Assessment of seawater quality: Do public perceptions of seawater quality match indications given by macroalgae?

Angela Bartolo

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Assessment of Seawater Quality: Do public perceptions of seawater quality match indications given by macroalgae?

Angela Bartolo

A thesis submitted to the Graduate Faculty of

JAMES MADISON UNIVERSITY

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Abstract

Determination of seawater quality is an essential activity in coastal areas especially in ones that attract bathers. This study aims to investigate whether the Ecological Quality Status (EQS) of seawater in bathing areas in the Maltese Islands differs across sites. The study also aims to investigate the correlation between public perceptions and objective measures of seawater quality as well as factors affecting perception of seawater quality. Another objective of this study is to investigate the public’s knowledge about macroalgae and opinion on macroalgae.

The EQS of seawater in six coastal sites in the Maltese Islands is investigated using the EEI-c method of Orfanidis, Panayotidis and Ugland (2011) by assessing the presence and abundance of macroalgae. Stakeholder perceptions of environmental quality are assessed by polling the opinions of 198 questionnaire respondents in the same study sites. Statistical analysis is used to analyse the data from the questionnaires and the data from the macroalgal fieldworks.

The results show that the EQS values differ across the study sites with St George’s Bay scoring lowest and Dwejra scoring highest, with subjective scores given by stakeholders generally being higher than objective assessments based on macroalgal populations, even though there is a correlation between the two. Nitrate levels in seawater do not differ significantly across sites. Stakeholder opinions on seawater quality and on educational activities do not differ with age, gender, level of education, nationality, and bathing frequency. Conversely, seawater quality rating scores are affected by respondents’ preference of bathing site and coastal area type (whether they preferred a rocky coast or a sandy beach).
The study shows that using macroalgae for rapid assessment of environmental quality is an approach that can give reliable results in the Maltese Islands. Given that it has been calibrated with stakeholder perceptions and other indicators, this approach may be used to inform beach management strategies regarding seawater quality. The public’s opinions may be used to inform educational initiatives to raise awareness of the importance of such habitats amongst other educational activities (since the majority of the respondents wish to see more educational activities on general environmental issues at the coastal areas).
1. Introduction

1.1 General

Coastal zones have high economic and environmental value and they are one of the most biologically-productive areas in the world (European Union, 2012a). Coastal and maritime tourism (CMT) is a major constituent of the Blue Growth plan launched by the European Commission in 2012 (European Commission, 2013).

While the European Commission has committed to encourage the sustainable development of maritime and coastal tourism for the purpose (in part) of creating more jobs (European Commission, 2013), the author would stress that this is only possible if the coast is managed in a sustainable manner. The coastal area should be managed from a holistic point of view so as to avoid overlooking important aspects of the area, and in this respect, the management of seawater quality at coastal areas is one of high priority. Managing seawater quality in a sustainable manner also necessitates managing agricultural land so as to avoid run-off and managing wastewater and other pollutants. In this study, Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for community action in the field of water policy, 1991 O.J. (L327) 1 [hereinafter the Water Framework Directive] was identified as an important policy due to the important nature of water as a resource. One of the biological quality elements identified within the Water Framework Directive as being an important indicator for determining the Ecological Quality Status (EQS) of seawater is macroalgae. This study used macroalgae as an indicator of ecological quality of six rocky coasts in the Maltese Islands. The results of the survey of macroalgae as biological indicators were
cross-calibrated with the results of a poll of stakeholder perceptions of seawater quality.

1.2 Scope of the work

The species richness and abundance of macroalgae on the rocky shores of the Maltese Islands has been documented in several studies (Azzopardi & Schembri, 2007, 2009, 2010a, 2010b, 2010c, 2010d; Calleja, 1991; Camilleri, 1995; Camilleri, 2005; Magro, 1991; Micallef, 1994; Vella, 1990; Zammit, 1999). The macroalgal studies have generally been carried out separately and no studies combining them to perceptions of the public were traced. As such, this study aims to address this knowledge gap by carrying out a study using a hybrid approach, where quantitative data on algal abundance is compared with qualitative data of stakeholder perception.

The present study is based on the following research questions:

(1) Do the different sites chosen differ in Ecological Quality Status (EQS) of seawater?

(2) Do public perceptions on seawater quality match indication given by macroalgae?

(3) How do nitrate levels compare to the indications given by macroalgae as well as public perceptions?

(4) Do public perceptions on seawater quality depend on age, gender, level of education, nationality, like/dislike of that particular rocky coast, frequency of attending the rocky coast and preference (i.e. rocky coast vs. sandy beach)?

(5) Can public perception be used as a reliable indicator of seawater quality?

(6) How do bathers and other shore users perceive macroalgae?
(7) Would the public like to see additional educational activities concerning environmental issues at the rocky coast?

(8) Which issues at the rocky coast are of highest public concern? How does concern about the coast and sea rank relative to other daily local and global concerns? How do the results in Malta compare to other countries?

(9) How can the seawater quality status of a rocky shore be improved?

(10) How can additional educational activities be introduced at the rocky coast?

The research questions referred to in the previous sections were used to devise the following hypotheses that were subsequently tested:

(1) The different sites chosen differ in EQS of water.

(2) Public perceptions on seawater quality align with indications given by macroalgae.

(3) Nitrate levels also align with indications given by macroalgae as well as public perception on seawater quality.

(4) Public perceptions on seawater quality depend on age, gender, level of education, nationality, like/dislike of that particular rocky coast, frequency of attending the rocky coast and preference between rocky coasts and sandy beaches.

(5) Public perceptions may be used as an indicator of seawater quality.

(6) Public perceptions on macroalgae are negative and the colour of the macroalgae makes no difference to the respondents.

(7) The public would like to see additional educational activities concerning environmental issues at the rocky coast.

(8) Seawater quality is of high concern to the bathers at the rocky coast but not an issue of high concern when compared to other global issues.
1.3 Structure of the dissertation

This Dissertation is divided into six chapters:

- The first chapter, the ‘Introduction’ introduces the subject matter of the dissertation and the aims and objectives of this study.

- The second chapter, the ‘Literature Review’ identifies literature relevant to the research questions. Other methods and concepts used by different European Union (EU) Member States are reviewed so as to be able to compare and contrast them with the methodology used for this study.

- The third chapter, the ‘Methodology’ describes the methodology adopted for this research and provides the references of where such methodology techniques were used.

- The fourth chapter, the ‘Results and Data Analysis’ presents the findings from the nitrates fieldworks and the macroalgae fieldworks as well as the statistical analysis from Statistical Package for the Social Sciences (SPSS) with regards to the quantitative data analysis retrieved from the questionnaires. The qualitative data retrieved through the questionnaires is also presented in this chapter.

- The fifth chapter, the ‘Discussion’ interprets the results and also provides recommendations in light of the previous chapters.

- The sixth and final chapter, the ‘Conclusion’ summarizes the findings whilst also suggesting recommendations for future studies.
2. Literature Review

2.1 Introduction
This chapter describes what makes a good bioindicator as well as the advantages and disadvantages of using such bioindicators as an alternative to other tests. The main shoreline and shallow-water marine macroalgal communities in the Maltese Islands are identified. The main seawater management issues in Malta are also identified, together with a climate change scenario. An explanation of the directives that relate to coastal water quality is provided and further importance is given to the Water Framework Directive as well as how this directive is being applied in Malta. Three models used by different countries to assess seawater quality through macroalgae are explored, these include: the Ecological Evaluation Index-continuous (EEI-c) (Orfanidis et al., 2011), cartography of littoral and upper-sublittoral rocky-shore communities (CARLIT) (Ballesteros, Torras, Pinedo, Garcia, Mangialajo, & de Torres, 2007) and BENTHOS (Pinedo, S., Garcia, M., Satta, M.P., de Torres, M., & Ballesteros, E, 2007). The reason why these three methods are being intercalibrated is also explored. Finally, the importance of involving stakeholders is justified.

2.2 An introduction to the Maltese Islands

2.2.1 Physical geography
The Maltese Archipelago (Figure 2.1) occupies a land area of 316km² in the Central Mediterranean and is made up of two main islands and a number of smaller islets. The main islands are Malta (245.7km²) and Gozo (67.1km²). The islets include Comino (2.8km²), St Paul’s Islands (10.134 ha.), Cominotto (9.864 ha.), Filfla (2.024 ha.) and General’s Rock (0.687 ha.) (Sandro Lanfranco, Lecture notes, 2013). The Maltese Islands are primarily composed of marine sedimentary limestones (Schembri, 1993).
Malta’s southwest coast is primarily made up of sea-cliffs, with the land tilted towards the northeast side which is, in turn, characterised by bays and inlets (Schembri, 1993).

Figure 2.1: The Maltese Archipelago (Source: http://www.mepa.org.mt/census/msc.htm).

The five main marine sedimentary strata that make up the Maltese Islands are the following: Lower Coralline Limestone, Globigerina Limestone, Blue Clay, Greensand and Upper Coralline Limestone, with the Lower Coralline limestone being the oldest and the Upper Coralline Limestone being the youngest (Schembri, 1993).

The average annual rainfall is around 530mm which falls mainly between October and March (Schembri, 1993). Natural freshwaters in the Maltese islands are mostly stored in aquifers which, in turn, depend on percolation of rainwater through rock (Schembri, 1993).
2.2.2 Human impact

2.2.2.1 Population density

The Maltese archipelago has one of the highest population densities in the world which is on the increase (Eurostat, 2013). Malta is the most densely populated EU country, with a mean population of 1,320 individuals/km$^2$ as opposed to the EU average: 116.6 individuals/km$^2$ (NSO, 2012). Furthermore, if one had to consider Malta and Gozo separately, the 2011 population density of Malta was 1,562 individuals/km$^2$ and 454 individuals/km$^2$ for Gozo (NSO, 2012); the population density of Malta on its own is therefore even higher than that of the Maltese archipelago as a whole.

Such a high human population density is disadvantageous to ecological communities since the pressures on both the land and coastal resources exerted are larger since with an increase in population, there is a higher demand for water, food and land use which impacts the environment further.

2.2.2.2 Tourism

One major sector of the Maltese economy is tourism which further increases the population density of Malta especially in the summer months, this sector has many advantages but it also poses some disturbances to coastal ecosystems. Seawater quality is in itself important not only for residents but also for tourism since the sunny climate and the sea are major attractants; therefore good management of seawater quality is of high importance for tourism.

Clean waters and ecosystems have been recognized as important for tourism and it has also been observed that tourists stop going to polluted areas such as in the New Jersey case where $800 million were lost from the tourism sector after it was reported
that medical wastes had been discarded on some of the beaches (Bookman 1997 as cited in U.S. Government, 1998). Additionally, it has been accepted that, in the future, the competitiveness of tourist destinations will depend on the degree of concern regarding sustainable tourism (Gunn, 1997; Laws, 1995 as cited in Kozak & Nield, 2004).

Every year, there are around 1.4 million tourists arriving in Malta; in 2011 there were 1,411,748 arrivals (NSO, 2012). The January to April 2013 statistics show a general increase in tourists visiting Malta when compared to 2012 (NSO, 2013). An increase in tourism is important for the economy, and therefore managing the tourism sector in a sustainable way is very important. One of the components of doing this is through seawater quality management.

Presently tourism already faces undulating problems such as those related to the economy, health or politics (Tourism and More, 2006). Additionally, tourism will face more problems in the future if not managed well, as suggested by the European Union (2012a) tourists’ activities may have damaging effects on coastal species and habitats and these damaging effects may increase in the future due to climate change. Therefore tourism management needs to take into consideration climate change issues for example sea level rise, coastal erosion, drought, floods and it also needs to consider that with the resources becoming more scarce, competition between other activities will rise which could lead to a vicious cycle and damage the stability of the tourism industry (European Union, 2012a).

Tourism makes up 7% of the EU’s Gross Domestic Product (GDP) and coastal tourism is a major contributor to this (European Union, 2012a). If managed in a sustainable way tourism has the potential to benefit the economy as well as the
delicate coastal areas (European Union, 2012a). The management of tourism should not be solely in the hands of decision-makers or environmental managers, it should be an integrated approach between all stakeholders including hotel workers, restaurateurs, park authorities and tour operators amongst other people (European Union, 2012a). The involvement of the general public in decision making is discussed in section 2.10.

2.3 Bioindicators

One of the most popular and important measures of environmental control and nature conservation is the usage of bioindicators (Füreder & Reynolds, 2003). Bioindicators are not a recent invention (Paoletti, Favretto, Stinner, Purrington, & Bater, 1991; Paoletti, 1999), but they have been used in many aspects, for example, in the past, canaries were used as bioindicators to indicate danger to coal miners in the United Kingdom (Holt & Miller, 2011).

Bioindicators could be species, communities or biological activities that are used to evaluate the environmental quality and its change with time (Holt & Miller, 2011). Changes can be either due to anthropogenic stressors or natural stressors, some examples given by Holt and Miller (2011) include pollution and land use changes as anthropogenic stressors and drought and late spring freeze as natural stressors. Holt and Miller (2011) also add that anthropogenic stressors are the primary focus of bioindicators. This is no surprise since the anthropogenic stressors are the stressors which depend on us humans and we can alter them to a great degree through environmental management.

Biomonitoring can be done in an active or passive method (Senate Department for Urban Development and the Environment, 1996), in the case of macroalgae it is
passive monitoring since the researchers use organisms that already exist in nature. On the other hand active biomonitoring would include placing the organisms in the site that needs to be monitored under controlled settings (Senate Department for Urban Development and the Environment, 1996).

Human health issues are increasing the use and progress of bioindicators and even though we have many technological means we are reverting to the biota of our ecosystems in order to find out what is happening to the world (Holt & Miller, 2011). Since species can only stand a certain amount of change to their environment, we can use them for evaluation purposes (Holt & Miller, 2011).

What is important to note is that not all biological processes, species or communities may be used as bioindicators. Table 2.1 shows what makes a good bioindicator, for example rare species with a very small tolerance might be too sensitive or too uncommon in order to be considered as a good bioindicator. On the other hand if the species are tolerant to large changes, they might not make good bioindicators since they will not show a change at a sufficient time for the changes to be reversed or improved (Holt & Miller, 2011). Similarly whole communities that have a range of tolerances can act as bioindicators.
Table 2.1: Characteristics of good bioindicators (Source: Holt & Miller, 2011).

<table>
<thead>
<tr>
<th>Good indicator ability</th>
<th>Provide measurable response (sensitive to the disturbance or stress but does not experience mortality or accumulate pollutants directly from their environment)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Response reflects the whole population/community/ecosystem response</td>
</tr>
<tr>
<td></td>
<td>Respond in proportion to the degree of contamination or degradation</td>
</tr>
<tr>
<td>Abundant and common</td>
<td>Adequate local population density (rare species are not optimal)</td>
</tr>
<tr>
<td></td>
<td>Common, including distribution within area of question</td>
</tr>
<tr>
<td></td>
<td>Relatively stable despite moderate climatic and environmental variability</td>
</tr>
<tr>
<td>Well-studied</td>
<td>Ecology and life history well understood</td>
</tr>
<tr>
<td></td>
<td>Taxonomically well documented and stable</td>
</tr>
<tr>
<td></td>
<td>Easy and cheap to survey</td>
</tr>
<tr>
<td>Economically/commercially important</td>
<td>Species already being harvested for other purposes</td>
</tr>
<tr>
<td></td>
<td>Public interest in or awareness of the species</td>
</tr>
</tbody>
</table>

Macroalgae (Figure 2.2) possess most of the above mentioned characteristics: they have good indicator ability, they are abundant and common, well-studied and they are also economically/commercially important. The commercial importance of macroalgae has been their use in the food industry, however there is now a growing interest in their use as biofuels. The economic importance of algae with regards to biofuels is only a recent phenomenon since with the ever growing concern over the disadvantages of fossil fuels and the concern that they are being exhausted, scientists have been looking elsewhere for alternatives and algae have been shown to be able to provide biofuel. Biofuels also come with disadvantages as do all energy sources, however it shows potential.
2.3.1 The advantages of using algae as bioindicators

One of the main advantages of using macroalgae as bioindicators is that they give an indication of the history of the seawater quality rather than a reflection of the real-time quality; this is because of their sessile state. As stated by Murray and Littler (1987 as cited in Ballesteros et al., 2007), the sedentary conditions of macroalgae make them ideal for studying the long-term exposure to pollutants or nutrients such as
nitrates since the more sensitive species decrease or disappear and are replaced by the more resistant opportunistic species.

Orfanidis, Panayotidis, and Stamatis (2001) and Gaspar, Pereira and Neto (2012) also echo this same idea of the advantageous nature of macroalgae due to their sessile quality. Orfanidis et al. (2001) describe macrophytes (which are plants which are large enough to be viewed with the naked eye and which include macroalgae) as being indicators that are sensitive to changes, that respond to the biotic and abiotic environment and Gaspar et al. (2012) also mention that they are important indicators of seawater quality over time.

Another advantage of macroalgae as bioindicators is that they provide a low cost and comparatively rapid assessment tool when compared to the rigorous technologies required to analyse very low concentrations of water pollutants that might be affecting seawater quality. Macroalgae communities are also relatively easy to identify (even though individual species may not be) and expertise is acquired rapidly, allowing large areas to be monitored relatively quickly (Ballesteros et al., 2007). Non-destructive methods and the easy application of such methods have a positive cost-benefit analysis relationship which is also rigorous from a scientific perspective (Guinda et al., 2008 as cited in Gaspar et al., 2012).

2.3.2 The disadvantages of using bioindicators

Even though the benefits of bioindicators outweigh their disadvantages, it is important to note that bioindicators also have some disadvantages. Some disadvantages mentioned by Holt and Miller (2011), are that:

- The indicators can sometimes be influenced by other factors such as disease rather than the stressor we are trying to measure;
• By studying one single indicator we might simplify things, since we will not
be considering the ecosystem as a whole.

The latter disadvantage is also the reason why in the Water Framework Directive,
water quality is assessed by using more than one ecological indicator, together
with hydromorphological and physico-chemical measurements. The Water
Framework Directive is explained in section 2.7.

2.4 Macroalgal communities of the Maltese mediolittoral

The tendency of seaweeds and other shoreline organisms to grow in particular zones
or belts is called Zonation and it is affected by factors such as exposure, wave action

The zonation model suggested by Pérès and Picard (1964 as cited in Micallef, 1994),
describes the phytal region (the region where light penetrates) as being divided into
four: supralittoral, mediolittoral, infralittoral and circalittoral (Figure 2.3).

Figure 2.3: The zonation model (Source: http://www.mepa.org.mt/biodiversity-habitats-marine).
The present study took place in the mediolittoral which is generally the depth range from 10cm to 150cm but which infrequently exceeds 200cm (Lanfranco, 1993 as cited in Micallef, 1994). The mediolittoral as described by Micallef (1994), usually depends on the high tide and low tide levels, however in the case of Malta which is micro-tidal, the mediolittoral depends on other factors such as barymetric and hydrodynamic factors (Lanfranco, 1993 as cited in Micallef, 1994). According to Calleja (1991), in the mediolittoral, plants have to adapt to the environment of a constantly changing seawater level which exposes them at times and submerges them at other times.

The seaweeds that are dominant in the mediolittoral include the Corallinaceae (calcified red algae). The dominance of Rhodophyta (‘red algae’) is common in the Mediterranean Sea since they have the ability of living in various conditions; some common red algae found in the mediolittoral include Corallina, Jania, Lithophyllum, Lithothamnium, Laurencia papillosa and Callithamnion (Calleja, 1991). Common green algae and some common brown algae in the lower mediolittoral include the green algae: Ulva and Enteromorpha and the brown algae: Cystoseira and Dictyopteris (Calleja, 1991).

Calleja (1991) found that in the studied rock pools in Malta which were in the mediolittoral zone, there were more blue-green algae (Cyanobacteria) due to a higher temperature, but the depressions also made it possible to find species such as Cystoseira spp. and Jania rubens which usually require greater depth. In the rock crevices studied by Calleja (1991), there were many epilithic (growing on stone) algae such as Cladophora spp. and Gelidium crinale.
The mediolittoral can be further divided into: the upper mediolittoral, the middle mediolittoral and the lower mediolittoral (Micallef, 1994).

In the higher and middle mediolittoral, one finds the zoobenthos which may be associated with *Rissoella verruculosa* or *Nemalion helminthoides* (both red algae) on sandstone but they are not present on limestones and in Malta they are often replaced by *Ralfsia veruida* (a brown alga) (Lanfranco 1993, in Micallef 1994).

In a study of the Maltese benthic algal communities, Micallef (1994) found that in the twelve sites studied (which included Qawra point in Malta and Qawra in Gozo which are similar sites to the ones being studied in this dissertation), the dominant species in the mediolittoral was *Jania rubens* (which was commonly found associated with *Cystoseira* spp.) even though *Polysiphonia opaca* or *Laurencia papillosa* were also very abundant (Micallef, 1994).

Table 2.2 provides pictures of some of the macroalgae that have been found in Malta according to the literature identified.

Table 2.2: Pictures of macroalgae (Source: http://www.algaebase.org/).

