. The majority of respondents (68%) believed they were in a good or very good state, 15% believed that they were poor or very poor while the remaining 17% believed that they were neither good nor bad. According to the authors, the majority of positive rankings could have been a result of the various marine related water management schemes put in place over the previous twenty years like the Water Framework Directive, the Bathing Waters Directive and the Marine Strategy Framework Directive.

When respondents were asked to rank the importance of the sea to them, they identified its value as a source of food, for regulating weather and climate and for recreation and tourism. This was evidence that respondents were aware of the importance of the non-market marine ecosystem services like climate regulation, recreation and scenery. The authors note that the non-market nature of these services does not make them any less important than those which have a market value and as such they should be considered in marine environmental decision making.

The study results also indicated that socio-demographic groups had an influence on respondents' values and concerns for the marine environment. Income was positively related to the importance respondents attached to the sea; particularly those individuals with lower annual incomes under valued the sea as a source of food

compared to those who had higher incomes. Generally this low rating of importance was typical from low income households for all marine related values.

In response to questions relating to how much of a threat different issues were to the Ireland's marine environment, industry pollution ranked highest (87%), followed by litter (86%), oil and gas extraction (81%) and ocean acidification (80%). Invasive species were considered a threat by 60% of respondents even though they did not pose a significant risk to Irish marine waters at the time of the survey in 2012. Surprisingly farming and aquaculture were considered a threat by less than 50% of the respondents, and only 52% believed fishing to be a significant threat. This public perception of threats to the marine environment did not coincide with the views of the Irish Environment Protection Agency (EPA) which considered marine litter, commercial fishing and the effects of agriculture, aquaculture, and climate change to pose a serious threat to Ireland's marine environment. This divergence in views between the public's perceptions of threats to the marine environment and those of the EPA is similar to that noted by Potts et al. (2011) where the general public's perceptions of threats to the marine environment were different from scientific facts.

Similar to the findings of Fetcher et al. (2009) and Potts et al. (2011), scientists were perceived to be best suited to manage the marine environment. Local and national government did not rank so well with only 25% and 27% of respondents feeling that they were competent to deal with the issue. A higher percentage of respondents (40%) believed that the EU was competent in managing the marine environment.

In conclusion, the Irish people were quite knowledgeable about the marine environment but their knowledge could be enhanced through improved communication. This would help bridge the identified knowledge gap. The findings provide a good knowledge foundation for an ecosystem based approach of management of the marine environment.

Beyond Europe there are a number of noteworthy studies on the public perceptions towards the marine environment, particularly in the US. Steel et al. (2005) investigated the level of public knowledge of oceans, and the effect of information sources on knowledge holding of Southern Californians. The study was in line with the 2004 Pew Oceans Commission Report suggestion of the need to improve public ocean literacy so as to enhance public support for ocean restoration efforts. The study involved a random sample survey of 1,233 households from 48 contiguous states in America. First, respondents were asked how well informed they were about ocean and coastal issues before subjecting them to an ocean related quiz. Results suggested that while the majority of respondents (two thirds) considered themselves informed, the ocean quiz scored on average below 50%, and respondents were found to have a difficult time identifying important ocean related terms.

Next, the study investigated the factors (situational, trans-situational and information source) which are associated with higher levels of knowledge. The frequency of visits

made to the ocean was positively associated to knowledge holding. However, the level of knowledge did not significantly differ between coastal and noncoastal residents and generally the public were not highly informed of ocean issues. This highlighted the need for information for all citizens, be it coastal or noncoastal about ocean issues. Also, the findings suggested that use of certain information sources could either contribute to knowledge or adversely impact knowledge levels. For example, using television and radio had a negative impact on knowledge retention.

The socio-demographic factors; level of education, age of the respondent, and being male positively influenced the level of information that respondents had, evidenced by knowledge of ocean terms and high scores on the ocean quiz. This was similar to findings of Buckley et al. (2011). Such variables point to the factors causing the knowledge gap and the need to consider them during the design of possible solutions aimed at closing it.

The second American study was by Pendleton et al. (2001) and was part of the University of Southern California Beach Project. The study had the purpose of eliciting Southern Californians' perceptions about the environment and beach recreation. A survey of 400 households in Los Angeles County was conducted and the respondents were asked questions concerning water and air quality, their participation in beach recreation, socio-economic status, and how long they had stayed in the area. When asked about the major problem facing the ocean, the majority of the respondents identified marine pollution and also believed that it had got worse than it had been five years before. This was contrary to the fact that there had been major advances in sanitation (sewage treatment), and storm water diversion which had reduced the total bacteria load in coastal waters.

The results also suggested that many of the respondents had visited the beach at least once during any summer but the majority (61.54%) did not make physical contact with the water. This was due to their perception of the ocean being more polluted than clean. The majority of the respondents got their information about beach cleanliness mostly from television news than from any other source like personal experience. When asked to rank ocean water pollution with some other issues like crime, public education, and air pollution; the majority of the respondents ranked it as less important than each one of them. The little importance attached to water pollution could explain the misperception about water quality. This calls for more public education campaigns and effective ways of delivering relevant information to the public since the media had not fully succeeded in properly informing the public about coastal water quality.