*Corallina elongata*
<table>
<thead>
<tr>
<th>Image</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td>Jania rubens</td>
</tr>
<tr>
<td><img src="image2.png" alt="Image" /></td>
<td>Ulva rigida</td>
</tr>
<tr>
<td><img src="image3.png" alt="Image" /></td>
<td>Laurencia papillosa</td>
</tr>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><strong>Gelidium crinale</strong></td>
</tr>
<tr>
<td>---------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td><img src="image2.png" alt="Image" /></td>
<td><strong>Cystoseira amentacea</strong></td>
</tr>
<tr>
<td><img src="image3.png" alt="Image" /></td>
<td><strong>Cystoseira compressa</strong></td>
</tr>
<tr>
<td>Image</td>
<td>Species</td>
</tr>
<tr>
<td>-------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><em>Dictyopteris prolifera</em></td>
</tr>
<tr>
<td><img src="image2.png" alt="Image" /></td>
<td><em>Stypocaulon scoparium</em></td>
</tr>
<tr>
<td><img src="image3.png" alt="Image" /></td>
<td><em>Polysiphonia opaca</em></td>
</tr>
<tr>
<td>Image</td>
<td>Name</td>
</tr>
<tr>
<td>-------</td>
<td>----------------</td>
</tr>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td>Caulerpa racemosa</td>
</tr>
<tr>
<td><img src="image2.png" alt="Image" /></td>
<td>Padina pavonica</td>
</tr>
<tr>
<td><img src="image3.png" alt="Image" /></td>
<td>Sargassum vulgare</td>
</tr>
</tbody>
</table>
2.5 The main seawater management issues in Malta

Water is a very important resource in Malta with 13% of the GDP being dependent on water (MEPA, 2011), “Good coastal water quality is key to healthy ecosystems and necessary to support coastal ecosystem services, including recreational and tourism assets” (MEPA, 2011, pp. 99-100). Therefore any seawater management issues must be tackled with urgency since even if one is not concerned about the environment; there are other concerns like economic and social wellbeing concerns.

Malta Environment and Planning Authority (MEPA) (2011) has divided the main water management issues in Malta into eight main themes which include not only surface waters but also ground water. Six out of eight of the water management issues concern surface waters (surface waters means all waters except for groundwater according to the Water Framework Directive). The main issues pertaining to seawater include safeguarding coastal waters and their sustainable development, conserving waters that are ecologically important, public awareness-raising and increasing the knowledge that currently exists (MEPA, 2011).

Some sectors that contribute to seawater quality are also being tackled by MEPA (2011); such sectors include: the agriculture and animal husbandry sector, the aquaculture sector and the industrial and urban environment. Other measures being taken by MEPA (2011) include the management of the marine environment including the natural environment and also considering the seawater quality of harbours and marinas. When considering harbours and marinas it is also important to take the economic benefits of such ‘heavily modified water bodies’ into consideration.

The cost of the measures being implemented is also important. MEPA (2011) is spending €14 million yearly for the basic measures (that are essential for compliance to the Water Framework Directive and other EU Directives) and €8.5 million for the
supplementary measures that are beyond the basic measures. This cost is necessary since the benefits that are associated with such measures will be greater than the costs.

2.5.1 Climate Change

As suggested by MEPA (2011), climate change has the potential to interfere with the plan of reaching the objectives set out by the Water Framework Directive.

The problem with water resources and climate change is expected to hit all of the Mediterranean including Malta and the impact on the water resources in the Mediterranean Sea is expected to be negative from both an environmental perspective and also a socio-economic perspective (MEPA, 2011). What is even worse is that anthropogenic activities are already putting the water resources under stress and therefore the vulnerability of such resources is increasing: climate change adaptation with regards to seawater resources is thus seen as very important (MEPA, 2011).

Some of the climatic changes that Malta might experience according to MEPA (2011) are: an increase in temperature and a decrease in precipitation, drought which is linked to temperature and precipitation, sea level rise and storm surges. Changes in temperature, precipitation and drought are likely to occur in the short or medium term (MEPA, 2011). According to MEPA (2011), the precautionary principle is being applied with regards to an increase in sea level rise and an increase in storm surges since there are uncertainties with regards to both.

MEPA (2011) divides the measures being taken to implement the Water Framework Directive into four categories: win-win measures, low-regret measures, flexible measures and regret measures.
1. Win-win measures are those measures that apart from helping in the implementation of the Water Framework Directive with regards to climate change, are also able to adapt to climate change, for example the increase in storage of rainwater helps to both decrease runoff entering the coastal water and ground water and also helps to store water for further use (MEPA, 2011).

2. Low-regret measures are those measures that are beneficial no matter how climate change unfolds, (MEPA, 2011), for example ensuring that bathing areas are of good quality standards (MEPA, 2011).

3. Flexible measures are those that as they are right now might not be good within a climate change environment; however they can be altered to be useful, for example carrying out a study to encourage integrated valley management (MEPA, 2011)

4. Regret measures are measures that are not suggested by MEPA (2011) and are measures that should not be suggested unless really necessary since they are not good within a climate change environment and they are not flexible.

The measures being implemented by Malta are mostly low-regret measures.

2.6 The Different Policies and Obligations of EU Member States

The Water Framework Directive (explained in more detail in the section 2.7) is the main directive related to water quality and quantity. As suggested in the Water Framework Directive, the aim of this directive is to create a framework for protecting all waters (coastal waters, transitional waters, surface waters and groundwater) which stops the degradation of seawater and improves not only the status of water ecosystems but also wetlands and terrestrial ecosystems with respect to their water requirements, encourages sustainable use of water, takes action in order to reduce or
stop priority substances, plays a part in the reduction of the events caused by floods and droughts, stops further pollution of groundwater and tries to improve its current status.

As also suggested in the Water Framework Directive, the latter mentioned directive contributes to other directives or conventions to which the European Member States are part of, for example in the Mediterranean, it contributes to the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (also known as the Barcelona Convention) and its Protocol for the Protection of the Mediterranean Sea Against Pollution from Land-Based Sources.

The Water Framework Directive also mentions the Drinking Water Directive since waters abstracted for drinking purposes should observe such regulations as listed in the latter mentioned directive and not only the Water Framework Directive.


The Bathing Water Directive (Council Directive 2006/7/EC) which repealed the 1976 Directive (Directive 76/160/EEC) is also another Directive specified by the Water Framework Directive as a requirement. As advised in the Bathing Water Directive, Member States are required to observe and classify the quality of bathing waters whilst also managing them accordingly and also reporting the information obtained to the public.
Another European Directive that aims at protecting the marine environment is the *Marine Strategy Framework Directive* (MSFD): in this case the target for Good Environmental Status (GEnS) is set for 2020 as can be seen in Figure 2.4.


The *Marine Strategy Framework Directive* sets out eleven descriptors of environmental status: biodiversity, non-indigenous species, populations of commercial species, food web structure, eutrophication, sea floor integrity, alterations to hydrography, contaminants, sea-food contaminants, marine litter and energy (including noise).

Water Framework Directive is more concerned with coastal water bodies taken separately, the Marine Strategy Framework Directive is more concerned with whole regions example the Greater North Sea (HM Government, 2012). Figure 2.5 shows the overlap between the Water Framework Directive and the Marine Strategy Framework Directive in the UK, but this is similar to other Member States including Malta.

![Figure 2.5: Map showing the overlap between the Water Framework Directive and the Marine Strategy Framework Directive (Source: HM Government, 2012).](image)

Of extreme importance is the Integrated Coastal Zone Management (ICZM) Protocol to the Barcelona Convention for the Mediterranean Sea, which is able to provide links between the, “EU Maritime Policy and the MSFD on the marine side and the Water
Framework Directive (WFD) and other relevant policy instruments on the land side” (European Union, 2012a, p.5). In this context, the ICZM has an important job in integrating different aspects and in uniting socio-economic and environmental issues in management and planning (European Union, 2012a). The Protocol on ICZM in the Mediterranean came into force in 2011 (UNEP, 2000-2007). The ICZM Protocol is being implemented by the Priority Actions Programme/ Regional Activity Centre (PAP/RAC) (Pegaso, 2013), the latter being part of the Mediterranean Action Plan (MAP) and under the umbrella of the United Nations Environment Programme (UNEP) (PAP, 2005-2010).

Figure 2.6 shows a summary of the main directives that pertain to EU waters.
2.7 The Water Framework Directive

The Water Framework Directive requires member states to classify water into the following ecological classes: ‘High’, ‘Good’, ‘Moderate’, ‘Low’ and ‘Bad’. In the 2009 Water Framework Directive intercalibration technical report, Member States intercalibrated different methods in assessing the EQS by using macroalgae. Amongst the methods proposed by the Mediterranean Intercalibration group were the following: the Ecological Evaluation Index which is used by Greece, Cyprus and Slovenia, CARLIT which is used by France, Italy, Spain and recently Malta, and BENTHOS which is used by Spain (Carletti & Heiskanen, 2009).
Since Malta forms part of the Mediterranean Geographical Intercalibration Group (GIG), more attention is given to methods and definitions proposed by this group. Reference sites are defined by the Mediterranean Geographical Intercalibration Group for coastal macroalgae as having the following criteria: “

(1) No settlement with more than 1000 inhabitants/km² in the next 15 km and/or more than 100 inhabitants/km² in the next 3 km within that area (number of inhabitants is restricted to winter population).

(2) No more than 10% of artificial coastline.

(3) No harbour (more than 100 boats) within 3 km.

(4) No beach regeneration within 1 km.

(5) No industries within 3 km.

(6) No fish farms within 1 km.

(7) No desalination plants within 1 km.

(8) No evidence of perennial species (Cystoseira for coastal waters) regression due to other unconsidered impacts” (Orfanidis et al., 2011, pp.205-206).

For Malta, no such reference sites exist since there are no sites that meet all the above criteria, therefore certain methods used by other countries need to be adapted.

Intercalibration is important with regards to the biological quality elements (BQEs) as it ensures comparability of methods between Member States (European Commission, 2011) and it ensures that the boundaries between the different statuses such as the ‘High-Good’ boundary are comparable between the EU Member States (European Commission, 2011).
Other methods used by the North East Atlantic GIG included RSL (Reduced Species List) used by Ireland, Norway, United Kingdom; CFR (Quality of Rocky Bottoms) used by Spain; P-MarMAT (Portuguese Marine Macroalgae Assessment) Tool used by Portugal; MAB (Macroalgae Blooming) used by Denmark, Ireland, Portugal, United Kingdom, Norway and Sweden; Subtidal Algae used by Denmark. The methods used within the North East Atlantic GIG will not be considered as a possible methodology since they require the classification of seawater into more types than is required by the Mediterranean GIG. The Mediterranean GIG uses only two factors in distinguishing water: substrate composition and depth whilst the North East Atlantic uses more (depth, salinity, tidal range, current velocity, exposure mixing and residence time), the reason for this is that Mediterranean ecosystems are relatively homogenous when compared to those of the Northern Seas (Carletti & Heiskanen, 2009).

What will be considered in a greater detail in future sections are the three methods proposed by the Mediterranean GIG: EEI, CARLIT and BENTHOS.

2.7.1 Ecological Quality Ratio (EQR) and Ecological Quality Status (EQS)

The Water Framework Directive requires Member States to distinguish between the different Ecological Quality Statuses which include: ‘High’, ‘Good’, ‘Moderate’, ‘Poor’ and ‘Bad’. The Ecological Quality Status (EQS) is based on the Ecological Quality Ratio (EQR) which is the ratio between the biological quality elements at a reference site and the biological quality elements at the site of study (Heiskanen, Van de Bund, Cardoso, & Nóges 2004). The EQR ranges from 0 to 1 where 1 is the best and 0 is the worst.
2.8 The Water Framework Directive in Malta

Malta was found guilty by the European Court of Justice of not achieving its EU commitments with regards to the WFD (The Times of Malta, 2010) but is now working towards achieving the obligations set out by this directive. The WFD requires Member States to achieve ‘Good’ status in both surface and ground water by 2015 and Malta has applied for some extensions, since in some water bodies, attainment of ‘Good’ status by 2015 cannot be realized even if the best management procedures are taken because of either the long recovery time of the water or because there is no affordable technical solution available (MEPA, 2011). For coastal waters the extension being requested is until 2021 instead of 2015 and this applies to Xaghjra area due to discharges of waste water (MEPA, 2011). With regards to the two ports in Malta, they fall in the criteria of heavily modified bodies where the aim is to improve their water status but without impacting their economic importance to a considerable degree (MEPA, 2011).

Coastal waters in Malta are divided into nine ‘Water Bodies’ as shown in Figure 2.7 and macroalgae is being monitored in all of the water bodies except in places where the hydromorphological changes have changed the coast to the extent of becoming artificial (the ‘Heavily Modified Water Bodies’ in Malta are shown as sections MTC105 and MTC107 in Figure 2.8) (Cardona, MEPA, e-mail, March 20, 2013). The results for the macroalgae being monitored by MEPA cannot be accessed yet since they are still being processed, however from the preliminary results of macroalgae, the indications are that the Maltese waters are in general of very good quality, however one must keep in mind that macroalgae is only one Biological Quality Element (BQE) and the quality of the water will have to be assessed by considering other BQEs, “and biological supporting quality elements such as chemical water
quality and hydromorphology in each water body” (Cardona, MEPA, e-mail, March 20, 2013).

MEPA is using CARLIT to monitor macroalgae. The advantages and disadvantages of using CARLIT will be discussed in section 2.9.2.

Figure 2.8, shows the ecological status of a draft method used by Malta using the angiosperm Posidonia oceanica as a bioindicator which was used in the determination of the status of the nine coastal bodies by Malta in the first Water Catchment Management Plan (WCMP) (MEPA, 2011). However as of 2011 as part of the WFD, Malta has collected scientific data on the four biological qualities monitored in coastal waters: benthic invertebrates, Posidonia oceanica, macroalgal communities and phytoplankton (MEPA, 2011).
Figure 2.7: The nine water bodies of Malta (Source: MEPA, 2011).
Figure 2.8: Map of ecological status using Posidonia oceanica as an indicator (Source: MEPA, 2011).
2.9 The Different methods used by the Mediterranean Geographical Intercalibration Group (GIG)

As mentioned above Malta forms part of the Mediterranean GIG, therefore the following three methods: the EEI/EEI-c, CARLIT and BENTHOS are being given importance since they are the official methods used by the Mediterranean GIG. This research study will be using an adapted version of the EEI-c. The EEI-c method was chosen over CARLIT and BENTHOS after evaluating the advantages and disadvantages of both. BENTHOS was considered insufficient for this research since it has been applied in Malta and did not discriminate between sites on a seasonal basis; it only discriminated between sites on an annual basis, therefore because of the time constraints BENTHOS could not be chosen. On the other hand, CARLIT was considered less rigorous than the EEI-c method even though CARLIT has several advantages such as being less time consuming than the EEI-c method and more cost-effective.

2.9.1 Ecological Evaluation Index (EEI)

The EEI has been used by Greece, Cyprus and Slovenia and according to Orfanidis et al., (2011), it has also been implemented successfully by Italy and Bulgaria. The older version of the EEI (developed in 2001) was also applied in Malta (Azzopardi & Schembri, 2009) but the results indicated some shortcomings since the EEI did discriminate among sites, however with anomalous results (Azzopardi & Schembri, 2009).

It is important to distinguish between the original EEI (Orfanidis et al., 2001, 2003) and EEI-c (Orfanidis et al., 2011). The EEI-c is based on the original EEI concept; however it is an improvement of the original formula.
The EEI (Orfanidis et al., 2001, 2003) included a model that used the functional model of life cycle theory (r-K-selected species) as an instrument in evaluating appearances and disappearances of various indicator species (Carletti & Heiskanen, 2009). The original EEI only differentiated between two Ecological Status Groups (ESGs) as shown in Figure 2.9.

![Figure 2.9: Ecological Status Groups (Source: Carletti & Heiskanen, 2009).](image)

There were a number of people who found difficulties in applying the original EEI, these included some sites in Spain, Croatia and Malta (Orfanidis et al., 2011).
The criticisms for the original EEI were, (1) species (e.g. of the genera *Cystoseira*) in the same ESG may have different degrees of response to the same stressors, (2) the original functional group approach predicted ecological attributes such as reproductive efforts rather than water quality degradation, and (3) the formula was not continuous with one value for every ESC making the boundaries disconnected (Orfanidis et al., 2011, p.201).

Taking the above criticism into account, Orfanidis et al. (2011) came up with a new formula, the EEI-c in order to remedy the original disadvantages. The improvements included: “

(1) The identification of ESGs using trait combinations in relative terms of species morphology, physiology, life strategy and distribution

(2) The development of a formula that expresses the ecosystem status in continuous numbers,

(3) Verification of EEI-c reference condition values in putatively pristine coastal and transitional water sites of Greece” (Orfanidis at al., 2011, p.202).

In the EEI there were only two clusters as mentioned above: ESG I: Late successional species and ESG II: opportunistic species. In the EEI-c, ESG I and ESG II were divided into three and two sub-clusters respectively. ESG I includes, “thick perennial (IA), thick plastic (IB) and shade-adapted plastic (IC) coastal water species” (Orfanidis et al., 2011, p. 199) and ESG II includes, “fleshy opportunistic (IIB) and filamentous sheet-like opportunistic (IIA) species” (Orfanidis et al., 2011, p.199). This new addition is what makes the EEI-c much more specific than the original EEI since now other traits are being taken into consideration.
The IA and IB group, represents, “slow-growing, sun-adapted species with a thick, differentiated thallus” (Orfanidis et al., 2011, p.209). They are both late-successional communities, however the IA group are found in pristine areas since they require a lot of light and they have a lot of nutrients in their internal reserves, whilst the IB group have adaptive plasticity so they are found in pristine areas or moderately degraded environments (Orfanidis et al., 2011). The IC group also represents slow growing species however they are shade-adapted: they are found in pristine as well as moderately degraded shores (Orfanidis et al., 2011)

The IIA and IIB group represents species that grow in large quantities in degraded and highly degraded environments respectively, the IIA group represents “fast-growing, sun-adapted, coarsely-branched species” (Orfanidis et al., 2011, p.210). The IIB group represents, “fast-growing, sun-adapted filamentous and sheet-like species with high reproductive capacity and short life histories.” (Orfanidis et al., 2011, p.210).

According to Orfanidis et al. (2011), the EEI-c can be used in depths less than 1m with a vegetation cover greater than 10%, in both rocky coastal and sedimentary transitional with a salinity greater than 10psu.

2.9.2 CARLIT

CARLIT is a method that involves a Geographical Information System (GIS) in order to acquire an environmental quality index. Ballesteros et al. (2007) describe the methodology of using CARLIT, as being one which uses a boat to map out littoral and sub-littoral communities; preferably done in the April to June period since this is the time of peak growth (Ballesteros et al., 2007). Sections are categorised into different geomorphological categories which is entered into GIS.
The Ecological Quality Ratio (EQR) provided by CARLIT is in compliance with the Water Framework Directive as it ranges from 0 to 1 and it is divided into the five categories as identified by the Water Framework Directive and as can be seen in Table 2.3.

<table>
<thead>
<tr>
<th>EQR</th>
<th>Ecological status</th>
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</thead>
<tbody>
<tr>
<td>&gt;0.75–1</td>
<td>High</td>
</tr>
<tr>
<td>&gt;0.60–0.75</td>
<td>Good</td>
</tr>
<tr>
<td>&gt;0.40–0.60</td>
<td>Moderate</td>
</tr>
<tr>
<td>&gt;0.25–0.40</td>
<td>Poor</td>
</tr>
<tr>
<td>0–0.25</td>
<td>Bad</td>
</tr>
</tbody>
</table>

The advantages mentioned by Ballesteros et al. (2007) of using CARLIT over other methods are:

1. It is a non-destructive method.
2. No laboratory work is involved, it is therefore low cost and quick (even though the first year takes a lot of time due to the creation of the GIS data but this is only done once and modified subsequently).
3. It does not rely on samples but on the whole shore therefore there is no problem of representativeness.
4. Continuous observations allow for the location of environmental problems which is of great value for management.

Ballesteros et al. (2007) also reflect on the disadvantages of CARLIT:

1. It is not adequate for shorelines that are entirely sandy.
2. It only considers a narrow belt that is between the littoral and sublittoral zone and does not take into account the extensive sublittoral assemblages.
2.9.3 BENTHOS

BENTHOS (the BENTHOS index) has been applied successfully in Spain. It has also been applied in Malta by Azzopardi and Schembri (2010a) but it was found to be good only when comparing annual values and not for comparing seasons separately (Azzopardi & Schembri, 2010a).

BENTHOS relies on detrended correspondence analysis (DCA) to show differences and similarities between species (Pinedo et al., 2007), however since in Malta it was found to discriminate between sites only when comparing annual values rather than seasonal values (Azzopardi & Schembri, 2010a), it was not considered for the present study since this study was under time constraints.

2.9.4 Intercalibration

Carletti and Heiskanen (2009) reported that the EEI and the BENTHOS methodologies were compared in 62 sites (11 sites in Greece and 51 sites in Slovenia), while the BENTHOS and the CARLIT methodologies were compared in 48 sites in Spain. The reported results showed that even though there are some differences which result in different Ecological Quality Ratios, the values were still very close in all countries. Therefore all three methods are accepted methods by the European Commission (Carletti and Heiskanen, 2009).

2.10 Involvement of Stakeholders

Figure 2.10 shows the findings of Potts, O’Higgins, Mee and Pita, (2011), which are based on the results of a 2010-2011 survey conducted in seven EU countries (UK, France, Germany, Spain, Portugal, Italy and Poland). From this survey, it was concluded that oceans are not a priority issue for the public since when asked to rate issues, the issues ranked as follows from the most important to the least important:
- The cost of living.
- Health and Education.
- The economy.
- Pollution.
- Affordable energy.
- Poverty.
- Climate Change.
- Terrorism.
- Ocean Health.
- Species loss.
- Safe available food.
Another conclusion made by Potts et al. (2011) from their results, is that public perception is different to the scientific perspective and that the disparities between the two may be attributed to failure of the marine scientific community to exchange their findings with the public since usually the public tends to rate visible matters as more important (Potts et al., 2011). The involvement of stakeholders is very important since it is the shared selections made by the public that impact the marine environment and understanding stakeholder perspectives is critical to understand how the policy
procedure reveals itself (Potts, et al., 2011). For these reasons, public perception is being given an important role in this research study.