Another study on the public perceptions towards the marine environment that took place in New Zealand is also worth mention. Eddy (2014) took note of the fact that global marine biodiversity loss from increased human activity has led to drives aimed at addressing this issue. One of them is the United Nations Environmental Program Aichi Biodiversity 10% global ocean protection target by 2020. Among other things,

the Aichi Biodiversity target required understanding the causes of biodiversity loss, addressing them and increasing public awareness of the values of biodiversity (CBD, 2010; Eddy, 2014).

The study by Eddy (2014) was in line with the above drive and was aimed at understanding what society knew about marine threats and how they perceived marine protected areas. It emphasized the gap between what the public knows about marine environment matters and the scientific consensus. The WWF-New Zealand commissioned two surveys on public perceptions of threats to the marine environment and level of protection of the marine environment in 2005 and in 2011. The author combined findings of these two surveys and compared them to findings of a report by MacDiarmid et al. (2012) comprising of expert opinions from 47 scientists on the marine environment. This was done to identify gaps between public perceptions and the actual threats and protection levels of the New Zealand marine environment.

Science experts identified the top five marine environment threats as ocean acidification, rising sea temperatures, bottom trawling, increased sedimentation from changes in land use, and climate change and dredging for shell fish tying in fifth position. The scientists also agreed that the majority of the top twelve threats (67%) originate from human activities and that the number of threats affecting marine habitats decreased with increasing ocean depth. On the other hand, when the public were asked about the top threats to the marine environment, respondents in both surveys identified commercial fishing, pollution/sewage, and recreational fishing as the top three threats. Agricultural runoff and overfishing were the fourth threat in 2005, and 2011 respectively. While shipping and climate change were joint fifth in 2005, dredging was the fifth most significant threat in 2011. Contrary to the experts' opinion, the public barely identified global threats to the marine environment originating from climate change, but instead were familiar with local threats.

The public also believed marine protected areas accounted for 31% of New Zealand's marine environment yet the actual protection level was 0.3%. This clearly outlines once again the mismatch between science and public knowledge regarding the marine environment, this time in New Zealand. This "disconnect between public perceptions of marine environmental issues and actual threats and protection measures" is similar to that found in the US by Steel et al (2005) and in the UK by Fletcher et al. (2009). Better communication of scientific findings to the public is required in order to bridge the gap in knowledge and understanding between scientists and the general public.

2.3 Marine environment perceptions of the younger citizens
In order to achieve the aims of environmental initiatives, it is necessary to not only focus on adults but also students' perceptions regarding marine environmental issues since the latter will become the adult population in time (Ballantyne, 2004). A number of studies have centred on children's and youth perceptions on marine environmental issues. In this section, five studies examining marine perceptions among the younger

generation are reviewed. Three of the studies focused on school going children between the ages 7 to 13 years and the last two studies focused on marine environment perceptions of college students.

Ballantyne (2004) undertook a study in Cape Town, South Africa, aimed at finding out students' perceptions of the marine environment. The study used focus groups with a total of 54 students aged between 10 and 11 years, from three government primary schools. In order to determine students' general knowledge about the sea they were asked several questions related to the sea, its origin, inhabitants, and ocean movements. Based on their responses the students were asked further questions to determine their understanding of topics such as tides, currents and salinity.

The results of the study showed that students had learnt about the sea at school, from watching television, reading books and visiting the aquarium. Students had an interest in marine life and could name a number of sea species. However, their understanding of the marine issues was narrow and at times incorrect. When asked about ocean movements like tides, currents and waves, responses indicated low knowledge levels and confusion regarding the meaning of these terms and what caused the movements.

Lastly, students were asked about the importance of the sea, whether people had an impact on it and what they wanted to learn about it. Personal life experiences partly influenced the values, attitudes and understanding of the marine environment. In addition, the values were focused on the provisioning services of the ocean with very few eco-centric viewpoints. The sea was viewed as an important resource "providing food, water, medicine, recreation and transport opportunities for people" (Ballantyne, 2004). In addition, the students' perceptions of the marine environment were judged to be sometimes incorrect or partly incorrect and were rather perceived to be based on a mixture of information, unproved theories and hearsay. It is important that young people have a correct understanding of the marine environment. The paper suggested that this could be done through aquaria and the use of exhibits which particularly address the misperceptions.

Much as it is reasonable to conclude that education influences ocean literacy, it solely might not be an effective strategy for enhancing marine awareness among students and environmentally mindful behaviour. A paper by Guest et al. (2015) was a result of the need to assess what factors influenced ocean literacy and behaviour. The purpose of the study was to assess the level of the students' valuation, knowledge, interest and interaction with the marine environment. The survey involved a total of 723 grade 7-12 students from 11 public schools in Nova Scotia, Canada. The ultimate goal of the study was to provide vital information to educators, policymakers, marine managers, conservationists, and industry to enhance effective decision making. An ocean quiz comprising questions in line with the 'Ocean Literacy Principles' established by the Ocean Literacy Campaign in the United States was used. Results indicated that ocean

science knowledge was low especially regarding physical and chemical ocean topics. Questions concerning ocean depth, saltiness, ocean currents, ocean acidification, source and amount of oxygen in the ocean, and how the ocean interacts with the land and atmosphere had very low scores. The scores were highest among the grade 11 students and lowest among grade 7 and 8 indicating knowledge retention since ocean science is taught from grade 8 to 11. Also male students scored better than female students.

When asked how important the marine environment was to them only 9% said it was unimportant. The remaining 91% said it was important citing environmental, recreational, economic and cultural reasons. Scoring well on the quiz was positively related to ocean valuation, and also to the frequency of interaction with the sea. The students were also asked what they wanted to learn about the ocean and 54% identified ocean related employment while 76% were interested in ocean animals. From the results of the study it was evident that education alone did not influence adequate levels of ocean literacy but that, as with Ahtiainen et al. (2013) and Jefferson et al. (2014), visits to the sea provided experience which was very influential in participants' knowledge retention. There was a need identified by the authors to develop ocean science education programmes which included field visits so as to enhance knowledge and retention of marine environmental issues and influence behavioural change.

Elsewhere, Wen and Lu (2013) conducted a study with the purpose of assessing the influence, if any, that the Taiwanese marine-related educational curricula could have had on students' knowledge, attitudes, and behaviour towards their marine environment. The study focused on 1050 students in senior years of primary school, as at this age they are believed to have started accumulating knowledge and might be able to overcome situational influence (behaviour influenced by circumstances) for example, dumping litter on the beach just because there are no waste bins.

When asked about the marine environment, its value to humans and how human activity impacted it, results of the study suggested that students were knowledgeable about the marine environment, answering 71% of the knowledge questions correctly. When asked about marine environmental protection behaviour and attitudes, attitudes to directly protect the environment scored higher than those for indirect protection. However with regard to actual protection behaviour, indirect behaviour scored higher than direct behaviour protective of the environment implying that attitudes did not necessarily translate into behaviour. This suggested that knowledge from schools alone did not greatly influence the students' protective behaviour towards the marine environment as had been expected. There could have been other factors in play, for instance, situational factors like regulation, encouragement, and time among others. Similar to Guest et al. (2015), results from Wen and Lu (2013) suggested that incorporating field visits in to the educational curriculum would result in greater influence of students' protective behaviour towards the environment. This presented a

need to revise the mode of delivery of the school curriculum in order to get better results.

In another study by Chen and Tsai (2015) where the perceptions of the marine environment among university students in Taiwan was assessed the authors contended that, at university, students increase the possibility of becoming future leaders upon completion of studies and this would put them in position to make environmental decisions that impact a number of people. The authors therefore believe that it is important that the students have a good understanding of marine environmental matters. The study by Chen and Tsai (2015) involved a survey of 825 students with the aim of assessing the understanding, attitudes and behaviour of university students in Taiwan towards the marine environment.

The findings of the study suggested that the students' self-reported environmental knowledge was quite good. Students were also asked to grade themselves on environmental behaviour and results showed that there were generally low self-reported actions towards environmental protection, especially if they involved spending money. Both self-reported knowledge of marine and coastal issues and environment conscious behaviour were higher for students who were enrolled on marine courses and those who took part in marine recreational activities. Practical environmental participation should be considered when formulating environmental initiatives.

Correlation analysis also revealed that the more knowledgeable a student was about the marine environment, the greater their protective behavior towards it was. However, this result was not guaranteed since the general score on environmental behavioral actions was low. A combination of more than one approach, for example knowledge acquired from education with practical actions to enhance experience, would result in higher marine and coastal literacy and responsible environmental behaviour. This conclusion was similar to that made in studies by Guest et al. (2015) and Chen and Tsai (2015).

A study by Cudaback (2006) at North Carolina State University-Raleigh was conducted in order to assess what the students knew about the ocean and also determine which aspects of the ocean they were interested in learning more about. Educating the young about marine matters is one way of enhancing their knowledge. This has to be done in a way that keeps them interested which requires educators to know their students interests. The Cudaback (2006) study involved a sample of 119 students entering a college-level course in introductory oceanography. The students were asked what they had previously they learnt about the ocean and other ocean related questions. The results indicated that students had a good knowledge of the ocean and that they had gained this information from a variety of sources. The majority of the respondents (56%) mentioned formal education as the source of ocean

science knowledge. Others mentioned personal experience (45%), media (science television channels) (25%) and friends and family (23%).