As mentioned in the previous section regarding the main seawater management issues in Malta, one of the issues is the need for increasing public awareness about water issues since this would allow for the community to support the management plan and its implementation (MEPA, 2011). With rocky shore management and also beach management, involving stakeholders has been identified as an important management strategy. The importance of beach management has increased and the scope has widened, however a bottom-up approach to beach users’ demands and preferences is still absent (Roca, Villares & Ortego, 2009, p.598). Roca et al. (2009) further claim that a bottom-up approach is very important but beach users’ preferences and demands must be used with caution by the project manager since sometimes what the beach user demands is not the best policy for sustainable management. This also applies to rocky shores and not just beaches. In such cases a balance has to be reached between what the bathers demand and what is best for the rocky coast and the coastal water system from a systems point of view. In this context, the questionnaire in this dissertation will identify whether stakeholders would like to have additional educational activities on general environmental issues at the rocky coast.
3. Methodology

3.1 General

The term ‘alga’ is not a valid taxonomic term and refers to a broad variety of organisms belonging to different domains of the tree of life and to different kingdoms within these domains. For the purposes of this study, an ‘alga’ is defined as a eukaryotic organism belonging to the Chlorophyta, Streptophyta (excluding Embryophyta) and Rhodophyta in the Kingdom Plantae and to the Phaeophyta and Dinophyta in the Kingdom Chromalveolata (Adl, Simpson, Farmer, Andersen, Anderson, Barta, ... & Taylor, 2005). This definition includes all the organisms that have, traditionally, been considered as algae by botanists, and excludes the prokaryotic cyanophyta/cyanobacteria (‘Blue-Green Algae’). A macroalga can be roughly defined as an individual alga that is visible to the unaided eye. (Graham, Graham, & Wilcox, 2009; Lardizabal, 2007). This would exclude microalgal blooms which, although collectively visible to the unaided eye, do not consist of a single individual. Algae, including macroalgae are important in coastal ecosystems since they are primary producers and thus provide food for other organisms (Markager & Sand-Jensen, 1992).

3.1.1 Justification for using nitrates as chemical indicators

Eutrophication happens when water bodies experience an extreme increase in plant growth due to an increase in nutrients (WHO, 2013). It is also suggested that land based happenings such as industrial waste, municipal waste, sewage and agricultural run-off account for about 80% of nutrients in the sea (WHO, 2013).

There are two nutrients (nitrogen and phosphorous) that cause eutrophication (WHO, 2013). Global climate change is also another factor that contributes to an increase in
eutrophication (Rabalais, Turner, Díaz & Justić, 2009; WHO, 2013). An increase in temperature (due to global climate change) will increase processes such as photosynthesis, thus increasing the number of macroalgae, however this is only up to a certain point (Rabalais et al., 2009). The main problem with global climate change with regards to eutrophication is expected to be the enhancement of the hydrological cycle since an increase in precipitation will result in more nutrients reaching the coastal waters (Rabalais et al., 2009).

The problem with eutrophication is that some flora and fauna prosper and increase in abundance whilst others become less abundant due to this competition with the flora and fauna that is thriving (WHO, 2013). Another problem is that eutrophication results in the depletion of oxygen when algae decompose (Glibert et al., 2005 as cited in Rabalais et al., 2009).

The main sources of nitrogen in the Mediterranean Sea are agricultural run-off and the atmosphere whilst the main causes of phosphorous are wastewaters from both urban and industrial systems that do not treat it properly (UNEP, 2007). The main reason for eutrophication can thus be attributed to tourism, industry, agriculture, urbanization of coastal areas and fisheries including aquaculture (UNEP, 2007).

According to Oviatt and Gold (2005), nitrogen is the limiting nutrient in seawater, as opposed to phosphate which is the limiting factor in freshwater. This is important since if we had to control nitrogen, we would be controlling the limiting nutrient. What the limiting nutrient means is that it limits the development of biomass (Oviatt & Gold, 2005).

In Malta, MEPA (2011) identified agricultural activities as being the main contributor to nitrate pollution in groundwater as well as being a possible source of nitrate
pollution of surface waters. Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources, 1991 O.J. (L375) 1 [hereinafter the Nitrates Directive] has the aim to reduce and improve the water pollution with regards to nitrates from agriculture run-off and the maximum limit set is 50 mg/l for nitrate concentration in water and 170 kg N/ha/yr is the maximum limit set for livestock manure applied to fields.

The Nitrates Directive has two options either to designate some parts of the countries as vulnerable zones or the designate the whole country as a vulnerable zone. In the case of Malta the latter was adopted. The Nitrates Directive forms an integral part of the Water Framework Directive.

3.1.2 Criteria for selection of study sites

The sites included in this study were selected on the basis of the following factors.

3.1.2.1 Rock outcrop

The type of rock was also deemed important on the basis of the geomorphology that it weathers to and due to the effect it exerts on the identity of organisms that colonize it (Schembri, Deidun, Mallia & Mercieca 2005). The sites chosen all outcropped on Coralline limestone (both Upper Coralline Limestone and Lower Coralline Limestone formations): Figure 3.1 and Figure 3.2 were used in the determination of the rock outcrop.

3.1.2.2 Slope

The slope of the shore was a potential limiting factor with regard to accessibility. As such, all sites selected were characterized by an angle of slope that did not reduce
their accessibility for the researcher (bearing in mind that equipment was being carried).

3.1.2.3 Popularity with bathers

Another important criterion for selection was that the sites needed to be popular with bathers since the respondents for the questionnaire developed for this study needed to be bathers using rocky coasts. Therefore after examining the bathing water quality report of 2012 (Environmental Health Directorate, 2013), it was determined that most sites were of ‘Excellent’ or ‘Good’ quality. Malta’s published information is available online on the Ministry of Health Website. In 2013, the monitoring started on 13th May (established as the beginning of the official bathing season) and with regards to the first week, all locations had ‘Excellent’ quality, the classification is based on the tests of the intestinal enterococci and *Escherichia coli* (Environmental Health Directorate, 2013).

In this context, the choice of sites with regards to bathing water quality was vast.
Figure 3.1: Geology of Malta (Source: Oil Exploration Directorate, 1993a). Sampling sites are indicated by the green circles and arrows.
Figure 3.2: Geology of Gozo (Source: Oil Exploration Directorate, 1993b). Sampling sites are indicated by the green circles and arrows.
There were other potential sites that satisfied the criteria used, apart from the six sites considered in this study; however it was not possible to include them all due to time constraints.

3.1.3 Study sites

Six sites, three in Malta and three in Gozo, were selected on the basis of the criteria outlined in paragraph 3.1.2. The sites chosen in Malta were Qawra point, Ghar Lapsi and St. George’s Bay, whilst the sites chosen in Gozo were Xwejni Bay, Xlendi and Dwejra. The locations of the sites are shown in Figure 3.3.
3.1.3.1 Malta: Qawra Point

Qawra point (Figure 3.4 and Figure 3.5; UTM: 33S 448246 3979569) is found in an urbanized area facing ‘Bahar ic-Caghaq’, it is surrounded by hotels and tourist resorts.
Qawra point is a Blue Flag beach and is very popular with tourists and also locals, therefore the bathing area is very busy during the summer months.

Figure 3.4: Map of Qawra Point (Base Image Source: Google Earth, 2013).

Figure 3.5: Qawra Point study site (photo taken by the researcher).
At Qawra point there is a pocket sandy beach between the rocky coasts and it is also close to Salina Bay which gets its name from the salt pans which were built there during the 16th century (Blue Flag, 2013).

In the vicinity of this site, outside of the swimming zone, one can also find moored boats.

3.1.3.2 Malta: St. George’s Bay

St. George’s Bay (Figure 3.6 and Figure 3.7; UTM: 33S 453842 3975925) in St. Julian's is very similar to Qawra point: it is found in the hub of hotels, tourist resorts and in a very urbanized area. It is also a Blue Flag beach and a very popular bay with bathers during the summer months. St. George’s Bay also has wheelchair access which is different from Qawra point where this facility is not available. Also, St. George’s Bay is made up of both a rocky coast and a sandy beach. The sandy stretch is the direct result of a beach-replenishment project which was carried out to restore and enlarge the original sandy beach which had gradually degraded (Blue Flag, 2013).

At St. George’s Bay one also finds the presence of moored pleasure boats, which is more evident than at Qawra point.

Bathing at St. George’s Bay was banned for a short period of time in September 2012, after a storm caused a possible sewage overflow (The Times of Malta, 2012). The same storm that caused the swimming ban at St. George’s Bay also caused a swimming ban at Xlendi (Gozo) and Fekruna (St. Paul’s Bay) (The Times of Malta, 2012).
Figure 3.6: Map of St. George’s Bay (Base Image Source: Google Earth, 2013).

Figure 3.7: St. George’s Bay study site (Source: Xuereb, 2012).
3.1.3.3 Malta: Ghar Lapsi

Ghar Lapsi (Figure 3.8 and Figure 3.9; UTM: 33S 447917 3964911) is located in the south-west of Malta, with a less urbanized surrounding than the other two locations in Malta (St. George’s Bay and Qawra point). Recently (15th May 2013 and 21st May 2011), Ghar Lapsi has been in the news (Times of Malta, 2013), with regards to the cliff collapse very close to one of the bathing areas. The Malta Council for Science and Technology has identified Ghar Lapsi as one of eight sites in Malta that are important for geological features (The Times of Malta, 2011).
Figure 3.8: Map of Ghar Lapsi (Base Image Source: Google Earth, 2013).

Figure 3.9: Ghar Lapsi study site (Source: Camilleri, 2011).
3.1.3.4 Gozo: Xwejni Bay

Xwejni Bay (Figure 3.10 and Figure 3.11; UTM: 33S 432348 3992990) is situated in Gozo between Marsalforn and Zebbug, very close to Qbajjar Bay, it is popular both with locals and Maltese as a bathing and swimming area but also as a popular Scuba diving site (Visit Gozo, 2013).
3.1.3.5 Gozo: Dwejra Area

Dwejra (Figure 3.12 and Figure 3.13; UTM 33S 427068 3989480) is a Marine Protected Area (MPA). Dwejra is a very popular site for diving but even more so for
its geological features; therefore one finds many tourists here since it is a tourist attraction.

Figure 3.12: Map of Dwejra (Base Image Source: Google Earth, 2013).

Figure 3.13: Dwejra study site (photo taken by the researcher).
3.1.3.6 Gozo: Xlendi Area

Xlendi (Figure 3.14 and Figure 3.15; UTM: 33S 429240 3987531) found in the south-west of Gozo used to be a fishing village but has now become a tourist attraction since it has many restaurants, bars and hotels (Gozo Views, 2013). Xlendi Bay is also a popular swimming area.
Figure 3.14: Map of Xlendi (Base Image Source: Google Earth, 2013).

Figure 3.15: Xlendi study site in Gozo (Source: Maraspin, 2010).
3.1.3.7 Marine Protected Areas (MPAs)

Marine Protected Areas are coastal zones that are protected for biological diversity or natural and cultural resources and that are officially managed by law or by other means (IUCN, 1994).

Reference to Figure 3.16 shows that five (Dwejra, Xwejni Bay, Qawra Point, St. George’s Bay and Ghar Lapsi) out of the six study areas are located in MPAs. However, these MPAs exist only on paper: Action plans or Management Plans (e.g. Rdum Majjiesa) are not being implemented (Dr. Deidun, personal correspondence, 12th August 2013).

Figure 3.16: Map showing the Marine Protected Areas. (Source: Schembri, 2012). Sampling sites are indicated by the green circles.
3.1.4 Variations between the study sites

The study sites varied in levels of anthropogenic stress and in exposure. Exposure is the degree of, “wave action on a given shore” (Borg & Schembri, 2012, p.36). Waves are important since they affect processes such as deposition, erosion, oxygen availability in the sea and supply of nutrients which in turn affect the species type and abundance of shore biota (Borg & Schembri, 2012).

The exposure index derivation consisted of using the Thomas Exposure Index (EI) since this index has been used to work out exposure of Maltese coasts (Borg & Schembri, 2012). The exposure index was devised by Thomas (1986) and adapted for the Maltese shores (Borg & Schembri, 2012).

A wind rose divided into 12 sectors (30° of arc each) was used to find out which of the wind sectors contribute most to exposure; this was done by placing the wind rose on the exact site on a map with sector one of the wind rose aligned with true north (Borg & Schembri, 2012). Figure 3.17 depicts how a wind rose is placed on the site location. The maps used for the present study were the Admiralty charts provided by Dr. Schembri (Department of Biology, University of Malta). The sectors that were not more than 50% obstructed by land were noted and for each sector the Wind Energy (W) in knots squared (kn²), the Fetch (F) in nautical miles (nm) and the extent of seawater less than 6m deep adjoining the coast (CS) in nautical miles (nm) (Borg & Schembri, 2012).
The three mentioned parameters (W, F and CS) were then inputted in the following equation which is the equation used to find the Thomas Exposure Index for Maltese shores (Borg & Schembri, 2012):

\[ EI = \Sigma \log W \times \log (1 + F/CS) \]

The values obtained are shown in Table 3.1 and the working for each coast is found in Appendix I.

The Thomas Exposure Index was calculated for the six study sites since wave exposure has been shown to affect the type of macroalgae growing in particular locations. This is discussed in section 5.2.
Table 3.1: The Exposure Index for each rocky coast under study.

<table>
<thead>
<tr>
<th>Rocky coast area</th>
<th>EI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qawra</td>
<td>7.01</td>
</tr>
<tr>
<td>St. George’s Bay</td>
<td>2.40</td>
</tr>
<tr>
<td>Ghar Lapsi</td>
<td>11.57</td>
</tr>
<tr>
<td>Xlendi</td>
<td>18.04</td>
</tr>
<tr>
<td>Xwejni Bay</td>
<td>2.94</td>
</tr>
<tr>
<td>Dwejra</td>
<td>26.88</td>
</tr>
</tbody>
</table>

3.2 Collection of data

The data on which this study is based was collected through field surveys of algal communities, nitrate tests and through questionnaires distributed to bathers in the six study sites. The timeline for the collection of data is shown in Table 3.2. Each of these data collection methods will be described in more detail in the sections that follow.

Table 3.2: Timeline for data collection.

<table>
<thead>
<tr>
<th></th>
<th>Week 1 of June 2013</th>
<th>Week 2 of June 2013</th>
<th>Week 3 of June 2013</th>
<th>Week 4 of June 2013</th>
<th>Week 1 of July 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macroalgal fieldwork</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrate tests (First set)</td>
<td></td>
<td></td>
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<tr>
<td>Nitrate tests (Replicates)</td>
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<tr>
<td>Nitrate tests (Replicates)</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Questionnaire Pilot study</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Questionnaires</td>
<td></td>
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</tr>
</tbody>
</table>

3.2.1 Macroalgal communities

Surveys assessing macroalgal presence and abundance were carried out during the first two weeks of June 2013.

An adapted version of the EEI-c method developed by Orfanidis et al. (2011) was used. The EEI-c method is built on the same theory of the EEI (2001, 2003), where
disturbances from pollution and/or excess nutrients on the ecosystem shift the situation from a pristine state to a degraded state in which the dominant species are no longer the late-successional species but the opportunistic species (Orfanidis, 2012).

The method consisted of constructing virtual (that is they were not really built) quadrats measuring 10m x 10m in different habitats (Orfanidis et al., 2011). Each virtual quadrat was oriented with two sides perpendicular to the shoreline and two sides parallel to the shoreline. In each 10m x 10m site, a metal frame quadrat of side 0.30m was ‘thrown’ (this refers to the random sampling procedure that will be described below) three times (Orfanidis, 2012). The size of the frame quadrat was set to 0.30m x 0.30m, since 0.2m x 0.2m is considered to be the smallest sampling area for the Mediterranean communities (Boudouresque & Belsher, 1979 as cited in Orfanidis et al., 2001). The frame quadrat was also sub-divided into a grid containing 100 identical grid-squares. In the theoretical example given by Orfanidis et al. (2011) the quadrats used were actually smaller than 0.30m x 0.30m. However, since the researcher was increasing the sampled area rather than decreasing it, it was deemed an improvement.

The 10m x 10m sampling sites had to be located at the shore and at a depth less than 1m, a vegetated coverage greater than 10% and salinity greater than 10psu (Orfanidis et al., 2011).

The position of the frame quadrat ‘throws’ was random and was determined as follows: two envelopes were prepared: one envelope containing ten sheets numbered from one to ten and another envelope with the letters from A to J. A sheet was collected from the first envelope and another sheet from the second envelope and the
letter plus number indicated a particular position on the sampling grid as shown in Figure 3.18. A measuring tape was used to measure distances and find the location of the random sample. This random sampling method was retrieved from http://www.biologycorner.com/worksheets/random_sampling.html and is also suggested by Science & Plants for Schools (2013).

For each random throw, the approximate location was recorded using a GPS receiver, with the accuracy of the recorded position being dependent on the accuracy of the GPS coordinates which was ±2-10m error (Garmin Marine 78-series). A digital photograph of the area covered by each throw of the frame quadrat was taken. This was used, in conjunction with field notes and laboratory data, to estimate the abundance of each species enclosed by the frame. Samples of the macroalgae within each quadrat were retrieved and stored in plastic bags and subsequently transported to the Botany Laboratory of the Department of Biology at the University of Malta for identification.

Algae were identified using a variety of techniques. Tentative identifications were carried out by comparing collected specimens with voucher specimens in the reference collection of the University of Malta. More detailed identification was carried out using Braune and Guiry (2011) for a general idea, Burrows (1991) for Chlorophyta (‘green algae’), Dixon and Irvine (1977), Irvine (1983), Maggs and Hommersand (1993), Irvine and Chamberlain (1994), Brodie and Irvine (2003), for Rhodophyta (‘red algae’) and Fletcher (1987) and Cormaci, Furnari, Catra, Alongi, and Giaccone (2012) for Phaeophyta (‘brown algae’). All identifications were cross-checked against expert opinion.
The abundance of each macroalgal species was quantified in terms of the approximate percentage cover within the frame quadrat. This was done by counting the grid squares in which the species appeared (Orfanidis et al., 2011).

The number of quadrats taken in each site was 12 which meant that in total 72 quadrates were sampled and analyzed. The number of quadrats was determined by using a method suggested by Pepe (2011) where the cumulative number of species was plotted against the number of quadrats and the number of quadrats was taken somewhere on the plateau where a larger number of quadrats did not result in more
species being recorded. This sampling method was deemed sufficient for this present study since more quadrats are more representative but there are time and money limitations in scientific studies (Pepe, 2011). Figure 3.19 shows this method graphically.

![Graph of cumulative number of species vs. quadrat number for all the sites.](image)

**Figure 3.19:** Graph of cumulative number of species vs. quadrat number for all the sites.

### 3.2.2 Nitrate levels in seawater

Low-resolution testing of seawater quality, here represented by levels of nitrate in seawater, was carried out three times: at the beginning of June, at the end of June and at the beginning of July 2013 (this made sure that there was a sufficient amount of replicates). The June sampling session ran concurrently with the collection of algal samples. Low-resolution levels of nitrate in seawater were measured using Sera Quick Test strips. The test strips were inserted in seawater for one second and then allowed to stabilize for 60 seconds after being removed from the water (as indicated in the instructions). Test strips were chosen over sensitive laboratory techniques such as
spectrophotometry since the colour changes of the test strips can differentiate between nitrate concentrations of 0mg/l, 10mg/l, 25mg/l, 50mg/l, 100mg/l and 250mg/l, which was considered to be sufficient for the purpose of this study. Spectrophotometric analysis would have allowed for more accuracy but would not have been practicable given the time constraints. Therefore, given the time constraints that this study was subject to, a larger sample size was chosen over higher accuracy as a necessary trade-off. Bischoff, Hiar and Turco (1996) evaluated test strips as opposed to analytical laboratory work in the measurement of nitrates: the conclusion was that the test strips were in agreement with tests held in the laboratory therefore they provided a low-cost analysis.

The tests for nitrates in sites in Malta were carried out on 13th June 2013, 27th June 2013 and 5th July 2013 whilst testing in sites in Gozo 19th June 2013, 28th June 2013 and 6th July 2013.

Ten independent readings were taken from each site during each sampling session. The tests were taken at intervals of 15 standard paces. The 15 standard paces would have been reduced to a smaller distance had there been variances in the readings, however the reading were the same across the rocky coast. Also, the readings for the nitrates were taken at varying depths in the following pattern: one test strip at the surface, another test strip at mid-depth, another test strip at the sea bottom and this pattern was repeated for the other test strips. This ensured that the researcher was not missing out any important readings. Nitrate levels at such a low depth (< 1m) do not vary much since nitrates and phosphates usually increase with a larger depth and reach a maximum in oceans at a depth of around 500 to 1500m (Muniz, Cruzado & De Villa, 2001), however taking readings at the various depths was done as a precautionary measure.
3.2.3 Shore user opinions

3.2.3.1 IRB protocol

An IRB (Institutional Review Board) Protocol was necessary for this study in order to ensure ethical compliances since this research involved human beings. The IRB protocol was accepted on 16th May 2013, this gave the researcher approval to start the study involving questionnaires.

3.2.3.2 Pilot testing the questionnaire

The pilot study (Appendix III) concerning stakeholder perceptions was held on 7th June 2013 and 9th June 2013, with eighteen questionnaires being distributed in two locations (Qawra point and St. George’s Bay). The intention of the pilot study was not to get preliminary results but rather to ensure that the wording of the questions was not ambiguous or open to misinterpretation. The questionnaire was distributed to eighteen rocky coast users. As suggested by Cohen, Manion and Morrison (2000), on pilot testing, the researcher used the respondents’ feedback in order to ensure clarity of questions. The feedback gathering consisted of first giving the questionnaire to the respondents and letting them answer it, then going through every question together with the respondents and asking them whether the question was clear, understandable and whether they would improve it.