When asked what they wanted to learn about the ocean, the majority of answers focused on the number of organisms in the ocean, rather than ecosystems. Less than 10% expressed interest in learning about ecosystems and how species adapt to their ever changing environment. When asked about the threats to the ocean, most students had knowledge of the effects of human activities on the sea with the majority (88%) citing pollution as the most serious. Some threats like effects of over fishing, coastal development, global warming and direct individual activities were rarely mentioned. While the authors concluded that the formal and informal education efforts to the improve students' knowledge about the ocean had not been in vain, the generally high level of knowledge could have been due to the fact that the students surveyed were entering a college-level course in oceanography, an area of interest to them. The good level of knowledge provides a basis upon which to build it further for example by having general college ocean courses taught for the purpose of promoting ocean literacy.

2.4. *Key findings from public perception studies of the marine environment*
Section 2 reviewed public perception studies of the marine environment. Understanding public views and attitudes is an important step in formulation of effective strategies aimed at enhancing public knowledge and actions towards their marine environment. The following are the key points noted from these studies:

- Generally, most studies noted a low level of awareness of marine environmental issues, with a mismatch between scientists' views and public views on marine environment in some cases.
- Self-reported levels of knowledge were usually higher than actual levels of knowledge evidenced by poor scores on survey questions.
- A number of studies showed that respondents felt bringing about change regarding the threats to the marine environment was beyond their personal control.
- The public generally showed interest in learning and protecting the environment by support for initiatives to improve the environment for example increased legislation and implementation of marine protected areas.
- Socio-demographic groupings had an influence on the findings with higher education levels; higher incomes; larger households; being older; visiting the resources more; coastal dwellers; and being female resulting in higher concern for marine environmental issues.
- There were several sources of marine environmental information available to the public but their associated level of trust varied. Overall, scientists working for research institutions, universities and environmental NGOs were trusted more than government institutions and private industry. Scientific publications were trusted the most, followed by internet, television and radio. The choice of

method used for enhancing awareness is very important as it has an impact on how the public perceives the content.

- Some studies indicated that perceptions of the young citizens on marine environment issues were low. However experience/practical approach to marine education tended to improve their knowledge of marine concepts.

The above review should not be taken as exhaustive. Other relevant studies concerning public perceptions on the marine environment include Brody and Koch (1990), Spruill (1997), Seys et al. (2008), WWF-New Zealand (2005), and WWF-New Zealand (2011). The next section reviews industry specific studies on the marine environment.

3. Public Perception studies on specific marine environmental issues

Marine related industries constitute an important economic sectors worldwide, comprising a number of activities including fishing, shipping, aquaculture, offshore renewable energy, tourism, and oil and gas among others. However, these industries pose serious threats to the marine environment and have raised environmental concern. Some studies of public perceptions of the marine environment have been industry specific and this section reviews the literature available on these sector specific perception studies.

3.1 Marine aquaculture

With the demand for sea food on the rise, the increase in fish farming activity has been inevitable. Aquaculture provides close to half of the world fish supply. The European Union is among the top five producers of sea food in the world. Its products are of high quality resulting from strict regulations that ensure sustainability and consumer standards. The EU is also the biggest importer of sea food products with imports being 60% of total European fish consumption (COM, 2009). According to the 'Farmed in the EU' report, the aquaculture sector directly employs about 85,000 people and had a turnover of approximately EUR 3.5 billion in 2012 (European Commission, 2014b).

Despite the positive economic effects of aquaculture, it raises considerable challenges, particularly in relation to environmental sustainability of production (COM, 2009; Read and Fernandes, 2003). Aquaculture leads to accumulation of waste material on the sea floor below the cages where the fish are contained. The waste can lead to algal blooms which deplete the water of oxygen and create dead zones near aquaculture sites (Read and Fernandes, 2003; Heffernan, 1999).

Fish farming also poses a risk of disease and parasite outbreaks which can spread in the fisheries and to the wild fish population. The antibiotics used to fight the outbreaks have adverse residual effects on the ecosystems and on the subsequent fish products (Sporong et al., 2005; Sapkota et al., 2008). Besides competing with fish from wild populations for food in case of an escape, there is a danger of genetic

interactions between the escaped farmed organisms with the wild fish communities (Grigorakis and Rigos, 2011). A number of studies have been undertaken in different countries to examine public perceptions of aquaculture. Below is a review of three studies on public perceptions of aquaculture in Australia, British Columbia and Scotland. Other relevant public perception studies with a focus on aquaculture include Whitmarsh and Palmieri (2009), Kaiser and Stead (2002) and Mazur and Cartis (2006) among others. The next section reviews the marine fishing sector.

Sustainable aquaculture requires taking into consideration the ecosystem perspective of its impacts since its success does not only depend on its economic contribution but also on its interaction with society and the environment. The study by Mazur and Curtis (2008) was conducted with the aim of understanding how the Australian public perceived aquaculture, in order to provide useful information that would be considered in managing aquaculture. The study involved interviews and postal surveys in the Eyre Peninsula and Port Phillip Bay region aimed at identifying the issues of interest to people living near aquaculture regions. The choice of these two regions was based on the fact that aquaculture is a major economic activity in both regions. The respondents were asked about the values and challenges of aquaculture, the trust they had in the government regarding the management of the industry and how this management could be improved.

First, respondents were required to rate their knowledge regarding aquaculture matters. The majority considered their knowledge level to be low especially with regard to the role of the state and local government towards aquaculture matters. The respondents however considered themselves quite knowledgeable about the environmental impacts of aquaculture on coastal recreation and marine ecology. They were also aware of the impact of storm-water on aquaculture itself. Respondents strongly recognized the socio-economic benefits of aquaculture especially its contribution to the economy, but were unsure about its environmental sustainability. Aquaculture benefits were generally rated more highly than the disadvantages despite the high level of uncertainty expressed about its future impacts. Results suggested that female respondents, having a higher level of education, being a member of coastal management or conservation group, and visiting aquaculture sites were associated with higher concern about the industry's environmental impacts. This provides an opportunity to tailor information packages and awareness campaigns to the information needs of the different groups.

When asked about the source of aquaculture information and associated level of trust, survey results suggested that those sources most frequently used had low credibility ratings. Examples of these were the media and governments. On the other hand, sources used less frequently received higher credibility ratings for example universities, research centers, the fishing industry, libraries, the Internet, and personal experience. Respondents were keen on improving government credibility and suggested that the government be more transparent, engage the public more, improve

communication, enact firm regulations, and provide clear accessible information. The authors concluded that the acceptability of the aquaculture industry to the public could be increased by improving communication, engaging the public, and providing readily available information about the industry.

A study conducted by D'anna and Murray (2015) examined public perceptions of aquaculture in British Columbia. The public survey of the residents of the Baynes Sound, British Columbia, was prompted by the need to assess how aquaculture affected the wellbeing of the different individuals around the aquaculture sites. The purpose of the survey was to elicit the public perceptions of the effects of aquaculture on the environment and the economy. The respondents were categorised as industry interviewees and non-industry interviewees. Participants were asked questions related to the environment and ecology of Baynes Sound, benefits and negative impacts of shellfish aquaculture as well as its management. Results suggested that respondents were familiar and aware of their environment and ecosystems and understood that aquaculture could exert negative changes on it.

Similar to Mazur and Curtis (2008), respondents tended to focus more on environmental and economic benefits of aquaculture. The majority of the respondents were uncertain about its impact on the environment although they still believed that those impacts were mainly negative. Some of the issues of concern raised included the effect on water quality, noise, species competition and predator interactions in the case of escaped fish, debris and garbage on beaches. Non-industry interviewees expressed more concern for aquaculture effects on the environment than industry interviewees; the latter being mainly focused on the environmental and economic benefits of aquaculture.

When asked about the management of the industry, the majority of the respondents felt that the industry was not properly managed, had weak controls and were subjected to overexploitation from self-interested groups. In addition, respondents expressed concern about the scarcity of aquaculture related information citing that proper studies were not being undertaken to examine issues of concern from aquaculture. This made them feel helpless and disconnected regarding the aquaculture issues. The authors suggested a need to improve management of shellfish aquaculture with more public engagement and recognition of the differing perspectives of wellbeing from the different members of the community.

The study by Whitmarsh and Wattage (2006) reviews public attitudes towards the environmental impact of salmon aquaculture in Scotland. The authors hypothesized that there was uncertainty, amongst the general public, about aquaculture impacts on the environment, with insufficient data available on the subject. The study sought to determine the level of importance attributable to the environmental impacts of salmon aquaculture by the public compared to its benefits. Secondly the study was aimed at assessing the economic benefits to society of more environmentally friendly salmon

aquaculture. When asked about what they considered to be most important issue regarding salmon aquaculture, the majority of respondents identified environmental protection through minimization of aquaculture effects, followed by improved product quality and sustaining employment. Fair prices and minimization of conflicts within the industry had the lowest rankings as priorities of the sector. This indicated that the public was concerned about the environment despite the benefits derived from aquaculture.

The main salmon aquaculture impact noted from the survey was organic pollution which could adversely affect water quality, thereby reducing the value of desirable features of the marine environment. The majority of respondents (76%) were willing to pay a higher price between 1 – 50% for salmon produced using a method that halved the nutrient discharge. Both the level of priority attached to environmentally sustainable aquaculture and household income were positively associated with willingness to pay for more environmentally friendly aquaculture. On the other hand, family size was negatively related to willingness to pay.

The findings of the study indicated that there could be an economic benefit to farmers from salmon farmed in ways which reduced organic pollution. This would be possible through higher pricing for products conforming to environmental standards. The authors concluded that public perceptions on the environmental performance of aquaculture were vital for public's acceptability of the sector and should be considered in the decision making process.

3.2 Marine fishing

European Union fishing (catches and aquaculture) accounts for 5% of the total world fish production, and of this catches represent about 80%. The industry employs over 350,000 people with the top four fishing member states being Spain, Denmark, the United Kingdom and France (European Commission, 2014a). However, poor fishing practices such as overfishing and illegal fishing make the industry unsustainable and have brought some fish stocks to the verge of extinction (European Commission, 2011). Increased aquaculture of carnivorous fish aggravates the issue of overfishing for forage fish (Sporrong et al. 2005). This section reviews two studies on marine fishing, the first by Kellert et al. (1995) and the second by Aslin and Byron (2003).