As also suggested by Cohen et al. (2000) the time of completion was taken into consideration: the respondents took between five to ten minutes to complete the questionnaire, which is well within the fifteen-minute maximum suggested by Williams and Micallef (2009). Williams and Micallef (2009) refer to questionnaires distributed to users of beaches, however many points made regarding beach questionnaires, could be adapted to rocky coast questionnaires.
The changes that took place after the pilot study were the following:

1. A small paragraph explaining the term ‘macroalgae’ was included at the beginning of the questionnaire since the majority of the respondents did not know what macroalgae were. Also, a coloured photo of different ‘macroalgae’ was printed, laminated and shown to the respondents so as to make the questionnaire more relevant.

2. The phrase ‘Non-Maltese’ was added after ‘European’ in Question 2 since some of the respondents correctly noted that the Maltese are also European.

3. Also, the question regarding whether the respondents had ever heard of the Water Framework Directive was removed, since it seemed to confuse most of the respondents and almost all of the respondents in the pilot study had never heard of it. Apart from this, the question was, in retrospect, not deemed very important for the data analysis so its exclusion was not a problem.

4. The word ‘beaches’ in question 8 was changed into ‘sandy beaches’ since the respondents were not sure about what the term ‘beaches’ referred to.

3.2.3.3 Sample size

The sample size for the final questionnaire was worked out by using an online sample size calculator as suggested by Dr. Camilleri (University of Malta, 27th March 2013).

The calculator results suggested 196 questionnaires as the sample size. A sample of 196 participants selected randomly from a large unknown population size guarantees a maximum margin of error of 7% for a 95% degree of confidence. This implies that if a sample proportion is computed using the sample of 196 participants then the population proportion can vary by at most 7% either way from this sample proportion.
The 196 questionnaires were divided between the six rocky coasts respectively which meant 32.67 questionnaires per rocky coast, therefore 33 questionnaires per rocky shore were completed, which meant that 198 respondents answered the questionnaire.

3.2.3.4 Timing of study

The questionnaire was held in the last two weeks of June 2013. This data was collected later than the macroalgae data since it was thought that there will be more beach users at the end of June rather than the beginning of June therefore the sample would be more representative.

3.2.3.5 Recruitment of respondents

The respondents were recruited on the spot. As indicated in the IRB Protocol, the researcher positioned herself at a fixed location on the rocky coast and initiated contact with the adult passing by at every 5 minute intervals (that is around 12 people approached every hour): this avoided selection bias in the study sample. The investigator introduced herself and outlined the objectives of the study. The participants were asked if they were comfortable filling in the questionnaire in English and whether they were willing to complete the anonymous questionnaire if they were older than eighteen years of age. The questionnaire indicated that by completing the questionnaire, the participant consented to take part and that they were older than eighteen years of age.

3.2.3.6 Completion of questionnaire

Whilst the investigator explained the purpose of the study, the participants were given a written copy of the equivalent information to review (Appendix II: the consent form). If the participant agreed to complete the questionnaire, they were given a pencil and a paper questionnaire with a verbal written instruction that they could
decline to complete/return the questionnaire at any time. The consent form as formulated under the IRB protocol regulations may be found in Appendix II.

The participants were also shown a laminated coloured photo of some macroalgae so as to make them feel more comfortable in answering the questions.

The participants were instructed to return the completed questionnaire to a cardboard box (that the researcher prepared beforehand) on the rocky coast.

3.3 Research Tools

3.3.1 The questionnaire

The questionnaire (Appendix IV) consisted of 15 numbered questions which were closed-ended. However, questions 7, 9 and 10 are divided into two parts: a closed-ended question together with an open-ended question as the second part of the question. The questionnaire is divided into two sections: section 1 deals with the factual information: rocky shore area, nationality, gender, age, the frequency of use of the rocky shore area and the highest level of education completed. Section 2 deals with other questions, mostly subjective such as: whether the particular rocky shore is a preferred one and what the respondents like or dislike about it, whether they prefer rocky coasts or beaches, whether they believe that macroalgae are related to water quality and why, how they would rate that particular rocky shore on a scale from 1 to 5 and why, whether they would like to see the addition of educational activities at this rocky coast, how they would rank a number of issues of concern, how they feel about the macroalgae attached to the rocky coast and which macroalgae do they object to (the green, the brown, the red).
Therefore this questionnaire had both factual and subjective questions as encouraged by Williams and Micallef (2009). Williams and Micallef (2009) also emphasized the importance of keeping the aims and objectives of the research in mind whilst designing the questionnaire and this was one important step of the process which the researcher did in May 2013: the questions of the questionnaire were all designed with the objectives in mind and also with the data analysis in mind.

The ten steps for good questionnaire design identified by Kidder and Judd (1986, as cited in Williams & Micallef, 2009) were followed in the design of the questionnaire. Some of the latter mentioned steps followed in designing the questionnaire for this research are the following:

- Consideration was given to the different types of interviewing methods, it was concluded that impersonal rather than face-to-face interviewing was better for this kind of study since the researcher would already know the results from the macroalgae fieldwork, nitrates fieldwork and other literature therefore the language the researcher might use might be biased and thus it might influence the respondents.

- The inclusion of ‘do not know’ answers since the researcher was interested even in uninformed opinions. Some of the questions had a ‘no preference’ or ‘I am not sure or do not really know’, this allows the respondents the choice of choosing that they do not know, rather than throwing a haphazard answer.

- Additional questions to some questions were also included in questions 7, 9 and 10 since this makes it possible to obtain the full information required.

- Considering both open- and closed-ended questions. Also, giving importance to the wording of closed-ended questions since the researcher may
unintentionally influence the respondents: for example in question 9 of this questionnaire a ‘why?’ question after the main question ensured that the respondents were not answering the questionnaire haphazardly.

- Giving importance to the wording of the questions and having it reviewed by sociologists, psychologists and coastal research personnel (Williams and Micallef, 2009) – in fact this questionnaire was reviewed by both Dr. Lanfranco and Dr. Micallef prior to the research, who are both well-experienced in this field, as well as Dr. Papadakis who is a social scientist.
- The optimum order of questions was also considered by thinking whether it made sense logically, whether certain questions were better at the start rather than at the end and also whether certain questions could influence subsequent questions.
- Subdivision and sections were also considered in fact the questionnaire was divided into two since the layout and presentation is very important.
- Having a pilot study: a pilot study was also held at the beginning of June which gave the researcher ample time to fix or adapt any shortcomings deemed necessary.
- Clarifying why data is needed if respondents feel that a question is inappropriate but moving on if they do not want to answer.

Additionally the twenty questions for successful questionnaires suggested by Davies (2007) were asked, the questions included the following: “

1. Are all your questions essential?
2. Is the structure of each question elegant and efficient?
3. Are there ambiguous words in any of the questions?
4. Are you certain that the words you have used in your questions will have the same meaning for your respondents as they have for you?

5. Are there probable ambiguities in any of the answers you might receive?

6. Is your questionnaire free of leading questions or loaded words?

7. Are you making any false assumptions about whether the respondents will have the appropriate knowledge to enable them to answer the questions?

8. Similarly, are there any questions that require respondents to express an opinion, when, in truth, they may never have thought about it and therefore have no opinions at all, not even neutral ones?

9. Are all your instructions to the respondents clear and unambiguous?

10. If it is a written questionnaire, is the layout such that the respondents have room to write what they want to write?

11. Are you making excessive demands on the time or patience of your respondents?

12. Where you are seeking opinions or judgments, is the format of your question and proffered answers appropriate to all likely responses?

13. If you are asking respondents to locate their opinions along a scale, is the method you have chosen the best possible?

14. Where you are seeking ‘facts’, is the format of your question and preferred answers appropriate to all likely circumstances?

15. Is there an appropriate balance between prestructured questions and open-answer question?
16. If your questionnaire involves any consideration of sensitive or embarrassing areas, have you designed it in such a way as to minimise or overcome possible negative reactions in the respondent?

17. Is the flow of your questionnaire as good as it can be?

18. If you are using supplementary materials (like show cards containing lists or pictures), are they well produced and manageable in a way that allows you to handle them in an efficient manner?

19. Is it apparent that you are courteously appreciative of the time that your respondents have given you?

20. Is your survey the end-product of two crucial preliminary stages: a period of exploration and pre-piloting; and a full-scale pilot study in which your final questionnaire was tested and, if necessary amended?”

(Davies, 2007, p.71-76).

3.4 Management and analysis of data

3.4.1 Quantitative Data Analysis

The data from the questionnaires and the data from the macroalgae fieldwork were coded into SPSS (Statistical Package for the Social Sciences), a statistical package for analyzing data (Muijs, 2004).

The nitrates data was not included in the statistical analysis (the nitrates value did not vary significantly throughout the rocky shores) but it was still interpreted. The data was coded. For example for the first question regarding rocky shore area, the number 1 represented Qawra Point, 2 represented Ghar Lapsi, 3 represented St. George’s Bay, 4 represented Dwejra, 5 represented Xwejni Bay and 6 represented Xlendi. Similarly the other answers to each question were coded using numerical values.
Once the data entry was ready, a frequency table using SPSS was generated and one could see that certain options were not very common therefore some options were grouped together. This recoding of data included:

- In question 2: Joining the ‘other’ plus ‘European (non-Maltese)’ options together in a new variable called ‘Non-Maltese’ since the option other had a low frequency.
- In question 4: Joining the age groups into less options since there were certain options that were not common for example the ’71 or above’ option.
- In question 5: joining the options that fit into the criteria more than once a year but less than once a week into one option.
- In question 6: Joining the ‘primary education’ with the ‘did not attend school’ option and joining the ‘completed tertiary education’ with the ‘completed post-tertiary education’.

The above was done, after consultation with an expert in statistical analysis (Dr. Liberato Camilleri, University of Malta), who deemed the above as a very important step prior to starting statistical analysis since certain options such as ‘attended primary school’ only had a frequency of two people so joining such categories made understanding and interpreting statistics better.

The tests used to analyze the data were the Kolmogorov-Smirnov test, the Spearman Correlation, the Binomial test, the Friedman test, the Kruskal-Wallis test and the Mann-Whitney test and ANCOVA regression analysis.

The Kolmogorov-Smirnov test was used to assess whether the score distribution was normal or skewed so as to determine whether to use parametric or non-parametric tests. The null hypothesis specifies that the distribution is normal and is accepted if
the p-value exceeds the 0.05 level of significance. As Dupont (2002) mentions in his explanation on the null hypothesis and the alternative hypothesis, the p-value is the criterion for whether to accept the null hypothesis or not. The alternative hypothesis specifies that the score distribution is skewed (not normal) and is accepted if the p-value is less than or equal to 0.05. “The normal probability density function is a symmetric bell shaved curve that is centered on its mean” (Dupont, 2002, p. 18).

The Spearman correlation coefficient ranges from -1 to 1 and measures the strength of the relationship between two variables having a metric scale. In the present study the Spearman correlation was used to determine whether there is a correlation between a large EQS and the participants providing high rating scores for seawater quality and vice-versa. The Spearman correlation is only used when the data is not normally distributed since otherwise the Pearson correlation is used (Mark A. Caruana, Lecture notes, 2012). The null hypothesis specifies that there is no relationship between the variables and is accepted if the p-value exceeds the 0.05 level of significance. The alternative hypothesis specifies that there is a significant relationship between the variables and is accepted if the p-value is less than or equal to 0.05.

The Binomial test was used to compare the mean rating score provided by the respondents for seawater quality with a specified ecological quality status score provided by the EEI-c method. Since the EQS score ranged from 1 to 10 it was divided by 2 so that both scales range from 1 to 5. The Binomial test is only used when the data is not normally distributed since otherwise the one sample t-test is used (Mark A. Caruana, Lecture notes, 2012). The null hypothesis specifies that the mean rating scores provided by the participants for seawater quality is comparable to the EQS and is accepted if the p-value exceeds the 0.05 level of significance. The
alternative hypothesis specifies that the mean rating scores provided by the participants for the seawater quality status differs significantly from the EQS and is accepted if the p-value is less than or equal to 0.05.

The Friedman test is used to compare mean ranking scores between several related statements. The null hypothesis specifies that the mean ranking scores provided for the statements are comparable and is accepted if the p-value exceeds the 0.05 level of significance. The alternative hypothesis specifies that the mean ranking scores provided for the statements differ significantly and is accepted if the p-value is less than or equal to 0.05.

The Kruskal-Wallis test was used to compare the mean rating score provided by the respondents for seawater quality between three or more independent groups (respondents were grouped by age, level of education, frequency of visit to the bay and preference between sandy beaches and rocky coasts). The Kruskal-Wallis test was also used to compare the mean rating score provided by the respondents for the additional educational activities between two or more independent groups. The Kruskal-Wallis is only used when the data is not normally distributed since otherwise the One-way ANOVA is used (Mark A. Caruana, Lecture notes, 2012). In the first case; the null hypothesis specifies that the mean rating scores provided by the participants for seawater quality are comparable between the groups and is accepted if the p-value is greater than the 0.05 level of significance. The alternative hypothesis specifies that the mean rating scores provided for seawater quality differs significantly between the groups and is accepted if the p-value is less than or equal 0.05 criterion. In the second case: the null hypothesis specifies that the mean rating scores provided by the participants for additional educational activities are comparable between the groups and is accepted if the p-value exceeds the 0.05 level of significance. The
alternative hypothesis specifies that the mean rating scores provided for additional educational activities differs significantly between the groups and is accepted if the p-value is less than or equal to 0.05.

The Mann-Whitney test was used to compare the mean rating score provided by the respondents for seawater quality between two independent groups (respondents were grouped by gender, nationality and preferred rocky shore area). The Mann-Whitney test was also used to compare the mean rating score provided by the respondents for the additional educational activities between two groups. In the first case: The null hypothesis specifies that the mean rating scores provided by the participants for seawater quality are comparable between the groups and is accepted if the p-value exceeds the 0.05 level of significance. The alternative hypothesis specifies that the mean rating scores provided for seawater quality differs significantly between the groups and is accepted if the p-value is less than or equal to 0.05. In the second case: the null hypothesis specifies that the mean rating scores provided by the participants for additional educational activities are comparable between the groups and is accepted if the p-value exceeds the 0.05 level of significance. The alternative hypothesis specifies that the mean rating scores provided for additional educational activities differs significantly between the groups and is accepted if the p-value is less than or equal to 0.05.

Additionally, ANCOVA regression analysis was used since the major limitation of the Mann-Whitney and Kruskal-Wallis test is that they investigate solely the relationship between a dependent variable (rating score for seawater quality provided the respondents) and a sole predictor (Dr. Liberato Camilleri, lecture notes, 25th July 2013). However, the goal of many research studies is to estimate collectively the quantitative effect of the predictors upon the dependent variable that they influence
and it is well known that a lone predictor could be rendered a very important contributor in explaining variations in the rating scores, but would be rendered unimportant in the presence of other predictors (Dr. Liberato Camilleri, lecture notes, 25th July 2013). In other words, the suitability of a predictor in a regression model fit often depends on what other predictors are included with it (Dr. Liberato Camilleri, lecture notes, 25th July 2013). ANCOVA regression analysis is a parametric test; however it is robust within itself for non-parametric data (Bryman & Cramer, 2001; Pallant, 2005). ANCOVA regression analysis was used since, “fortunately, most of the techniques are reasonably ‘robust’ or tolerant of violations of this assumption” (Pallant, 2005, p. 198) of normality and with a big sample size (usually larger than 30), the violation of this assumption does not cause huge problems (Pallant, 2005).

3.4.2 Qualitative data analysis

The open-ended answers to question 7, 9 and 10 were read during a single sitting and recurring themes were noted. A list of answers to each question was compiled and the number of times they appeared was noted. This allowed the researcher to represent the qualitative data in table format. The researcher then summarized general themes. The tables with the general themes are presented in chapter 4.

3.5 Reliability, Validity and Generalizability

Reliability deals with how well the research project has been carried out, and whether if the research project had to be carried out by someone else it would result in the same results (Blaxter et al., 2001).

To ensure reliability with regards to the qualitative data, the procedures followed were those suggested by Gibbs (2007, as cited in Creswell, 2009) which consisted of checking codes several times during the coding process so as to ensure no change in
definition given by the respondents was made and also doing the coding process in one sitting by one researcher rather than many researchers which could lead to drifts within the codes.

Validity implies whether the procedure taken really measures the problem or subject that you want to measure (Blaxter, Hughes & Tight, 2001).

With regards to validity of qualitative procedures, the procedural methods used, also given by Creswell (2009) included the clarification of bias that the researcher might have had with regards to the study so as to avoid it whilst interpreting the respondents’ answers and whilst coding the answers.

To ensure internal validity with regards to the quantitative procedures the researcher used procedures of good practice given by Creswell (2009) which included selecting the participants randomly at the rocky coast depending on who was passing by a particular point so as to ensure that characteristics such as age, gender and so on had an equal probability of being selected. Random selection is also suggested by Miller and Salkind (2012), who suggest that is a factor that could jeopardize internal validity as well as external validity. Also, with regards to external validity, the researcher used procedures of good practice given by Creswell (2009) which meant that the results were not generalized to past or future situations since the results were time bound and in order to be able to generalize the results, the study would need to be replicated at different times to check whether the same results would occur (Creswell, 2009). Generalizability (representativeness) implies whether the outcomes of the research could be applied to other situations beyond the research project (Blaxter et al., 2001).
4. Results and Data Analysis

4.1 Calculation of the EQS at every study site

The percentage coverage of each identified species at each rocky coast was tabulated as shown for the case of Qawra in Table 4.1. Each identified species was given its ESG which was done by using the ESGs assigned by Orfanidis et al. (2011), the only macroalgal genus that was not tabulated was *Cladophoropsis* (found at Qawra and Ghar Lapsi) since this was not on the list given by Orfanidis et al. (2011).

The Ecological Quality Status was worked out by using the equations suggested by Orfanidis et al. (2011). This involved working out the mean absolute percentage coverage of algae assigned to each of the Ecological Status Groups (IA, IB, IC, IIA and IIB) and then working out the mean absolute coverage for Ecological Status Groups (ESG) I and II. Finally, the numbers obtained for ESGI and ESGII were inputted in a Microsoft Excel file which worked out the final number (that is the Ecological Quality Status). The Microsoft Excel file was downloaded from: [http://eei.gr/](http://eei.gr/) but it can also be done manually since it uses the equations given in Orfanidis et al. (2011). The equations used in the Microsoft Excel File (as retrieved from Orfanidis et al., 2011) are the following:

\[
p(x,y) = a + b \times \frac{x}{100} + c \times \frac{x}{100}^2 + d \times \frac{y}{100} + e \times \frac{y}{100}^2 + f \times \frac{x}{100} \times \frac{y}{100}
\]

(where \(a = 0.4680\) \(b = 1.2088\) \(c = -0.3583\) \(d = -1.1289\) \(e = 0.5129\) \(f = -0.1869\) and \(x = ESGI, y = ESGII\))

\[
f(x,y) = \min\{1, p(x,y)\}
\]

\[ESI(x,y) = 2 + 8 \times \min\{1, p(x,y)\}\]
After following the procedure suggested by Orfanidis et al. (2011), the Ecological Quality Status was determined by using Table 4.2.

Table 4.1: Coverage of each Ecological Status Group (ESGs: IA, IB, IC, IIA, IIB) present in each quadrat at Qawra.

<table>
<thead>
<tr>
<th>Quadrat</th>
<th>Coverage of every identified species</th>
<th>Coverage of each Ecological Status group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cladophoropsis</td>
<td>Jania</td>
</tr>
<tr>
<td>Quadrat 1</td>
<td>49%</td>
<td>25%</td>
</tr>
<tr>
<td>Quadrat 2</td>
<td>64%</td>
<td>36%</td>
</tr>
<tr>
<td>Quadrat 3</td>
<td>8%</td>
<td>80%</td>
</tr>
<tr>
<td>Quadrat 4</td>
<td>13%</td>
<td>45%</td>
</tr>
<tr>
<td>Quadrat 5</td>
<td>13%</td>
<td>60%</td>
</tr>
<tr>
<td>Quadrat 6</td>
<td>80%</td>
<td>10%</td>
</tr>
<tr>
<td>Quadrat 7</td>
<td>40%</td>
<td>65%</td>
</tr>
<tr>
<td>Quadrat 8</td>
<td>10%</td>
<td>20%</td>
</tr>
<tr>
<td>Quadrat 9</td>
<td>28%</td>
<td>26%</td>
</tr>
<tr>
<td>Quadrat 10</td>
<td>30%</td>
<td>20%</td>
</tr>
<tr>
<td>Quadrat 11</td>
<td>16%</td>
<td>20%</td>
</tr>
<tr>
<td>Quadrat 12</td>
<td>20%</td>
<td>23%</td>
</tr>
</tbody>
</table>

Mean absolute coverage of ESG IA

\[
\text{Mean absolute coverage of ESG IA} = \frac{\text{Sum of ESGIA macroalgal coverage in total number of quadrats}}{\text{Total number of quadrats}} = \frac{(45 + 31 + 80 + 40 + 22 + 58 + 60 + 20 + 20)}{12} = 31.33
\]

Mean absolute coverage of ESG IB

\[
\text{Mean absolute coverage of ESG IB} = \frac{\text{Sum of ESGIB macroalgal coverage in total number of quadrats}}{\text{Total number of quadrats}} = \frac{(50 + 5 + 10 + 22)}{12} = 7.25
\]
Mean absolute coverage of ESG IC

\[
 \text{Mean absolute coverage of ESG IC} = \frac{\text{Sum of ESGIC macroalgal coverage in total number of quadrats}}{\text{Total number of quadrats}} = \frac{(25 + 8 + 28 + 30 + 16 + 20 + 10)}{12} = 11.42
\]

Mean absolute coverage of ESG IIA

\[
 \text{Mean absolute coverage of ESG IIA} = \frac{\text{Sum of ESGIIA macroalgal coverage in total number of quadrats}}{\text{Total number of quadrats}} = \frac{(6 + 100 + 80 + 73 + 65 + 60 + 20 + 20 + 23 + 54)}{12} = 41.75
\]

Mean absolute coverage of ESG IIB

\[
 \text{Mean absolute coverage of ESG IIB} = \frac{\text{Sum of ESGIIB macroalgal coverage in total number of quadrats}}{\text{Total number of quadrats}} = 0
\]

The above mean absolute coverage of ESG IA, ESG IB, ESG IC, ESG IIA and ESG IIB were used to calculate the mean absolute coverage of ESGI and ESGII:

ESG I = (ESGIA X 1) + (ESGIB X 0.8) + (ESGIC X 0.6) = (31.33 X 1) + (7.25 X 0.8) + (11.42 X 0.6) = 43.982

ESG II = (ESGIIA X 0.8) + (ESGIIB X 1) = 41.75 X 0.8 = 33.4

These results were used as inputs in the formula suggested by Orfanidis et al. (2011), giving an EEI-c value of 6.66, corresponding to ‘Good-Moderate’ status.