About two decades ago there were conflicts about the use of fisheries and marine mammals in the northwest Atlantic. Public concerns were contributory to these conflicts yet a detailed knowledge of these concerns was lacking. Kellert et al. (1995) therefore conducted a postal survey with the purpose of finding out Canadians public knowledge and attitudes towards commercial fisheries management and marine mammal conservation in the northwest Atlantic Ocean. When an assessment of their knowledge was done, the majority of the public (95%) were found to be well informed about the conflicts amongst the public, sealers and commercial fishers concerning the prioritization of commercial fishing industry goals. The public had low levels of knowledge of marine mammal biology but showed more concern for

ecological issues with regard to effects of commercial fishing. On the other hand, the fishers and sealers strongly supported employment and economic perspectives. Some of the major commercial fishing threats identified by the public included illegal fishers from other countries, pollution, overfishing, and marine mammal entanglement in fishing nets. The public showed support for minimization of entanglement of marine mammals in the fishing nets and for the creation of protected areas for marine mammals especially at critical times like reproduction. The authors suggested that public concerns should be considered during policy formulation to ensure public acceptability and conflict resolution.

In Australia, a study on public perceptions of the fishing industry was conducted by Aslin and Byron (2003) and it covered the commercial, recreational and traditional fishing sectors. The aim of the study was to assess general public perceptions, knowledge and attitudes of the fishing industry. The survey involved telephone interviews with 1,004 adults and focus group discussions with 63 individuals. Similar to the findings of Kellert et al. (1995), respondents showed a high level of concern about the management of the fishing industry, particularly the sustainability of the commercial fishing. 65% identified overfishing as the main threat, with wild fish catching considered environmentally unsustainable by 64% of the participants, while fish farming, recreational and traditional fishing were considered relatively sustainable. The majority of the respondents cared about their environment and understood the consequences caused by certain fishing practices like catching undersized or too many fish, or not freeing marine mammals caught by accident.

In terms of management of the fishing industry, over 75% of respondents were in favor of creation of more marine protected areas and stronger government controls for the environment. 79% suggested more community consultation on matters concerning the industry's management. Respondents were also asked about the issues facing the fishing industry and 92% mentioned the introduction of foreign species, illegal fishing vessels and lack of information about the industry as being of major concern.

When asked about their main source of industry information, 54% identified television, 45% identified newspapers and 17% identified radio. A further 5% of the respondents indicated they had not received any information at all. Universities, research centres, environmental organisations were considered as credible sources of information while government was considered as the least credible source. This finding was similar to what was noted in a number of papers reviewed earlier in this dissertation including Buckley et al. (2011) and Corner et al. (2014).

3.3. Marine tourism

According to the European Union's Blue Growth Study (2013), the coastal and marine tourism sector is the leading maritime sector in terms of gross value added and employment. Cruise tourism alone provided about 330,000 jobs and had a direct turnover of €15.5 billion in 2012. The Blue Growth Study (2013), aimed at providing maritime policy relevant information and highlighted the unsustainability of marine tourism as one of the major challenges facing the industry. Particularly, it noted the

negative social and environmental externalities of tourism including beach litter, direct dumping of sewage and garbage from cruise ships and hotels into the water and marine habitats, damage to corals, pollution and over fishing to meet increased tourist demand for sea food. Tourism may also disturb the serenity of marine species (Davenport and Davenport, 2006; Gladstone et al., 2013).

A number of studies on public perceptions of marine tourism have been undertaken including Harriott (2002), European Commission (2012), Sharma and Dyer (2009) and Brida et al. (2011) among others. The report by Harriott (2002) on public perceptions on the Great Barrier Reef (GBR) of Australia was in line with the initiative of the partnership between coral reef management, researchers and the tourism industry to enhance knowledge and promote sustainability of the GBR. The research involved a literature review of previous public perception studies on the impacts of tourism on the GBR with the purpose highlighting what the public knew about the Reef, threats to it and what could be done to conserve it while also enjoying its benefits. The study highlighted that the public was very much concerned about the Great Barrier Reef Marine Park (GBRMP) and aware of the impacts that tourism had on it. Tourism was considered to be the third most significant threat to the GBR, after pollution and general human impact but more significant than oil spills, overfishing and agricultural run-off.

Harriott (2002) also highlighted a major finding of another survey by Moscardo et al. (2000) which was focused on international tourists to the GBR. It indicated that while the public was aware that tourism could have adverse effects on the GBR, their understanding of detailed ways of how this could happen was very low. In addition, the public was very concerned about tourism regulation in the GBR despite the fact that strong regulations were already in existence. This suggested that public perceptions were different from the industry facts creating a need for public awareness drives.

The European Commission (2012) compiled a report on the results of an online public consultation on the challenges and opportunities for maritime and coastal tourism in the EU. The survey was done to support the European Commission strategy of promoting an all-round coastal and marine tourism industry in terms of sustainability and up to date information. Results of a public survey of 192 respondents suggested that most respondents considered their knowledge of coastal and marine tourism very good. The majority of respondents showed concern about the industry's sustainability and were in support of a strategy that would promote tourism while also ensuring its sustainability. Other issues respondents were concerned about included the lack of product diversification and innovation strategies, climate change, growing competition from non-EU destinations and the lack of skilled professionals in the sector.

The respondents were asked to identify some possible actions that could be undertaken to improve the impacts of the industry on the marine environment. In response, they identified improving industry communication and regulation, reducing boat pollution, reducing litter, responsible tourist actions and creation of an industry website. In order to further growth of the industry, the respondents suggested promotion of competiveness of the EU tourism sector by having common transport infrastructures, common cultural or industrial maritime heritage, and common quality standards. Both Harriott (2002) and the European Commission (2012) clearly pointed out the strong public concerns for the environment and support for efforts aimed at making tourism more sustainable.

3.4. Offshore wind farms

The need to reduce carbon dioxide emissions has resulted in exploration of alternative, more efficient renewable energy sources, like wind energy. A number of studies have been undertaken to elicit public perceptions of offshore wind energy including Haggett (2008), Haggett (2011), Haven et al (2011), Ladenburg (2009) and Ladenburg (2010) among others. Haggett (2011) reported on the need to understand the role and importance of public views on offshore wind power in the UK following opposition and conflicts regarding offshore wind farms. The paper focused on the impacts of offshore wind farms on the people and communities who live adjacent to and use offshore resources. The report highlighted that the major concern to the public was the adverse impact on the aesthetic value of the ocean as a result of the presence of wind turbines. The report noted that a solution to this would be to position the turbines further into the sea. This however presented the issue of inappropriate technology and finances for such a venture. In addition, placing them further into the sea might not completely solve their visual impact. Secondly, the public were aware of the possible damage to the local sea environment were the turbines are located including interruption of habitats and life of sea species and birds. Offshore wind farms were also considered to have a negative effect on local fishing, boating and tourism. The author concluded that considering local impacts of offshore wind farms is an important step to developing successful wind energy with public acceptance.

Elsewhere, a study by Ladenburg (2009) was conducted in Denmark with the aim of assessing the effect of prior experience on perceived visual impacts of offshore wind farms. The results suggested that prior experience significantly influenced public views of wind farms. In particular, respondents who had experienced wind farms far off from the coast had more positive views of the visual impacts of wind farms while those who had experienced wind farms close to the coast considered visual impact of wind farms more negatively. Another study by Ladenburg (2010) on public perceptions on offshore wind farms in Denmark revealed that socio demographic factors had an influence on the public's attitudes towards offshore wind farms. Annual income and being a male were negatively associated with positive attitude towards offshore wind firms. On the other hand, the higher the level of education, the more positive their attitude was towards offshore wind energy. The studies above

highlighted the non-market values (aesthetic and habitat) of the ocean and how installation of wind turbines would have a negative impact on them. These non-market ecosystem service benefit values need to be considered when deciding location of offshore wind farms.

This section reviewed public perception studies on specific marine industries. Several factors were noted, but most important was that much as the public acknowledged economic benefits from the marine industries, they were aware of other non-market ecosystem values of the marine environment and were concerned about its sustainability. They suggested ways of ensuring sustainability like increasing regulation, providing accessible information for the public and public engagement among others. The findings of such studies are very important in the formulation of successful industry specific marine environment strategies.

4. Conclusions

This paper reviewed literature on public perceptions towards the marine environment and provided information on key principles for influencing society and bringing about behavioural change. The marine environment is very important for human wellbeing for its provisioning, regulating and supporting services. However, increased population and human activities are putting a strain on it and threatening its sustainability. A top-down approach to management of the marine environment has not always been successful creating a need for an ecosystem based approach, and more public engagement. The ecosystem approach takes into account public perception and encourages agencies to consider the public when making decisions in order to have public participation or 'buy in' to the various policies/strategies to management of the resource. Humans are an important component of the ecosystem and understanding their attitudes towards the marine environment is vital to the success of marine strategies. Several threats were identified in the studies reviewed here and these need to be addressed to ensure sustainability of marine resources.

Sections 2 and 3 reviewed public perceptions of the marine environment and summarised general findings and the factors which influenced public views, attitudes, concerns, and behaviour. A table summarizing the main findings of the studies reviewed in this report is presented in appendix I. Knowledge of the findings is very useful in guiding policy and in guiding the work of Sea Change with relevant examples. Below are the key principles for influencing society and bringing about behavioural change.

4.1. Key principles for influencing society and bringing about behavioural change

There is a need for continuous assessment of public perceptions of the marine environments in order to identify the knowledge gaps and address them accordingly. Since different sources of information had different levels of trust and accessibility, it is important to use several forms of communication to ensure that all people get the

message. The communication style chosen should be transparent and free of jargon. It is also important to build public trust in government and industry as sources of credible information and disprove commonly held negative views. This can be done by improving their transparency and accountability.