**Table 4.2:** Table showing the boundaries between Ecological Quality Statuses (Source: Orfanidis et al., 2011).

<table>
<thead>
<tr>
<th>Ecological Status classes</th>
<th>EEI-c (boundary values)</th>
<th>EEI-cEQR (boundary values)</th>
<th>No. of theoretical values</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>9.72±0.46SD</td>
<td>0.97±0.06SD</td>
<td>334</td>
</tr>
<tr>
<td>Good-High</td>
<td>8.09±0.74SD</td>
<td>0.76±0.09SD</td>
<td>193</td>
</tr>
<tr>
<td>Good-Moderate</td>
<td>5.84±0.70SD</td>
<td>0.48±0.09SD</td>
<td>617</td>
</tr>
<tr>
<td>Moderate-Low</td>
<td>4.04±0.68SD</td>
<td>0.25±0.08SD</td>
<td>383</td>
</tr>
<tr>
<td>Bad</td>
<td>2.34±0.10SD</td>
<td>0.04±0.10SD</td>
<td>473</td>
</tr>
</tbody>
</table>
The other EEI-c values for the other five sites were worked out in the same way as the method shown for Qawra. The results are shown in Table 4.3. The working for these values is shown in Appendix V.

Table 4.3: The EQS value at each site.

<table>
<thead>
<tr>
<th>Site</th>
<th>EEI-c value</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qawra</td>
<td>6.66</td>
<td>‘Good-Moderate’</td>
</tr>
<tr>
<td>Ghar Lapsi</td>
<td>5.95</td>
<td>‘Good-Moderate’</td>
</tr>
<tr>
<td>St. George’s Bay</td>
<td>2.63</td>
<td>‘Bad’</td>
</tr>
<tr>
<td>Xlendi</td>
<td>8.59</td>
<td>‘Good-High’</td>
</tr>
<tr>
<td>Xwejni Bay</td>
<td>6.14</td>
<td>‘Good-Moderate’</td>
</tr>
<tr>
<td>Dwejra</td>
<td>8.93</td>
<td>‘Good-High’</td>
</tr>
</tbody>
</table>

4.2 Levels of nitrate in seawater

The results showed no variation (within the limits of resolution of the test kits used) as nitrate levels in all sites were in the 0-10 mg/l range. Nitrate levels were not used in subsequent statistical analyses; however they were interpreted and are discussed in the next chapter.

4.3 Calibration of questionnaire results with macroalgal data

4.3.1 Introduction

The questionnaire was completed by 198 respondents. From the 198 questionnaire respondents: there were 117 Maltese and 81 Non-Maltese (Figure 4.1), The gender ratio of the sample was 83 males to 115 females (Figure 4.1) whilst, as regards the age profile, 93 respondents were 18 to 30 years old, 61 respondents were 31-50 years old and 44 respondents were 51 years old or above (Figure 4.2).
The questionnaire results and the macroalgae fieldwork results were used together for the following purposes:

(1) To find out whether there was a correlation between the ratings of the seawater quality status perceived by the respondents and that obtained by the EEI-c method.
(2) To compare the mean ratings of the seawater quality status provided by the respondents to that provided by the EEI-c method.

(3) To compare the mean rating scores provided by the respondents for seawater quality between independent groups (grouped by gender, age, nationality, level of education, frequency of visit to the shore, preference between sandy beaches or rocky coast and whether they were at a preferred rocky coast).

The questionnaire was also used to find out whether bathers would like to see any additional educational activities at the rocky coast and whether this varied with gender, age, nationality, level of education and frequency of visit to the shore. The questionnaire was also used to explore what the respondents think about macroalgae.

4.3.2 Controlling for normality of the data

The distribution of the rating score provided for seawater quality at rocky coasts was skewed (not normal) since the p-value was less than the 0.05 level of significance. As a result, non-parametric tests were employed when using the seawater quality ratings given by the respondents.

The distribution for the question regarding educational activities was also skewed (not normal) since the p-value was less than the 0.05 level of significance. As a result, non-parametric tests were employed when analyzing this question.

4.3.3 Comparing the scores given by the respondents with the score determined by the macroalgae

The Spearman Correlation coefficient (0.276) relating the ecological status score with the rating score provided by the respondents for seawater quality was positive. This implied that for large EQS the participants provided higher rating scores for seawater and for smaller EQS the participants provided lower rating scores. This positive
relationship was significant ($r=0.276; p<0.001$) and not attributable to chance. The relationship between the score provided by the participants and that calculated through the EEI-c method (the EQS) is shown in Figure 4.3.

Even though the values regarding seawater quality provided by the respondents were generally higher than the ecological quality status (EQS) of the seawater obtained from the macroalgae fieldwork, the values of the respondents increased when the value obtained from the macroalgae fieldwork increased.

![Graph of Score vs. Study site](image)

Figure 4.3: Relationship between the score provided by the participants and the EQS.

4.3.4 Comparing the mean rating score provided by the participants with the EQS value

A summarized table of the results obtained is shown in Table 4.4. The latter shows that the mean rating scores provided by the respondents differed significantly ($p<0.05$) from each of the EQS values obtained for all the rocky coasts except for Dwejra.
### 4.3.5 Comparing the mean rating score for seawater quality between independent groups

#### 4.3.5.1 Effect of nationality on responses

From Table 4.5 it can be seen that there was no significant difference (p>0.05) between the response of the Maltese and the Non-Maltese with regards to seawater quality rating. The null hypothesis was accepted and therefore we can say that the responses of the Maltese respondents and the Non-Maltese respondents were comparable with regards to seawater quality status.
Table 4.5: p-values showing whether nationality makes a difference in responses on seawater quality.

<table>
<thead>
<tr>
<th>Rocky shore area</th>
<th>Nationality</th>
<th>Mean ± SD</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qawra Point</td>
<td>Maltese</td>
<td>4.47 ± 0.612</td>
<td>0.306</td>
</tr>
<tr>
<td></td>
<td>Non-Maltese</td>
<td>4.00 ± 1.206</td>
<td></td>
</tr>
<tr>
<td>Ghar Lapsi</td>
<td>Maltese</td>
<td>4.41 ± 0.694</td>
<td>0.425</td>
</tr>
<tr>
<td></td>
<td>Non-Maltese</td>
<td>4.17 ± 0.753</td>
<td></td>
</tr>
<tr>
<td>St George's Bay</td>
<td>Maltese</td>
<td>3.13 ± 1.088</td>
<td>0.763</td>
</tr>
<tr>
<td></td>
<td>Non-Maltese</td>
<td>3.29 ± 0.920</td>
<td></td>
</tr>
<tr>
<td>Dwejra</td>
<td>Maltese</td>
<td>4.45 ± 0.688</td>
<td>0.777</td>
</tr>
<tr>
<td></td>
<td>Non-Maltese</td>
<td>4.56 ± 0.512</td>
<td></td>
</tr>
<tr>
<td>Xwejni Bay</td>
<td>Maltese</td>
<td>4.38 ± 0.885</td>
<td>0.434</td>
</tr>
<tr>
<td></td>
<td>Non-Maltese</td>
<td>4.29 ± 0.611</td>
<td></td>
</tr>
<tr>
<td>Xlendi</td>
<td>Maltese</td>
<td>4.04 ± 0.790</td>
<td>0.803</td>
</tr>
<tr>
<td></td>
<td>Non-Maltese</td>
<td>4.00 ± 0.632</td>
<td></td>
</tr>
</tbody>
</table>

The above can be further explained by means of Figure 4.4 that reflects the 95% confidence intervals which provide a range of values for the actual rating score of water quality if the whole population had to be included in the study. When confidence intervals overlapped considerably, this indicated that the mean rating scores provided by the groups were comparable. Conversely when confidence intervals were disjoint or overlapped slightly, this indicated that the mean rating scores provided by the groups differed significantly. In Figure 4.4 one can observe that the 95% confidence intervals overlapped considerably thus this further confirms that the groups were comparable with regards to nationality.
4.3.5.2 Effect of gender on responses

From Table 4.6 it can be seen that there was no significant difference \( p>0.05 \) between the response of males and females with regards to seawater quality ratings. The null hypothesis was accepted and therefore we can say that the responses of males and females were comparable with regards to seawater quality status.
Table 4.6: p-value showing whether gender makes a difference in responses on seawater quality.

<table>
<thead>
<tr>
<th>Rocky shore area</th>
<th>Gender</th>
<th>Mean ± SD</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qawra Point</td>
<td>Male</td>
<td>4.07 ± 1.100</td>
<td>0.259</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>4.50 ± 0.632</td>
<td></td>
</tr>
<tr>
<td>Ghar Lapsi</td>
<td>Male</td>
<td>4.38 ± 0.518</td>
<td>0.835</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>4.36 ± 0.757</td>
<td></td>
</tr>
<tr>
<td>St George’s Bay</td>
<td>Male</td>
<td>3.19 ± 1.109</td>
<td>0.910</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>3.24 ± 0.903</td>
<td></td>
</tr>
<tr>
<td>Dwejra</td>
<td>Male</td>
<td>4.57 ± 0.514</td>
<td>0.739</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>4.46 ± 0.660</td>
<td></td>
</tr>
<tr>
<td>Xwejni Bay</td>
<td>Male</td>
<td>4.19 ± 0.834</td>
<td>0.280</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>4.50 ± 0.650</td>
<td></td>
</tr>
<tr>
<td>Xlendi</td>
<td>Male</td>
<td>4.07 ± 0.730</td>
<td>0.895</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>4.00 ± 0.791</td>
<td></td>
</tr>
</tbody>
</table>

The above can be further explained by means of Figure 4.5 which shows the 95% confidence intervals. Since the confidence intervals overlapped considerably, this confirmed that the male and female responses were comparable.
4.3.5.3 Effect of age on responses

As can be seen in Table 4.7, age had no bearing on the response on seawater quality since the age groups in each rocky coast were comparable and there was no significant difference (p>0.05) between different age groups. This can be further explained in Figure 4.6 where the confidence intervals for each rocky coast overlapped, implying that the mean rating scores provided were comparable.
Table 4.7: p-value showing whether age makes a difference in responses on seawater quality.

<table>
<thead>
<tr>
<th>Rocky shore area</th>
<th>Age</th>
<th>Mean ± SD</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qawra Point</td>
<td>18-30</td>
<td>4.31 ± 0.751</td>
<td>0.409</td>
</tr>
<tr>
<td></td>
<td>31-50</td>
<td>3.88 ± 1.356</td>
<td></td>
</tr>
<tr>
<td></td>
<td>51 or above</td>
<td>4.60 ± 0.516</td>
<td></td>
</tr>
<tr>
<td>Ghar Lapsi</td>
<td>18-30</td>
<td>4.14 ± 0.770</td>
<td>0.243</td>
</tr>
<tr>
<td></td>
<td>31-50</td>
<td>4.45 ± 0.522</td>
<td></td>
</tr>
<tr>
<td></td>
<td>51 or above</td>
<td>4.63 ± 0.744</td>
<td></td>
</tr>
<tr>
<td>St George's Bay</td>
<td>18-30</td>
<td>3.27 ± 1.041</td>
<td>0.504</td>
</tr>
<tr>
<td></td>
<td>31-50</td>
<td>3.00 ± 0.816</td>
<td></td>
</tr>
<tr>
<td>Dwejra</td>
<td>18-30</td>
<td>4.41 ± 0.618</td>
<td>0.244</td>
</tr>
<tr>
<td></td>
<td>31-50</td>
<td>4.57 ± 0.535</td>
<td></td>
</tr>
<tr>
<td></td>
<td>51 or above</td>
<td>5.00 ± 0.000</td>
<td></td>
</tr>
<tr>
<td>Xwejni Bay</td>
<td>18-30</td>
<td>4.67 ± 0.816</td>
<td>0.183</td>
</tr>
<tr>
<td></td>
<td>31-50</td>
<td>4.33 ± 0.888</td>
<td></td>
</tr>
<tr>
<td></td>
<td>51 or above</td>
<td>4.17 ± 0.577</td>
<td></td>
</tr>
<tr>
<td>Xlendi</td>
<td>18-30</td>
<td>4.15 ± 0.555</td>
<td>0.659</td>
</tr>
<tr>
<td></td>
<td>31-50</td>
<td>4.00 ± 0.913</td>
<td></td>
</tr>
<tr>
<td></td>
<td>51 or above</td>
<td>3.80 ± 0.837</td>
<td></td>
</tr>
</tbody>
</table>
4.3.5.4 Effect of frequency of visits to the rocky coast on responses

From Table 4.8 one can conclude that there was no significant difference (p>0.05) between the respondents that visit the rocky coast on a regular basis and respondents that were occasional visitors. The null hypothesis was accepted, therefore it was determined that the responses of the participants that visit the rocky coast on a regular basis were comparable to the responses of the occasional visitors.
Table 4.8: p-value showing whether frequency of visit makes a difference in responses on seawater quality.

<table>
<thead>
<tr>
<th>Rocky shore area</th>
<th>How often do you frequently visit this rocky shore?</th>
<th>Mean ± SD</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qawra Point</td>
<td>It is my first time here</td>
<td>3.63 ± 1.302</td>
<td>0.505</td>
</tr>
<tr>
<td></td>
<td>More than once a year but less than once a week</td>
<td>4.64 ± 0.505</td>
<td></td>
</tr>
<tr>
<td></td>
<td>More than once a week</td>
<td>4.42 ± 0.669</td>
<td></td>
</tr>
<tr>
<td>Ghar Lapsi</td>
<td>It is my first time here</td>
<td>4.29 ± 0.756</td>
<td>0.860</td>
</tr>
<tr>
<td></td>
<td>More than once a year but less than once a week</td>
<td>4.45 ± 0.688</td>
<td></td>
</tr>
<tr>
<td></td>
<td>More than once a week</td>
<td>4.33 ± 0.724</td>
<td></td>
</tr>
<tr>
<td>St George's Bay</td>
<td>It is my first time here</td>
<td>3.00 ± 1.095</td>
<td>0.704</td>
</tr>
<tr>
<td></td>
<td>More than once a year but less than once a week</td>
<td>3.33 ± 0.900</td>
<td></td>
</tr>
<tr>
<td></td>
<td>More than once a week</td>
<td>3.29 ± 1.113</td>
<td></td>
</tr>
<tr>
<td>Dwejra</td>
<td>It is my first time here</td>
<td>4.56 ± 0.512</td>
<td>0.779</td>
</tr>
<tr>
<td></td>
<td>More than once a year but less than once a week</td>
<td>4.50 ± 0.756</td>
<td></td>
</tr>
<tr>
<td></td>
<td>More than once a week</td>
<td>4.33 ± 0.577</td>
<td></td>
</tr>
<tr>
<td>Xwejni Bay</td>
<td>It is my first time here</td>
<td>4.20 ± 0.632</td>
<td>0.150</td>
</tr>
<tr>
<td></td>
<td>More than once a year but less than once a week</td>
<td>4.29 ± 0.849</td>
<td></td>
</tr>
<tr>
<td></td>
<td>More than once a week</td>
<td>5.00 ± 0.000</td>
<td></td>
</tr>
<tr>
<td>Xlendi</td>
<td>It is my first time here</td>
<td>3.75 ± 0.707</td>
<td>0.361</td>
</tr>
<tr>
<td></td>
<td>More than once a year but less than once a week</td>
<td>4.09 ± 0.831</td>
<td></td>
</tr>
<tr>
<td></td>
<td>More than once a week</td>
<td>4.17 ± 0.718</td>
<td></td>
</tr>
</tbody>
</table>

Figure 4.7, further explains the above, since the 95% confidence intervals overlapped considerably for each rocky coast; therefore this confirmed that the mean rating scores provided by the groups were comparable.
4.3.5.5 Effect of level of education on responses

From Table 4.9 it can be seen that there was no significant difference (p>0.05) between the responses of the respondents based on level of education. The null hypothesis was accepted; therefore we can say that respondents of different educational backgrounds were comparable with regards to seawater quality status rating.
Table 4.9: p-value showing whether level of education makes a difference in responses on seawater quality.

<table>
<thead>
<tr>
<th>Rocky shore area</th>
<th>What is the highest level of education you have</th>
<th>Mean ± SD</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qawra Point</td>
<td>Secondary education or lower</td>
<td>4.37 ± 0.684</td>
<td>0.904</td>
</tr>
<tr>
<td></td>
<td>Completed post-secondary education</td>
<td>4.40 ± 0.894</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Completed tertiary education</td>
<td>4.00 ± 1.414</td>
<td></td>
</tr>
<tr>
<td>Ghar Lapsi</td>
<td>Secondary education or lower</td>
<td>4.53 ± 0.612</td>
<td>0.332</td>
</tr>
<tr>
<td></td>
<td>Completed post-secondary education</td>
<td>4.17 ± 0.753</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Completed tertiary education</td>
<td>4.13 ± 0.835</td>
<td></td>
</tr>
<tr>
<td>St George's Bay</td>
<td>Secondary education or lower</td>
<td>3.29 ± 0.914</td>
<td>0.863</td>
</tr>
<tr>
<td></td>
<td>Completed post-secondary education</td>
<td>3.25 ± 1.708</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Completed tertiary education</td>
<td>3.13 ± 0.915</td>
<td></td>
</tr>
<tr>
<td>Dwejra</td>
<td>Secondary education or lower</td>
<td>4.57 ± 0.535</td>
<td>0.505</td>
</tr>
<tr>
<td></td>
<td>Completed post-secondary education</td>
<td>4.38 ± 0.650</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Completed tertiary education</td>
<td>4.71 ± 0.488</td>
<td></td>
</tr>
<tr>
<td>Xwejni Bay</td>
<td>Secondary education or lower</td>
<td>4.29 ± 0.951</td>
<td>0.996</td>
</tr>
<tr>
<td></td>
<td>Completed post-secondary education</td>
<td>4.17 ± 1.169</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Completed tertiary education</td>
<td>4.41 ± 0.507</td>
<td></td>
</tr>
<tr>
<td>Xlendi</td>
<td>Secondary education or lower</td>
<td>4.00 ± 0.907</td>
<td>0.919</td>
</tr>
<tr>
<td></td>
<td>Completed post-secondary education</td>
<td>4.17 ± 0.408</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Completed tertiary education</td>
<td>4.00 ± 0.577</td>
<td></td>
</tr>
</tbody>
</table>

Figure 4.8 further confirms the above statement that the mean rating scores provided were comparable, since the 95% confidence intervals overlapped considerably.
4.3.5.6 Effect of preferred rocky shore area on responses

From Table 4.10 it can be seen that there was a significant difference (p<0.05) with regards to seawater quality rating between the respondents that answered that the rocky coast was one of their preferred shores and those that answered that the rocky coast was not one of their preferred shores.
Table 4.10: p-value showing whether preference of rocky shore area makes a difference in responses on seawater quality.

<table>
<thead>
<tr>
<th>Is this one of your preferred rocky shores?</th>
<th>Mean ± SD</th>
<th>95% Confidence Interval for Mean</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lower Bound</td>
<td>Upper Bound</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>3.63 ± 1.137</td>
<td>3.32 - 3.93</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Yes</td>
<td>4.32 ± 0.684</td>
<td>4.20 - 4.44</td>
<td></td>
</tr>
</tbody>
</table>

4.3.5.7 Effect of preference between rocky coasts and sandy beaches on responses

From Table 4.11 it can be seen that there was a significant difference (p<0.05) with regards to seawater quality rating between the respondents that prefer rocky coasts and the respondents that prefer sandy beaches. This can further be explained by Figure 4.9, since the 95% confidence intervals were disjoint implying that the mean rating scores provided by the groups differed significantly.

Table 4.11: p-value showing whether preference between rocky coasts or sandy beaches makes a difference in responses on seawater quality.

<table>
<thead>
<tr>
<th>Preference</th>
<th>Mean ± SD</th>
<th>95% Confidence Interval for Mean</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lower Bound</td>
<td>Upper Bound</td>
<td></td>
</tr>
<tr>
<td>Rocky coasts</td>
<td>4.28 ± 0.929</td>
<td>4.08 - 4.48</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Sandy beaches</td>
<td>3.71 ± 0.854</td>
<td>3.48 - 3.94</td>
<td></td>
</tr>
<tr>
<td>No particular preference</td>
<td>4.27 ± 0.758</td>
<td>4.04 - 4.50</td>
<td></td>
</tr>
</tbody>
</table>
Figure 4.9: Mean score of the seawater quality by the independent groups (grouping based on preference between rocky coasts and sandy beaches) at each rocky coast.

4.3.6 The three significant predictors

Table 4.12 shows the three significant predictors from the nine predictors used in the ANCOVA regression analysis. The nine predictors were questions 1,2,3,4,5,6,7,8 and 13 of the questionnaire. By using a backward elimination procedure, the regression model identified three significant predictors which collectively explained 31.3% of the total variance in the responses (rating score for seawater quality provided by the respondents).
Table 4.12 only shows the significant predictors since the Law of Parsimony states that a regression model that includes solely the significant predictors provides a better fit than a regression model which includes also redundant predictors (Dr. Camilleri, University of Malta, personal correspondence, 2013).

‘Rocky shore area’ is the best predictor of the rating scores (p<0.001). This is followed by ‘Preferred rocky shore overall’ (p = 0.007) and ‘Preferred rocky shore/beach for recreational purposes’ (p = 0.012). The other predictors contributed marginally in explaining the total variance and were excluded from the model fit.

The regression model, confirmed the Kruskal-Wallis results as well as showing that the mentioned three predictors did not change when taken with other predictors.

Table 4.12: Table showing the three significant predictors.

<table>
<thead>
<tr>
<th>Source</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rocky shore area</td>
<td>≤0.001</td>
</tr>
<tr>
<td>Preferred rocky shore overall</td>
<td>0.007</td>
</tr>
<tr>
<td>Preferred shore for recreational purposes</td>
<td>0.012</td>
</tr>
</tbody>
</table>

4.3.7 Lowest concern and highest concern issues at the rocky coast

In question 12 of the questionnaire, the respondents were asked to rank five issues of concern from 1 to 5 where 1 implied lowest concern/ low importance issue and 5 implied highest concern/ highest importance issue. The five issues of concern were based on literature by Williams and Micallef (2009) who suggest that research by many researchers including: Morgan and Williams, 1995; Micallef et al, 1999; Morgan et al, 1996; 2000; Tudor and Williams, 2006; House and Phillips, 2007; Marin et al, 2007, has shown that in the Euro-Mediterranean region and the United States, the five main issues of concern at the shore were litter, safety, scenery, facilities and water quality.
There was a significant difference (p<0.001) between the five issues of concern as rated by the respondents. In descending order from highest to lowest the issues ranked as follows: water quality, scenery, safety, litter and facilities.

As can be seen from Figure 4.10, the 95% confidence intervals of water quality and scenery overlapped considerably implying that there was no significant difference between the two, however there was a significant difference between water quality and the other three issues of concern: safety, litter and facilities.
4.3.8 Lowest concern and highest concern issues in general

In question 15 of the questionnaire, the respondents were asked to rank ten global issues of concern from 1 to 10 where 1 meant lowest concern and 10 meant highest concern. The respondents were asked this question so that the results could be compared and contrasted to the results obtained from the study that took place in seven European countries: UK, France, Germany, Spain, Portugal, Italy and Poland.
(Potts et al., 2011). In fact the ten issues of concern provided for the respondents were based on the research by Potts et al. (2011).


There was a significant difference (p<0.001) between the issues of concern. ‘Health and education’ was significantly higher than the other issues of concern. The latter can be seen in Figure 4.11 which shows that the 95% confidence interval of ‘Health and education’ did not overlap with any of the other 95% confidence intervals. Terrorism which was the least concern issue was significantly lower to: the economy, ocean/sea water health, the cost of living, affordable energy and health and education.
4.3.9 Respondents’ understanding of macroalgae

In question 9 of the questionnaire, the respondents were asked if they believed that macroalgae were related to water quality, the correct answer being “Yes, some macroalgae are an indication of good water quality whilst other macroalgae are an indication of poor water quality”. As can be seen in Figure 4.12, the most frequent answer was “I am not sure or do not really know” with 49% of the respondents answering so. The correct answer was answered by 22.2% of the respondents.
4.3.10 How do the respondents feel about the macroalgae?

As can be seen in Figure 4.13, the most common answer (48.48%) to question 13 of the questionnaire was that the macroalgae make no difference to the respondents and do not affect their enjoyment of the coastal area, however it is worth noting that 39.39% answered that the macroalgae annoy them and reduce their enjoyment of the coastal area. Only 12.12% answered that they like the macroalgae.
Figure 4.13: How the public feels about the macroalgae.
4.3.11 The respondents’ perception of colour of the macroalgae

As can be seen in Figure 4.14, the macroalgae colour made no difference to most of the respondents (75.76%). However between the brown, the green and the red macroalgae: the brown macroalgae bothered the respondents more (19.70%) as opposed to the green macroalgae (4.04%) and the red macroalgae (0.51%).

Figure 4.14: How the public feels about the macroalgal colour.
4.3.12 Would the respondents like to see any additional educational activities?

With regards to whether the respondents would like to see any additional educational activities concerning general environmental issues at the rocky coast, the majority answered, "agree" (37.37%) which was very close to the second most frequent answer, "strongly agree" (36.87%). The rest of the responses were "neither agree nor disagree" (18.69%), "disagree" (3.54%) and "strongly disagree" (3.54%). This can be seen in Figure 4.15.

![Figure 4.15: The percentages of the respondents that would or would not like to see additional educational activities concerning general environmental issues at the rocky coast.](image-url)
4.3.13 Comparing the educational activities responses between independent groups

4.3.13.1 Effect of nationality on responses

From Table 4.13, it can be concluded that there was no significant difference (p>0.05) between the Maltese and the Non-Maltese with regards to their response on seeing additional educational activities. This may also be seen in Figure 4.16, since the 95% confidence intervals at each rocky coast overlapped significantly, confirming that the mean rating scores provided by the groups were comparable.

Table 4.13: p-value showing whether nationality makes a difference in responses on educational activities.

<table>
<thead>
<tr>
<th>Rocky shore area</th>
<th>Nationality</th>
<th>Mean ± SD</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qawra Point</td>
<td>Maltese</td>
<td>3.65 ± 1.226</td>
<td>0.273</td>
</tr>
<tr>
<td></td>
<td>Non-Maltese</td>
<td>3.31 ± 0.947</td>
<td></td>
</tr>
<tr>
<td>Ghar Lapsi</td>
<td>Maltese</td>
<td>4.52 ± 0.935</td>
<td>0.021</td>
</tr>
<tr>
<td></td>
<td>Non-Maltese</td>
<td>3.83 ± 0.753</td>
<td></td>
</tr>
<tr>
<td>St George's Bay</td>
<td>Maltese</td>
<td>4.19 ± 0.750</td>
<td>0.421</td>
</tr>
<tr>
<td></td>
<td>Non-Maltese</td>
<td>4.41 ± 0.507</td>
<td></td>
</tr>
<tr>
<td>Dwejra</td>
<td>Maltese</td>
<td>3.83 ± 0.937</td>
<td>0.582</td>
</tr>
<tr>
<td></td>
<td>Non-Maltese</td>
<td>3.95 ± 1.117</td>
<td></td>
</tr>
<tr>
<td>Xwejni Bay</td>
<td>Maltese</td>
<td>3.47 ± 1.375</td>
<td>0.445</td>
</tr>
<tr>
<td></td>
<td>Non-Maltese</td>
<td>3.88 ± 1.025</td>
<td></td>
</tr>
<tr>
<td>Xlendi</td>
<td>Maltese</td>
<td>4.32 ± 0.748</td>
<td>0.504</td>
</tr>
<tr>
<td></td>
<td>Non-Maltese</td>
<td>4.13 ± 0.835</td>
<td></td>
</tr>
</tbody>
</table>
Figure 4.16: Mean score for additional educational activities by the independent groups (grouping based on nationality) at each rocky coast.

4.3.13.2 Effect of gender on responses

Table 4.14 shows that there was no significant difference (p>0.05) between males and females with regards to their response on seeing additional educational activities. This holds for all the rocky coasts except for Xlendi (p<0.05).

In Figure 4.17 it can be seen that the 95% confidence intervals at each rocky coast (with the exception of Xlendi) overlapped significantly which confirmed that the mean rating scores provided by the groups were comparable.
Table 4.14: p-value showing whether gender makes a difference in responses on educational activities.

<table>
<thead>
<tr>
<th>Rocky shore area</th>
<th>Gender</th>
<th>Mean ± SD</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qawra Point</td>
<td>Male</td>
<td>3.73 ± 1.438</td>
<td>0.192</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>3.33 ± 0.767</td>
<td></td>
</tr>
<tr>
<td>Ghar Lapsi</td>
<td>Male</td>
<td>4.63 ± 0.744</td>
<td>0.386</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>4.32 ± 0.988</td>
<td></td>
</tr>
<tr>
<td>St George's Bay</td>
<td>Male</td>
<td>4.19 ± 0.655</td>
<td>0.315</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>4.41 ± 0.618</td>
<td></td>
</tr>
<tr>
<td>Dwejra</td>
<td>Male</td>
<td>4.14 ± 0.864</td>
<td>0.358</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>3.74 ± 1.147</td>
<td></td>
</tr>
<tr>
<td>Xwejni Bay</td>
<td>Male</td>
<td>3.44 ± 1.263</td>
<td>0.297</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>3.88 ± 1.166</td>
<td></td>
</tr>
<tr>
<td>Xlendi</td>
<td>Male</td>
<td>4.57 ± 0.646</td>
<td>0.039</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>4.05 ± 0.780</td>
<td></td>
</tr>
</tbody>
</table>
Figure 4.17: Mean score for additional educational activities by the independent groups (grouping based on gender) at each rocky coast.
4.3.13.3 Effect of age on responses

From Table 4.15, it can be seen that there was no significant difference (p>0.05) between respondents from different age groups with regards to their response on seeing additional educational activities.

This may also be seen in Figure 4.18, since the 95% confidence intervals at each rocky coast overlapped significantly, confirming that the mean rating scores provided by the groups were comparable.

Table 4.15: p-value showing whether age makes a difference in responses on educational activities.

<table>
<thead>
<tr>
<th>Rocky shore area</th>
<th>Age</th>
<th>Mean ± SD</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qawra Point</td>
<td>18-30</td>
<td>3.36 ± 0.929</td>
<td>0.199</td>
</tr>
<tr>
<td></td>
<td>31-50</td>
<td>3.11 ± 1.364</td>
<td></td>
</tr>
<tr>
<td></td>
<td>51 or above</td>
<td>4.10 ± 0.994</td>
<td></td>
</tr>
<tr>
<td>Ghar Lapsi</td>
<td>18-30</td>
<td>4.29 ± 0.726</td>
<td>0.268</td>
</tr>
<tr>
<td></td>
<td>31-50</td>
<td>4.45 ± 0.820</td>
<td></td>
</tr>
<tr>
<td></td>
<td>51 or above</td>
<td>4.50 ± 1.414</td>
<td></td>
</tr>
<tr>
<td>St George's Bay</td>
<td>18-30</td>
<td>4.35 ± 0.689</td>
<td>0.325</td>
</tr>
<tr>
<td></td>
<td>31-50</td>
<td>4.14 ± 0.378</td>
<td></td>
</tr>
<tr>
<td>Dwejra</td>
<td>18-30</td>
<td>3.84 ± 1.068</td>
<td>0.878</td>
</tr>
<tr>
<td></td>
<td>31-50</td>
<td>4.00 ± 1.000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>51 or above</td>
<td>4.00 ± 1.225</td>
<td></td>
</tr>
<tr>
<td>Xwejni Bay</td>
<td>18-30</td>
<td>3.33 ± 1.506</td>
<td>0.775</td>
</tr>
<tr>
<td></td>
<td>31-50</td>
<td>3.67 ± 1.231</td>
<td></td>
</tr>
<tr>
<td></td>
<td>51 or above</td>
<td>3.80 ± 1.146</td>
<td></td>
</tr>
<tr>
<td>Xlendi</td>
<td>18-30</td>
<td>4.36 ± 0.745</td>
<td>0.804</td>
</tr>
<tr>
<td></td>
<td>31-50</td>
<td>4.23 ± 0.599</td>
<td></td>
</tr>
<tr>
<td></td>
<td>51 or above</td>
<td>4.17 ± 1.169</td>
<td></td>
</tr>
</tbody>
</table>
4.3.13.4 Effect of frequency of visit to the rocky coast on responses

Table 4.16 shows that there was no significant difference (p>0.05) between the respondents that visit the shore often and those that do not visit the shore often with regards to their response on seeing additional educational activities; this holds for all the rocky coasts except for Xlendi (p=0.05) which is a borderline case.
This may be further explained by Figure 4.19, since the 95% confidence intervals at each rock coast overlapped significantly which confirmed that the mean rating scores provided by the groups were comparable.

Table 4.16: p-value showing whether frequency of visit makes a difference in responses on educational activities.

<table>
<thead>
<tr>
<th>Rocky shore area</th>
<th>How often do you frequently visit this rocky shore?</th>
<th>Mean ± SD</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qawra Point</td>
<td>It is my first time here</td>
<td>3.22 ± 1.093</td>
<td>0.523</td>
</tr>
<tr>
<td></td>
<td>More than once a year but less than once a week</td>
<td>3.50 ± 1.000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>More than once a week</td>
<td>3.67 ± 1.155</td>
<td></td>
</tr>
<tr>
<td>Ghar Lapsi</td>
<td>It is my first time here</td>
<td>4.14 ± 0.900</td>
<td>0.505</td>
</tr>
<tr>
<td></td>
<td>More than once a year but less than once a week</td>
<td>4.64 ± 0.505</td>
<td></td>
</tr>
<tr>
<td></td>
<td>More than once a week</td>
<td>4.33 ± 1.175</td>
<td></td>
</tr>
<tr>
<td>St George's Bay</td>
<td>It is my first time here</td>
<td>4.36 ± 0.505</td>
<td>0.760</td>
</tr>
<tr>
<td></td>
<td>More than once a year but less than once a week</td>
<td>4.33 ± 0.724</td>
<td></td>
</tr>
<tr>
<td></td>
<td>More than once a week</td>
<td>4.14 ± 0.690</td>
<td></td>
</tr>
<tr>
<td>Dwejra</td>
<td>It is my first time here</td>
<td>4.10 ± 0.912</td>
<td>0.488</td>
</tr>
<tr>
<td></td>
<td>More than once a year but less than once a week</td>
<td>3.60 ± 1.350</td>
<td></td>
</tr>
<tr>
<td></td>
<td>More than once a week</td>
<td>3.67 ± 0.577</td>
<td></td>
</tr>
<tr>
<td>Xwejni Bay</td>
<td>It is my first time here</td>
<td>3.45 ± 1.036</td>
<td>0.355</td>
</tr>
<tr>
<td></td>
<td>More than once a year but less than once a week</td>
<td>3.67 ± 1.283</td>
<td></td>
</tr>
<tr>
<td></td>
<td>More than once a week</td>
<td>4.25 ± 1.500</td>
<td></td>
</tr>
<tr>
<td>Xlendi</td>
<td>It is my first time here</td>
<td>4.20 ± 0.789</td>
<td>0.050</td>
</tr>
<tr>
<td></td>
<td>More than once a year but less than once a week</td>
<td>3.91 ± 0.831</td>
<td></td>
</tr>
<tr>
<td></td>
<td>More than once a week</td>
<td>4.67 ± 0.492</td>
<td></td>
</tr>
</tbody>
</table>
4.3.13.5 Effect of level of education on responses

As can be seen in Table 4.17, there is no significant difference (p>0.05) between the respondents from different levels of education with regards to their response on seeing additional educational activities. This may also be confirmed by means of Figure 4.20, since the 95% confidence intervals at each rocky coast overlapped significantly which implied that the mean rating scores provided by the groups were comparable.
Table 4.17: p-value showing whether level of education makes a difference in responses on educational activities.

<table>
<thead>
<tr>
<th>Rocky shore area</th>
<th>What is the highest level of education you have completed?</th>
<th>Mean ± SD</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qawra Point</td>
<td>Secondary education or lower</td>
<td>3.50 ± 1.100</td>
<td>0.915</td>
</tr>
<tr>
<td></td>
<td>Completed post-secondary education</td>
<td>3.50 ± 0.837</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Completed tertiary education</td>
<td>3.43 ± 1.272</td>
<td></td>
</tr>
<tr>
<td>Ghar Lapsi</td>
<td>Secondary education or lower</td>
<td>4.53 ± 1.020</td>
<td>0.101</td>
</tr>
<tr>
<td></td>
<td>Completed post-secondary education</td>
<td>4.50 ± 0.837</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Completed tertiary education</td>
<td>4.00 ± 0.756</td>
<td></td>
</tr>
<tr>
<td>St George's Bay</td>
<td>Secondary education or lower</td>
<td>4.14 ± 0.770</td>
<td>0.569</td>
</tr>
<tr>
<td></td>
<td>Completed post-secondary education</td>
<td>4.50 ± 0.577</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Completed tertiary education</td>
<td>4.40 ± 0.507</td>
<td></td>
</tr>
<tr>
<td>Dwejra</td>
<td>Secondary education or lower</td>
<td>3.78 ± 0.972</td>
<td>0.748</td>
</tr>
<tr>
<td></td>
<td>Completed post-secondary education</td>
<td>3.93 ± 0.997</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Completed tertiary education</td>
<td>4.00 ± 1.247</td>
<td></td>
</tr>
<tr>
<td>Xwejni Bay</td>
<td>Secondary education or lower</td>
<td>4.25 ± 0.886</td>
<td>0.208</td>
</tr>
<tr>
<td></td>
<td>Completed post-secondary education</td>
<td>3.00 ± 1.690</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Completed tertiary education</td>
<td>3.71 ± 0.985</td>
<td></td>
</tr>
<tr>
<td>Xlendi</td>
<td>Secondary education or lower</td>
<td>4.22 ± 0.808</td>
<td>0.234</td>
</tr>
<tr>
<td></td>
<td>Completed post-secondary education</td>
<td>4.00 ± 0.632</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Completed tertiary education</td>
<td>4.56 ± 0.726</td>
<td></td>
</tr>
</tbody>
</table>
Figure 4.20: Mean score for additional educational activities by the independent groups (grouping based on level of education) at each rocky coast.
4.4 Qualitative data analysis

4.4.1 Introduction

There were three questions (in the questionnaire) that required qualitative data analysis and these were questions 7, 9 and 10 since they consisted of two parts a closed-ended question and an open-ended question.

4.4.2 Likes and dislikes of the respondents about a particular rocky coast

From Table 4.18 it can be concluded that the three major criteria that were repeated as likes of the respondents were the following: scenery/views, clean environment and clean seawater. On the other hand from Table 4.19, one can see that the three major criteria that were repeated as dislikes of the respondents were the following: crowded shores, rough rocks and artificial sand (this being the case at the St. George’s Bay since this Bay is partly rocky coast and partly imported sand not native to the area).
Table 4.18: The respondents’ preferences at each rocky coast and in total.

<table>
<thead>
<tr>
<th>Likes of the respondents</th>
<th>Number of respondents:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Qawra</td>
</tr>
<tr>
<td>Scenery/views</td>
<td>3</td>
</tr>
<tr>
<td>Clean environment</td>
<td>6</td>
</tr>
<tr>
<td>Clean seawater</td>
<td>5</td>
</tr>
<tr>
<td>Quiet</td>
<td>6</td>
</tr>
<tr>
<td>Live/work close by</td>
<td>1</td>
</tr>
<tr>
<td>Good for diving</td>
<td>0</td>
</tr>
<tr>
<td>Natural</td>
<td>0</td>
</tr>
<tr>
<td>Not sandy</td>
<td>6</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
</tr>
<tr>
<td>Grew up here</td>
<td>1</td>
</tr>
<tr>
<td>Easy access</td>
<td>0</td>
</tr>
<tr>
<td>Safe/life guard present</td>
<td>1</td>
</tr>
<tr>
<td>Seabed different heights</td>
<td>0</td>
</tr>
<tr>
<td>Sand</td>
<td>0</td>
</tr>
<tr>
<td>Marine life</td>
<td>0</td>
</tr>
<tr>
<td>Clear seawater</td>
<td>0</td>
</tr>
<tr>
<td>Not many tourists</td>
<td>0</td>
</tr>
<tr>
<td>A lot of people</td>
<td>0</td>
</tr>
<tr>
<td>Good for catching Octopus</td>
<td>0</td>
</tr>
<tr>
<td>In the centre</td>
<td>0</td>
</tr>
<tr>
<td>Algae</td>
<td>0</td>
</tr>
<tr>
<td>Unpolluted rocks</td>
<td>0</td>
</tr>
<tr>
<td>Deep seawater</td>
<td>0</td>
</tr>
<tr>
<td>Shallow pools</td>
<td>0</td>
</tr>
<tr>
<td>Bar excess</td>
<td>1</td>
</tr>
<tr>
<td>Souvenirs</td>
<td>0</td>
</tr>
</tbody>
</table>
Table 4.19: The respondents’ negative preferences at each rocky coast and in total.