In most of the studies, socio-demographic groups and individuals' own local circumstances had an influence on public perceptions. This requires marine strategies to be tailored to the different factors influencing perceptions. There is a need for public engagement/co-management to increase acceptability of the strategies as simply presenting facts about the problem is insufficient to influence behavioral change. "People need to understand the issue, feel concerned, responsible, motivated and able to take action and perceive that others are working toward a similar goal" (Hartley et al., 2015).

Finally, children are an important source of social influence and can shape the environmental values, knowledge, attitudes and behaviour of their peers. For an ocean literate generation globally, ocean awareness programmes need to target the young so as to ensure that their environmental orientation is founded on accurate knowledge and understanding of environmental issues. Educational efforts need to be coupled with field visits as experience was found to positively influence knowledge retention. Europe has put in place strategies aimed at increasing ocean literacy. One of them is the European Marine Science Educators Association (EMSEA) formed with the main objective of establishing a platform for ocean education. EMSEA is dedicated to facilitating the exchange of best practices in marine education, providing a networking directory for marine educators, and organizing annual conferences for educators throughout Europe. The first ocean literacy conference in Europe was held in Bruges (BE) on October 2012. One of the key objectives of this conference was to address the lack of ocean-related content in science education by formulating strategies to bring ocean sciences into mainstream science education. The conference also highlighted the importance of formal and informal marine education projects in enhancing public involvement and active participation (Copejans et al., 2012).

To further increase literacy, there is the "Farmed in the EU" School Project which was designed to raise awareness of the aquaculture sector among Europe's teenagers (12-18 years old). The youth get knowledge concerning the impacts of aquaculture on their local communities, exploring its role in food production and environmental preservation. Currently the project is being piloted in 20 schools across 10 EU countries namely Czech Republic, France, Germany, Greece, Hungary, Ireland, Italy, Poland, Spain, and the United Kingdom. The teachers also have a project kit to help them plan and run the project (Farmed in the EU, 2014b).

5. References

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Appendix I:
Table summarizing findings of the public perception studies of the marine environment.

Issues considered	Studies that considered this issue	Main findings
Threats to the marine environment	Potts et al. (2011) Fletcher et (2009) Buckley et al. (2011) Cobham Resource Consultants (1997) Fletcher et al. (2009) Corner et al. (2014) Pendleton et al. (2001) Eddy (2014) Cudaback (2006) Harriott (2002)	The main threats to the environment identified across the studies were over fishing, climate change, litter and pollution as the most important of them all.
Importance of the ocean	Potts et al. (2011) Cobham Resource Consultants (1997) Hynes et al. (2014) Haggett (2011)	Oceans were identified as important primarily as a food source but also for its aesthetic value and climate regulation
Sources of information	Buckley et al. (2011) Corner et al. (2014) Mazur and Curtis (2008)	The most credible sources of information were identified as scientific publications while the most used source of information was television. Government sources were the least trusted
Management of the marine environment	Potts et al. (2011) Hynes et al. (2014) Fetcher et al. (2009)	Environmental groups and scientists were believed to be the most competent to manage marine resources, while government was believed to the least competent.
	Cobham Resource Consultants (1997) Mazur and Curtis (2008) Whitmarsh and Wattage (2006) Kellert et al. (1995 Aslin and Byron (2003) European Commission (2012)	Respondents were concerned about the marine environment and supported actions aimed at improving management and sustainability of marine resources, like stronger regulations, creation of marine protected areas, etcetera.
Knowledge of the marine	Corner et al. (2014) Steel et al. (2005)	Respondents had low levels of knowledge about the marine

Issues considered	Studies that considered this issue	Main findings
environment	Ballantyne (2004) Guest et al. (2015)	environment/Self-reported knowledge was higher than actual knowledge
	Potts et al. (2011) Jefferson et al. (2014) Corner et al. (2014) Hynes et al. (2014) Pendleton et al. (2001) Eddy (2014)	Divergence between public perceptions and scientific facts
	Fletcher et al. (2009) Guest et al. (2015) Cudaback (2006)	Respondents showed interest in learning more about the marine environment
	Jefferson et al. (2014) Ahtiainen et al. (2013) Steel et al. (2005) Guest et al. (2015) Wen and Lu (2013) Chen and Tsai (2015)	Frequency of visits/experience was positively related to knowledge of the marine environment
Accountability and responsibility to take action	Gelcich et al. (2014) Ahtiainen et al. (2013) D'anna and Murray (2015)	Individuals felt there was nothing they could personally do to address marine environment threats
Socio-demographic influence	Buckley et al. (2011) Ahtiainen et al. (2013) Jefferson et al. (2014) Hynes et al. (2014) Steel et al. (2005) Mazur and Curtis (2008)	Being female, income, education level, and age were positively related to concern for the marine environment

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