<table>
<thead>
<tr>
<th>Dislikes of the respondents</th>
<th>Number of respondent:</th>
<th>Qawra</th>
<th>Ghar Lapsi</th>
<th>St. George’s Bay</th>
<th>Dwejra Bay</th>
<th>Xwejni Bay</th>
<th>Xlendi</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crowded</td>
<td></td>
<td>1</td>
<td>0</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>Rough rocks</td>
<td></td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>Artificial sand</td>
<td></td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Macroalgae</td>
<td></td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Not a good swimming area/ rough sea</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Dirty</td>
<td></td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Not suitable for children, elderly or disabled</td>
<td></td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Not enough area where to sit</td>
<td></td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Has not been fixed for many years</td>
<td></td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Surrounded by buildings</td>
<td></td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Seawater not clean</td>
<td></td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Seawater not clear</td>
<td></td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Surrounded by boats</td>
<td></td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Dangerous</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>People discard waste into the sea</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Noisy</td>
<td></td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>
4.4.3 What is the seawater quality rating given by the respondents based upon?

Table 4.20 shows that the major criteria which the respondents used to base their seawater quality rating on were the following: cleanliness, clarity, whether there was discarded waste products in the seawater, colour of seawater, amount of people at the shore, marine life and visible/no visible pollution.
Table 4.20: The criteria used by the respondents in order to rate the seawater quality.

<table>
<thead>
<tr>
<th>Criteria given by the respondents</th>
<th>Number of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean</td>
<td>53</td>
</tr>
<tr>
<td>Clarity</td>
<td>52</td>
</tr>
<tr>
<td>Whether there is discarded waste products in seawater</td>
<td>12</td>
</tr>
<tr>
<td>Colour</td>
<td>7</td>
</tr>
<tr>
<td>Too many people</td>
<td>4</td>
</tr>
<tr>
<td>Thriving marine life</td>
<td>4</td>
</tr>
<tr>
<td>Visible pollution/no visible pollution</td>
<td>4</td>
</tr>
<tr>
<td>Calm/ rough</td>
<td>3</td>
</tr>
<tr>
<td>Comparison to other beaches or comparison to last year</td>
<td>3</td>
</tr>
<tr>
<td>Smell</td>
<td>3</td>
</tr>
<tr>
<td>Absence/presence of sewage</td>
<td>3</td>
</tr>
<tr>
<td>Nice</td>
<td>3</td>
</tr>
<tr>
<td>Healthy</td>
<td>3</td>
</tr>
<tr>
<td>Fresh</td>
<td>3</td>
</tr>
<tr>
<td>Presence/ absence of boats</td>
<td>3</td>
</tr>
<tr>
<td>Safe</td>
<td>2</td>
</tr>
<tr>
<td>Jellyfish</td>
<td>2</td>
</tr>
<tr>
<td>Location (in centre or isolated)</td>
<td>2</td>
</tr>
<tr>
<td>Beautiful</td>
<td>2</td>
</tr>
<tr>
<td>Healer (helps cure: acne and foot pain)</td>
<td>2</td>
</tr>
<tr>
<td>Temperature</td>
<td>1</td>
</tr>
<tr>
<td>People swim drunk at night</td>
<td>1</td>
</tr>
<tr>
<td>Very well kept</td>
<td>1</td>
</tr>
<tr>
<td>People not careful in keeping it clean</td>
<td>1</td>
</tr>
<tr>
<td>Deep</td>
<td>1</td>
</tr>
<tr>
<td>Blue flag beach</td>
<td>1</td>
</tr>
<tr>
<td>No debris</td>
<td>1</td>
</tr>
<tr>
<td>Bathing signs</td>
<td>1</td>
</tr>
<tr>
<td>E.U. laws</td>
<td>1</td>
</tr>
<tr>
<td>In the middle of Europe</td>
<td>1</td>
</tr>
</tbody>
</table>

4.4.4 Verifying correct answers with regards to question 9

The correct answer to the question about whether macroalgae are related to seawater quality was, “Yes, different macroalgae can show different things, some macroalgae are an indication of good quality whilst other macroalgae are an indication of poor
quality”. Out of the 198 respondents, only 44 respondents answered question 9 correctly. Part two of question 9 was an open-ended question which asked the respondents why they believed that their answer was correct. This was done both as a precautionary question that makes respondents think twice before giving an answer but also to see whether the respondents that got the correct answer could explain what they believed.

As can be seen in Table 4.21, out of the 44 respondents that answered correctly, 13 left the answer blank, 1 explained microalgae instead of macroalgae, 8 answered that they have heard it or read it somewhere, 5 answered that they know through their experience in different shores and 17 elaborated further. The second part of question 9 shows that out of the 44 respondents that answered correctly, not all of them were sure or could elaborate further.

Table 4.21: Qualitative results to the question regarding macroalgae as indicators of seawater quality.

<table>
<thead>
<tr>
<th>Response</th>
<th>Number of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elaborated further</td>
<td>17</td>
</tr>
<tr>
<td>Blank answer</td>
<td>13</td>
</tr>
<tr>
<td>Heard it/read it somewhere</td>
<td>8</td>
</tr>
<tr>
<td>From experience</td>
<td>5</td>
</tr>
<tr>
<td>Explained microalgae instead of macroalgae</td>
<td>1</td>
</tr>
</tbody>
</table>
5. Discussion

5.1 Summary of results

A presentation of the findings was shown in the previous chapter. Among the many findings it was concluded that the EQS obtained from the macroalgal data was the highest for Dwejra with an EQS value of 8.93 which corresponds to ‘Good-High’ status. Xlendi followed Dwejra with an EQS value of 8.59 also ‘Good-High’ status. Qawra, Xwejni Bay and Ghar Lapsi scored an EQS value of 6.66, 6.14 and 5.95 respectively, these values all fell in the ‘Good-Moderate’ status. The lowest value was recorded from St. George’s Bay with an EQS of 2.63 that corresponds to ‘Bad’ status.

The nitrates results were all the same so they were not pursued further in the analysis; however this chapter provides a suggested explanation for the result.

The Spearman correlation coefficient ($r=0.267; p<0.001$) relating the EQS to the rating score by the respondents for seawater quality was positive and statistically-significant therefore there is a positive relationship between the two, even though the values provided by the respondents were generally higher. The EQS values and the mean rating score provided by the participants were significantly different to each other in five out of the six cases. So even though there is a positive relationship between the two, they are still different.

Nationality, gender, age, frequency of visit to the rocky coast and level of education had no effect on the responses given by the respondents regarding seawater quality. However what did make a significant difference was whether the respondents preferred that particular rocky shore area and also whether the respondents preferred sandy beaches or rocky coasts. With regards to what criteria the respondents used for rating seawater quality, the main criteria were: cleanliness, clarity, whether there was
discarded waste products in the seawater, colour, amount of people at the shore, marine life and visible/no visible pollution.

Among the five issues of concern at the rocky coast, water quality and scenery were ranked as the highest issues of concern/importance, with water quality being significantly higher than safety, litter and facilities. However, on a global scale of issues of concern, ocean/sea health ranked fifth with health and education being the highest ranked category (significantly higher than all other categories): this finding will be contrasted with the findings of Potts et al. (2011) in a study that took place in seven European countries. With regards to what they like or dislike about a particular rocky shore, the three main themes with regards to ‘likes’ that were repeated by the respondents were scenery/views, clean environment and clean seawater. The three main themes with regards to ‘dislikes’ were crowded shores, rough rocks and artificial sand. Artificial sand refers to the sand at St. George’s Bay which is not natural to that locality but is sand that has been imported from the Al Jashia quarry in Aqaba (Jordan) (Ebejer, 2004 as cited in Borg, Gauci, Magro & Micallef, 2006).

With regards to the respondents’ understanding of macroalgae as indicators of seawater quality it can be concluded that most respondents do not know about this. Also, the macroalgae make no difference to some of the respondents (48.48%), even though a substantial amount (39.39%) answered that the macroalgae annoy them and feel that they reduce their enjoyment of the coastal area. Also, the macroalgal colour makes no difference to most of the respondents, even though if taken separately the brown macroalgae annoy the respondents more than the green or red macroalgae.

With reference to educational activities, 37.37% agree and 36.87% strongly agree to additional educational activities regarding environmental issues at the coast.
Nationality, gender, age, frequency of visit to the rocky shore and level of education had no effect on the responses given by the respondents regarding additional educational activities at the rocky shore.

5.2 Comparing the EQS values

From the EEI-c method, it was concluded that Dwejra and Xlendi obtained the best EQS values (8.93 and 8.59 respectively) and St. George’s Bay obtained the lowest EQS value (2.63). It is difficult to identify the reason for such discrepancies might be, in fact this is the case in most situations and frequently we cannot identify the cause or the most problematic pressure in not achieving good ecological status since there might also be more than one stressor (a multi-stress situation) (Galle, 2012 as cited in European Union, 2012b).

However some evident differences between these sites are: the Exposure Index which is greater for Dwejra and Xlendi than for St. George’s Bay which is an enclosed bay. The exposure index values for Dwejra, Xlendi and St. George’s Bay are 18.04, 26.88 and 2.4 respectively. One can observe the EQS and EI values of each site in Table 5.1. Vella (1990) and Magro (1991) are amongst some of the researchers who found a strong correlation between wave intensity and type of algal coverage.
Another difference amongst the sites is the human impact on each site, for example St. George’s Bay has a very high human impact and is the most crowded bay amongst the study sites chosen. In a study by Borg et al. (2006), it was concluded that *Posidonia Oceanica* at St. George’s Bay was ‘stressed’ as opposed to that at control sites and this difference was attributed to anthropogenic impacts such as mooring. Since moored boats at St. George’s Bay are more numerous than at other sites therefore they could also be affecting the abiotic environment and, hence, the algal communities. Both boat usage and maintenance impact the seawater and hence the macroalgae, through the release of contaminants, “through physical alterations like propeller wash and anchor chain scour, and through shading of the bottom” (Buzzards Bay National Estuary Program, 2012). Anchor chains rubbing the bottom tend to remove seagrass or the habitats living there and re-suspend the sediments at the bottom including bacteria (Buzzards Bay National Estuary Program, 2012). In a study by Eriksson, Sandströmb, Isæusc, Schreiberd and Karåsb (2004) who studied 44 sheltered inlets with different amounts of boat impacts, the authors concluded that

Table 5.1: EQS and EI values for each site.

<table>
<thead>
<tr>
<th>Site</th>
<th>EQS</th>
<th>Exposure Index (EI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dwejra</td>
<td>8.93</td>
<td>18.04</td>
</tr>
<tr>
<td>Xlendi</td>
<td>8.59</td>
<td>26.88</td>
</tr>
<tr>
<td>Qawra</td>
<td>6.66</td>
<td>7.01</td>
</tr>
<tr>
<td>Xwejni Bay</td>
<td>6.14</td>
<td>2.94</td>
</tr>
<tr>
<td>Ghar Lapsi</td>
<td>5.95</td>
<td>11.57</td>
</tr>
<tr>
<td>St. George’s Bay</td>
<td>2.63</td>
<td>2.4</td>
</tr>
</tbody>
</table>
both boat traffic as well as boat recreational activities cause significant negative alterations on the composition of communities and on species richness of macrophytes. The major factors suggested by Eriksson et al. (2004) are the increase in suspension and turbidity from scouring and from waves caused by boats. According to Eriksson et al. (2004) species which are sensitive to light were less abundant in places that were more turbid.

Another possible contributing factor with regards to St. George’s Bay’s low EQS value is the short-duration influx of sewage that occurred in September 2012 (The Times of Malta, 2012). This influx was recorded a short time before the current study commenced and may therefore have affected the macroalgal communities at that particular location. As discussed in chapter 2, the EEI-c method is dependent on the abundance of ESGI species and ESGII species and with an increase in sewage, ESGI species are replaced by the opportunistic ESGII species. In chapter 2, it was also discussed how there was a swimming ban at Xlendi at the same time as that of St. George’s Bay, however the Exposure Index of Xlendi is greater than that of St. George’s Bay therefore the effects of the sewage overflow on the ecological status of St. George’s Bay might have been greater than that on Xlendi Bay.

One might also think that the beach replenishment project at St. George’s Bay might have had an effect on the macroalgae since beach nourishment is often associated with an increase in turbidity which then results in less sunlight reaching the macroalgae. However, Borg et al. (2006) monitored Posidonia oceanica before and after the beach replenishment project in order to find out whether there were any negative effects and concluded that there were no significant changes and thus concluded that the replenishment project was a successful one since there was no increase in turbidity.
Tourism is also another pressure on St. George’s Bay and, as mentioned in chapter 2, tourism has both negatives and positives and one of the negatives is that they affect the already highly-impacted resources which are under pressure from Malta’s dense population. Anthropogenic stress results from human activities such as swimming in the sea since their paths re-suspend sediments thus increasing turbidity and possibly bacteria that has set to the bottom.

However, the tourism industry is so important for Malta’s economy that one cannot look at it from a negative perspective only but, on the other hand, it has to be managed in a sustainable way.

With regards to managing water bodies, some management plans that are of particular interest for improving the ecological quality status are found in Appendix VI. These management plans are of interest since they tackle seawater quality management from a systems perspective rather than tackling the problem from a fragmented one-dimensional view.

However, one should be careful when applying management plans applied by other EU member states since the Maltese water bodies might differ to some extent. This is also recognized by the European Commission’s “Blueprint to safeguard Europe’s Water Resources” (which is a follow up to the Water Framework Directive) which “recognizes that the aquatic environments differ greatly across the EU and therefore does not propose any one-size-fits-all solution” (European Commission, 2012, p.2).

However, there is much that one can learn from other countries. The sharing of ideas between EU member states is greatly encouraged since there is much to learn from previous work done by other member states in fact the European Commission encourages a peer review system for the Water Framework Directive’s River Basin
Management Plan which in the case of Malta is the Water Catchment Management Plan (European Commission, 2012).

5.3 Humans as indicators of seawater quality

From the Spearman’s correlation coefficient it was determined that there is a significant positive relationship between the respondents’ rating of seawater quality and the EQS value even though the correlation coefficient is not very strong as would be the case had the coefficient to be larger. A short-sighted conclusion would therefore conclude that humans’ perception can be used as an indicator of seawater quality. However, this has to be analysed in light of what the respondents’ based their seawater rating on; which included many factors. The most common factors that were repeated by many of the respondents were the following: cleanliness, clarity, whether there was discarded waste products in the seawater, seawater colour, amount of people at the shore, marine life and visible/no visible pollution. Although this list is a good start for rating water quality since people seem to be looking at different aspects and including criteria such as marine life which is important for seawater quality, there still exist some gaps since there are some things which are not visible to the naked eye and may only be determined through more rigorous testing. In fact, macroalgae as a Biological Quality Element (BQE) is only one factor of many other factors in the Water Framework Directive list of indicators; therefore the macroalgae results are also not conclusive on their own. Among the other indicators which are necessary in order to be able to make a complete conclusion regarding the seawater quality of a water body are other biological indicators, hydromorphological indicators and chemical indicators. Apart from macroalgae, the other biological quality indicators include: phytoplankton, angiosperms and benthic invertebrate fauna. The hydromorphological quality elements include: tidal regime, morphological conditions
and the physicochemical quality elements include: general condition such as temperature, oxygenation conditions, transparency and nutrient concentrations, specific synthetic pollutants and specific non-synthetic pollutants.

As mentioned in chapter 2, MEPA is currently undertaking a project where all the above mentioned indicators are being taken into consideration since the results of the macroalgae have to be interpreted by considering all the other indicators. The report by MEPA was expected to be ready by June 2013, however due to the weather conditions and windy extremes, the consultants were given an extension till the end of September 2013 (Claudine Cardona, 22\textsuperscript{nd} July 2013, personal communication).

Therefore, while one can conclude that human perceptions seem to differentiate between quality statuses, they cannot be taken on their own since this may lead to large errors and incorrect conclusions. Also, if we had to take solely human perceptions into account, they can lead to further errors since they may be based on irrelevant and unscientific criteria. For example, ‘cleanliness’ is a very subjective term.

With regards to the rating of seawater quality, there were no significant differences when respondents were grouped by nationality, gender, age, frequency of visit to the rocky shore or level of education.

The only two groupings that were found to have a significant difference between respondents were with regards to: preferred rocky coast or preference between sandy beaches or rocky coasts.

The respondents that answered that the particular rocky coast was one of their preferred bathing areas tended to rate the seawater quality status higher (better) than
those that did not particularly like the rocky coast. Also, if the respondents preferred sandy beaches, they tended to rate the seawater quality lower than those that preferred rocky coasts. This shows that humans are influenced by other factors and that the seawater quality status rating might be based on preconceptions that humans hold which are not based on seawater quality but factors such as what type of coast it is.

One might argue that this could be argued from a different perspective with regards to preferred rocky coast and that maybe the seawater quality rating affects whether the rocky coast is one of the respondents’ preferred rocky coasts. That is, seawater quality is affecting the question regarding preferred rocky coasts, rather than the other way around. However, the second part of the question with regards to preferred rocky coasts was a qualitative question which asked the respondents why they liked or disliked the rocky coast and clean or clear seawater was mentioned by 21 respondents (18 respondents mentioned the that they liked the seawater quality and 3 mentioned it as a negative aspect that is as a dislike) which means that only 21 respondents out of 198 respondents (10% of the respondents) mentioned seawater quality as being the reason on which they based their preference. Therefore water quality rating is affected by both the respondents’ preference between sandy beaches or rocky shores and also by whether that particular shore is one of their preferred bathing areas.

### 5.4 Additional educational activities

Since 37.37% of the respondents agree and 36.87% of the respondents strongly agree with additional educational activities regarding environmental issues at the coast, it is suggested that management of coastal areas and tourism should include, at an early stage, educational activities. Also, since nationality, gender, age, frequency of visit to the rocky shore and level of education made no difference to the responses on
additional educational activities, it can also be concluded that educational activities should target all the mentioned groups; activities should therefore not be targeting a specific age group but rather the whole spectrum of ages. Appendix VII provides a list of some possible educational activities that could be undertaken in the Maltese Islands.

Having attended the consultation meeting regarding “A Blueprint to Safeguard Europe’s Water Resources” (1st August 2013) organized by the Malta-EU Steering and Action Committee (MEUSAC) and having listened to the opinions of different stakeholders, it is evident that stakeholders are increasingly concerned about the seawater problems both from a water quality and also from a water quantity perspective. Amongst the stakeholders there were some members of the Malta Water Association, some local council members concerned about the water usage in recreational house pools in their area, some representatives of businesses and people from the general public mainly concerned with the changes that they are seeing around them with regards to water resources. The increase in involvement by stakeholders is important since water should be “Everybody’s Business” (Malta Water Association, 2013). Thus, in the future it is important for water management to cover all aspects at the coast such as tourism and also educational activities and involvement of stakeholders were stakeholders are not merely given information but are part and parcel of the whole planning phase of management plans.

5.5 Priority issues in Malta

Water quality ranked first amongst the five issues of concern at the coast (water quality, scenery, safety, litter and facilities), however ocean/sea health obtained the fifth rank with regards to ten global issues of concern.
In the present study the rank of ocean/sea health is a higher concern issue than that obtained from Potts et al.’s (2011) study which included 7000 interviews in seven European countries. Potts et al. provided respondents with 11 issues of concern which were: the cost of living, health and education, the economy, pollution, affordable energy, poverty, climate change, terrorism, ocean health, species loss and safe available food. Ocean health ranked ninth out of eleven issues of concern in the study by Potts et al. (2011). For comparative purposes, the issues used in this present study were taken from Potts et al. (2011), the only issue of concern not included in this study was pollution, which was omitted in order to have 10 issues rather than 11 so as to reduce complexity since questions that involve ranking tend to confuse respondents (Dr. Liberato Camilleri, University of Malta, personal communication, 27th March 2013).

A possible reason this discrepancy between the present study and the study by Potts et al. (2011) may be linked to the fact that ‘terrorism’ ranked last with the data obtained from Malta as opposed to that obtained by Potts et al. (2011) where terrorism ranked at a higher position than ocean health. Terrorism might seem to be a remote issue for people who are in Malta whereas ‘sea health’ is a more concrete and immediate concern. Since Malta is surrounded by sea, the public might feel more connected to the ocean/sea health rather than in other countries where the sea might not be that close by. Another two issues which are of higher concern (than ocean health) amongst the results obtained by Potts et al. (2011), are climate change and poverty. In the present study climate change and poverty ranked lower than ocean/sea health. Another reason may be that most of the respondents were “on holiday” and “by the sea” thus distancing themselves from issues such as terrorism, climate change and poverty.
5.6 Perception of Macroalgae

The respondents did not express a clear knowledge about macroalgae being used as an indicator of seawater quality since only 44 respondents answered correctly to the quantitative part of question 9 of the questionnaire. Moreover, the qualitative part of question 9 showed that not all of the 44 respondents actually knew what they had answered in the quantitative part. This could suggest that more information (such as posters or flyers) should be available at the rocky coast since most of the respondents wish to have more education on the matter (as is suggested by the majority of the respondents answering that they strongly agree or agree to additional educational activities at the rocky coast).

Also, the macroalgae seem to bother some of the respondents (39.39%), even though they make no difference to 48.48% of the respondents. Maybe if the respondents knew more about the macroalgae, they could appreciate them more as an important part of the ecosystem. Macroalgae are not generally considered as “cute” by many humans therefore this makes their survival seem unimportant to many humans. “The word ‘cute’ is colloquial and its marginal linguistic status might be thought to indicate that cuteness is unimportant” (Morreall, 1991, p.39). However “cuteness” has been important in the conservation of certain charismatic species as opposed to others and in fact there has been a dominance of the conservation of mammals and birds in recent years (Wilson, 1992 as cited in Entwistle & Stephenson, 2000). Some have argued that conserving these charismatic species helps conserve the less charismatic species that live in the same habitat (Johnsingh & Joshua, 1994 as cited in Entwistle & Stephenson, 2000). However the researcher does not agree with this view and prefers the view put forward by Ceballos and Brown (1995 as cited in Entwistle & Stephenson, 2000, p.119) that is that the “under-representation of other species on
the conservation agenda may lead to a lack of effective conservation, despite threats equivalent to, or greater than, the more high profile, popular or charismatic species”.

5.7 The most desirable aspects of a rocky coast

From the open-ended question regarding what made a rocky coast one of the respondents’ preferred rocky coasts or not, it was concluded that scenery/view, clean environment and clean seawater ranked the highest on the positive side whilst crowded, rough rocks and artificial sand ranked highest on the negative side.

This is similar to other studies that took place at rocky coasts as well as sandy beaches. In a study by Roca and Villares (2008) in Spain, it was concluded that the most desirable aspect by the respondents was ‘clean water and sand’ and also in a study by the Metropolitan Beaches of Barcelona (n.d., as cited in Roca and Villares, 2008) the most desirable items were related to health and safety so if you look at clean environment and clean water on the positive side and rough rocks on the negative side, they would fall under this category.

However this present study is most similar to a study by Nelson, Botterill and Williams (1999) since the first priority with reference to the most desirable aspects at the shore was given to scenery, and then came beach safety and water quality. The Nelson et al. (1999) study addressed public perceptions especially with regards to debris pollution and with regards to beach management.

Also, what the above positive and negative preferences imply is that more effort has to be done with regards to cleaning the general environment and the water if one is to satisfy the respondents’ preferences with regards to choosing a rocky shore. The management implication is that one must follow many strategies including on the one hand focusing on social-awareness in the promotion of behaviours and attitudes and
on the other hand, increasing investment in more bins and more cleaning at the coast (Roca & Villares, 2008). While the researchers agrees with the latter sentiment, the researcher also agrees with Roig et al. (2005, as cited in Roca & Villares, 2008) who suggested that environmental managers should not overdo it and suggest soft-measures rather than providing everything that the bathers want.

Scenery/view was the number one positive preference of the respondents. The importance of scenery for tourists visiting a shore has been documented by many researchers including Morgan and Williams (1995 as cited in Ergin, Micallef and Williams, 2008).

Scenery “is a section of any coastal landscape inventory available for managers or planners for coastal preservation, protection, development etc.” (Ergin, Micallef and Williams, 2008) and it is not as easily managed as some of the other criteria since the evaluation of scenery is usually very subjective, even though indices for the evaluation of scenery have been developed in order to help environmental managers and academics improve the use of coasts by humans and in order to help the users appreciate the scenery (Ergin, Micallef and Williams, 2008).

5.8 Interpretation of the nitrates results

The nitrates results were all the same at every rock coast. The reason for this may be linked to the fact that the June and July period are dry seasons in Malta and therefore not affected by runoff from rainwater. An increase in nitrates during the wet months has been observed and documented by Whitehouse, Priddle and Symon (1996) amongst other researchers and in a monitoring programme in the Maltese Islands it was determined that the nitrate levels at three coastal shores varied seasonally with the maxima being recorded “at the end of April 2012” (MRRA, 2013).
6. Conclusion

6.1 Conclusion

The main finding of this research project was that the EEI-c macroalgal method discriminated among sites, giving ‘Good’ ecological status or better to five out of the six sites studied and ‘Bad’ Ecological status to one site (St. George’s Bay). Therefore from the discussion in chapter 5 on why the latter mentioned results were obtained, it can be concluded that the EEI-c method does provide a good method in discriminating between sites and the researcher recommends it as a tool in environmental management. However, the macroalgal results (from the EEI-c method) should not be interpreted on their own but other biological indicators as well as chemical indicators and hydromorphological indicators should be used in order to avoid a short-sighted management plan. If used in Malta, the EEI-c method will need to be improved with regards to adding more species on the list such as *Cladophoropsis* since the absence of such species on the list given by Orfanidis et al. (2011) might bias the results.

The nitrates tests were not sufficient in discriminating between sites in the summer/dry period, therefore it is suggested that the nitrates tests should take place during the rainy period and more sensitive tests should be used during the summer months.

While human perception on seawater quality discriminated among sites, with the discrimination appearing to correlate with that given by the EEI-c method, it may be concluded that human perception of seawater quality is a good indicator of seawater quality only if it is one of several indicators. As observed in chapter 5, human
perceptions on seawater quality are based on multiple variables such as clarity which is subjective and unscientific.

The key aspects of water management plans regarding seawater quality were identified to include the management of agriculture, tourism, fishing, aquaculture, boating, eco-labelling, sewage treatment, the involvement of stakeholders and climate change issues.

Additional educational activities were seen by the public in a positive light with the majority of the respondents wanting more educational activities regarding general environmental issues at the shore. In light of this knowledge, some possible educational activities were identified (Appendix VII). In particular, Blue Flag educational activities for sandy beaches were identified as being largely applicable to rocky shores, and were as such, recommended.

A positive aspect of the research was with regards to the global priority issues identified by Potts et al. (2011). In Malta, ‘sea/ocean health’ ranked better than it did in another seven countries. Therefore in consideration of this and the fact that the Maltese and non-Maltese in Malta might appreciate or feel more connected to seawater than in other countries, policy makers should maintain a high priority in strengthening the seawater quality of the Maltese seas.

With regards to macroalgae, the general public does not seem to be aware of their benefits and in the future, awareness-raising about macroalgae and other organisms which are amongst the less charismatic organisms should form part of management plans.
6.2 Limitations

The limitations of the present study were the following:

- The sites chosen were only considered as bays rather than a whole area where the bay is merely one part of a larger whole. However choosing small areas was necessary due to time constraints. Ideally a larger water body would be studied as is the case with MEPA studies where one seawater body includes a large area as shown in Figure 2.7 (in chapter 2) and where a bay such as the ones in the present study are part of a larger ecological quality status survey.

- Time constraints preventing nitrate testing in the winter period may have influenced the results since nitrates vary with run-off which is present largely during the rainy period.

- Most countries have River Basin Management Plans (RBMP) rather than Water Catchment Management Plan (WCMP) as is the case with Malta, therefore taking ideas from other countries’ management plans is less straightforward since they tend to focus on rivers and lakes. Having said that, most ideas can be adapted to coastal water even though it is not always the case.

6.3 Recommendations for further study

Since several literature sources considered other biological indicators apart from macroalgae especially with regards to those suggested by the Water Framework Directive such as phytoplankton and benthic invertebrate fauna, it would be interesting to apply these biological indicators to the rocky coast studied in the present study and to see how they compare to macroalgae indices.

It would also be interesting to apply BENTHOS and CARLIT methods to the rocky coasts studied in the present study and to see how they compare to the EEI-c index.
It is also recommended to compare the results of this study with those in the final results of the study undertaken by MEPA once these results are published.

Also, with regards to the absence of *Cladophoropsis* (macroalgae present in the Qawra and Ghar Lapsi samples) from the list of species given by Orfanidis et al. (2011), it would be suggested to study where such species lies in the EEI-c method.

Another recommendation would be to compare the EEI-c method with other macroalgal methods that have been used in Malta such as those used by Azzopardi and Schembri (2007, 2009, 2010b, 2010c) in their extensive studies that took place in the following sites: Qbajjar, St. Paul’s Bay. Marsascala, St. Angelo, Manoel island and Birzebbuga.

With regards to the *Water Framework Directive*, it would be interesting to consider not only surface water but also groundwater and water scarcity since these are important aspects of this directive together with water quality.
Appendix I: The Thomas Exposure Index
<table>
<thead>
<tr>
<th>Site</th>
<th>Sector</th>
<th>Wind energy W(Kn²)</th>
<th>F (cm on map)</th>
<th>F (NM)</th>
<th>CS (cm on Map)</th>
<th>CS (NM)</th>
<th>log(W) x log(1+F/CS)</th>
<th>∑ log(W) x log(1+F/CS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dwejra</td>
<td>8</td>
<td>6.233</td>
<td>open sea</td>
<td>100</td>
<td>0.03</td>
<td>0.001</td>
<td>3.906</td>
<td>26.88</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>8.517</td>
<td>open sea</td>
<td>100</td>
<td>0.03</td>
<td>0.001</td>
<td>4.573</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>13.789</td>
<td>open sea</td>
<td>100</td>
<td>0.01</td>
<td>0.000</td>
<td>6.145</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>30.267</td>
<td>open sea</td>
<td>100</td>
<td>0.05</td>
<td>0.002</td>
<td>6.951</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>11.008</td>
<td>open sea</td>
<td>100</td>
<td>0.02</td>
<td>0.001</td>
<td>5.304</td>
<td></td>
</tr>
<tr>
<td>Qawra</td>
<td>3</td>
<td>6.654</td>
<td>1.20</td>
<td>0.002</td>
<td>0.02</td>
<td>0.000</td>
<td>1.469</td>
<td>7.01</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>6.942</td>
<td>open sea</td>
<td>100</td>
<td>0.02</td>
<td>0.000</td>
<td>5.542</td>
<td></td>
</tr>
<tr>
<td>Xlendi</td>
<td>8</td>
<td>6.233</td>
<td>open sea</td>
<td>100</td>
<td>0.06</td>
<td>0.000</td>
<td>4.855</td>
<td>18.04</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>8.517</td>
<td>open sea</td>
<td>100</td>
<td>0.06</td>
<td>0.000</td>
<td>5.683</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>13.789</td>
<td>open sea</td>
<td>100</td>
<td>0.02</td>
<td>0.000</td>
<td>7.505</td>
<td></td>
</tr>
<tr>
<td>Xwejni Bay</td>
<td>1</td>
<td>2.878</td>
<td>open sea</td>
<td>100</td>
<td>0.03</td>
<td>0.000</td>
<td>2.943</td>
<td>2.94</td>
</tr>
<tr>
<td>Ghar lapsi</td>
<td>5</td>
<td>8.32</td>
<td>open sea</td>
<td>100</td>
<td>1.00</td>
<td>0.001</td>
<td>4.497</td>
<td>11.57</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>7.148</td>
<td>open sea</td>
<td>100</td>
<td>0.04</td>
<td>0.000</td>
<td>5.369</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>5.027</td>
<td>8</td>
<td>0.010</td>
<td>0.03</td>
<td>0.000</td>
<td>1.702</td>
<td></td>
</tr>
<tr>
<td>St George’s Bay</td>
<td>4</td>
<td>6.942</td>
<td>open sea</td>
<td>100</td>
<td>3.50</td>
<td>0.142</td>
<td>2.398</td>
<td>2.40</td>
</tr>
</tbody>
</table>
Appendix II: The consent form
You are being asked to participate in a research study conducted by Angela Bartolo from James Madison University and the University of Malta. One purpose of this study is to assess public perceptions of sea water quality. This study will contribute to the researcher’s completion of her master’s thesis.

This survey will be conducted in English. If you are not comfortable reading or speaking English, then you do not need to participate in the survey. If you are comfortable with English and are willing, please take 5-10 minutes to complete this survey, and return it to the indicated bin. You will be asked to provide answers to a series of questions related to sea water quality, macroalgae, and educational activities. I do not perceive risks beyond the risks associated with everyday life as a consequence of your participation in this survey.

There are no direct benefits from participation in this study except that you will be able to get a copy of the results once the results are ready. The benefits of the research are good for increasing the knowledge that we currently have in Malta on seawater quality.

This survey is entirely anonymous. There is no way that you, or your responses, can be personally identified.

Your participation is entirely voluntary. You are not obligated to complete the questionnaire, and if you start to answer it, you are not obligated to finish it. You can quit at any time. By completing the survey, you certify that you are consenting to participate in this study and that you are at least 18 years old.

Thank you for your help.
Appendix III: The pilot questionnaire
QUESTIONNAIRE SURVEY OF ROCKY SHORE-USER PERCEPTIONS ON WATER QUALITY

By completing this survey, I indicate that I understand what is being requested of me as a participant in this study. I freely consent to participate and know that I do not have to complete this survey. I have given satisfactory answers to my questions. I certify that I am at least 18 years of age.

Section 1

1. Rocky shore area: Pilot Study

2. Nationality
   - Maltese/Gozitan
   - European
   - Other

3. Gender
   - Male
   - Female

4. Age
   - 18-30
   - 31-40
   - 41-50
   - 51-60
   - 61 to 70
   - 71 or above

5. How often do you frequently visit this rocky shore?
   - It is my first time here
   - Once a month
   - Once every two weeks
   - Once a week
   - More than once a week
   - Other, please specify...
6. What is the highest level of education you have completed?

☐ Did not attend school
☐ Graduated from secondary school
☐ Graduated from upper secondary school (JC/MCAST/Higher National Diploma)
☐ Graduated from tertiary education
☐ Other, please specify...

---

Section 2

7. Is this one of your preferred rocky shores?

☐ No
☐ Yes

What do you especially like or dislike about it?

---

8. Do you prefer rocky coasts or beaches?

☐ Rocky coasts
☐ Beaches
☐ No particular preference

---

9. Do you believe that macroalgae are related to water quality?

☐ No, they do not indicate anything
☐ Yes, they show that the water is of good quality
☐ Yes, they show that the water is of poor quality
☐ Yes, different macroalgae can show different things, some macroalgae are an indication of good quality whilst other macroalgae are an indication of poor quality
☐ I am not sure or do not really know

If you answered no or yes: why do you believe so?
10. In general, how would you rate the water quality at this rocky coast? (5=High quality, 4=Good quality, 3=Moderate quality, 2=Poor quality, 1=Bad quality)
   - ☐ 1
   - ☐ 2
   - ☐ 3
   - ☐ 4
   - ☐ 5
   - ☐ No opinion/no ability to judge

   Why?

11. How strongly do you agree with the statement that “I would like to see the addition of educational activities at this rocky coast”?
   - ☐ 1 Strongly agree
   - ☐ 2 Agree
   - ☐ 3 Neither agree nor disagree
   - ☐ 4 Disagree
   - ☐ 5 Strongly disagree

12. How would you rank the following five issues of concern in order of priority (at any rocky coast): scenery, water quality, safety, litter and facilities? Please use a scale from 1 to 5 where 1 implies lowest concern/low importance issues and 5 implies highest concern/high importance issue.

<table>
<thead>
<tr>
<th>Scenery</th>
<th>Water quality</th>
<th>Safety</th>
<th>Litter</th>
<th>Facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
13. Have you ever heard of the EU Water Framework Directive? Yes/No

14. How do you feel about the macroalgae attached to the rocks?

☐ They annoy me and reduce my enjoyment of the coastal area
☐ I like the macroalgae and they enhance my enjoyment of the coastal area
☐ The macroalgae make no difference to me and do not affect my enjoyment of the coastal area

15. Which macroalgae do you object to?

☐ The green macroalgae
☐ The brown macroalgae
☐ The red macroalgae
☐ The colour makes no difference to me
Appendix IV: The questionnaire
QUESTIONNAIRE SURVEY OF ROCKY SHORE-USER PERCEPTIONS ON WATER QUALITY

By completing this survey, I indicate that I understand what is being requested of me as a participant in this study. I freely consent to participate and know that I do not have to complete this survey. I have given satisfactory answers to my questions. I certify that I am at least 18 years of age.

Section 1

1. Rocky shore area:

2. Nationality
   - Maltese/Gozitan
   - European (Non-Maltese)
   - Other

3. Gender
   - Male
   - Female

4. Age
   - 18-30
   - 31-40
   - 41-50
   - 51-60
   - 61 to 70
   - 71 or above

5. How often do you frequently visit this rocky shore?
   - It is my first or second time here
   - Once a month
   - Once every two weeks
   - Once a week
   - More than once a week
   - Other, please specify...
6. What is the highest level of education you have completed?
   - Did not attend school
   - Completed secondary school
   - Completed upper secondary school (JC/MCAST/Higher National Diploma)
   - Completed tertiary education
   - Other, please specify...

Section 2

Please read the following explanation: macroalgae also called seaweed, can be brown, red or green; they are often found attached to the rocky coast but may sometimes be floating in the water.

7. Is this one of your preferred rocky shores?
   - No
   - Yes

What do you especially like or dislike about it?

8. Do you prefer rocky coasts or beaches for recreational purposes?
   - Rocky coasts
   - Sandy beaches
   - No particular preference

9. Do you believe that macroalgae are related to water quality?
   - No, they do not indicate anything
   - Yes, they show that the water is of good quality
   - Yes, they show that the water is of poor quality
   - Yes, different macroalgae can show different things, some macroalgae are an indication of good quality whilst other macroalgae are an indication of poor quality
   - I am not sure or do not really know
If you answered no or yes: why do you believe so?

10. In general, how would you rate the water quality at this rocky coast? (5=High quality, 4=Good quality, 3=Moderate quality, 2=Poor quality, 1=Bad quality)
   - [ ] 1
   - [ ] 2
   - [ ] 3
   - [ ] 4
   - [ ] 5
   - [ ] No opinion/no ability to judge

   Why?

11. Would you like to see additional educational activities at this coast concerning general environmental issues?
   - [ ] 1 Strongly disagree
   - [ ] 2 Disagree
   - [ ] 3 Neither agree nor disagree
   - [ ] 4 Agree
   - [ ] 5 Strongly agree

12. How would you rank the following five issues of concern in order of priority (at any rocky coast): scenery, water quality, safety, litter and facilities? Please use a scale from 1 to 5 where 1 implies lowest concern/low importance issues and 5 implies highest concern/high importance issue.

<table>
<thead>
<tr>
<th>Scenery</th>
<th>Water quality</th>
<th>Safety</th>
<th>Litter</th>
<th>Facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
13. How do you feel about the macroalgae attached to the rocks?
☐ They annoy me and reduce my enjoyment of the coastal area
☐ I like the macroalgae and they enhance my enjoyment of the coastal area
☐ The macroalgae make no difference to me and do not affect my enjoyment of the coastal area

14. Which macroalgae do you object to?
☐ The green macroalgae
☐ The brown macroalgae
☐ The red macroalgae
☐ The colour makes no difference to me

15. Rank the following ten issues from 1 to 10 in order of priority, where 1 is the lowest issues of concern and 10 is the highest issue of concern.

<table>
<thead>
<tr>
<th>Health and education</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Affordable energy</td>
<td></td>
</tr>
<tr>
<td>The cost of living</td>
<td></td>
</tr>
<tr>
<td>Poverty</td>
<td></td>
</tr>
<tr>
<td>Ocean/sea water health</td>
<td></td>
</tr>
<tr>
<td>The economy</td>
<td></td>
</tr>
<tr>
<td>Terrorism</td>
<td></td>
</tr>
<tr>
<td>Climate change</td>
<td></td>
</tr>
<tr>
<td>Species loss</td>
<td></td>
</tr>
<tr>
<td>Safe available food</td>
<td></td>
</tr>
</tbody>
</table>
Appendix V: EQS values
Ghar Lapsi, Malta

Coverage of each Ecological Status Group (ESGs: IA, IB, IC, IIA, IIB) present in each quadrat at Ghar Lapsi.

<table>
<thead>
<tr>
<th>Ghar Lapsi Malta</th>
<th>Coverage of every identified species</th>
<th>Coverage of each Ecological Status group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dictyopteris</td>
<td>Sargassum</td>
</tr>
<tr>
<td>Quadrat 1</td>
<td>16%</td>
<td>24%</td>
</tr>
<tr>
<td>Quadrat 2</td>
<td>&lt;1%</td>
<td>14%</td>
</tr>
<tr>
<td>Quadrat 3</td>
<td>90%</td>
<td>11%</td>
</tr>
<tr>
<td>Quadrat 4</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Quadrat 5</td>
<td>62%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Quadrat 6</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Quadrat 7</td>
<td>10%</td>
<td>80%</td>
</tr>
<tr>
<td>Quadrat 8</td>
<td>28%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Quadrat 9</td>
<td>2%</td>
<td>37%</td>
</tr>
<tr>
<td>Quadrat 10</td>
<td>2%</td>
<td>45%</td>
</tr>
<tr>
<td>Quadrat 11</td>
<td>32%</td>
<td>14%</td>
</tr>
<tr>
<td>Quadrat 12</td>
<td>&lt;1%</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>

Mean relative coverage of ESG IA

$$\frac{\text{Sum of } \text{ESGIA macroalgal coverage in total number of quadrats}}{\text{Total number of quadrats}} = \frac{(24 + 62 + 100 + 28 + 37)}{12} = 20.92$$

Mean relative coverage of ESG IB

$$\frac{\text{Sum of } \text{ESGIB macroalgal coverage in total number of quadrats}}{\text{Total number of quadrats}} = \frac{(52 + 25 + 90 + 45 + 31 + 24)}{12} = 22.25$$

Mean relative coverage of ESG IC

$$\frac{\text{Sum of } \text{ESGIC macroalgal coverage in total number of quadrats}}{\text{Total number of quadrats}} = \frac{(48 + 4)}{12} = 4.33$$
Mean absolute coverage of ESG IIA

\[
= \frac{\text{Sum of ESG IIA macroalgal coverage in total number of quadrats}}{\text{Total number of quadrats}} = \frac{20 + 60 + 11 + 10 + 100 + 22 + 46 + 80 + 65 + 70}{12} = 40.33
\]

Mean absolute coverage of ESG IIB

\[
= \frac{\text{Sum of ESG IIB macroalgal coverage in total number of quadrats}}{\text{Total number of quadrats}} = \frac{16 + 14 + 80 + 2}{12} = 9.33
\]

Using the above mean absolute coverage of ESG IA, ESG IB, ESG IC, ESG IIA and ESG IIB to calculate the mean absolute coverage of ESGI and ESGII:

ESG I = (ESGIA X 1) + (ESGIB X 0.8) + (ESGIC X 0.6) = (20.92 X 1) + (22.25 X 0.8) + (4.33 X 0.6) = 41.318

ESG II = (ESGIIA X 0.8) + (ESGIIB X 1) = (40.33 X 0.8) + (9.33 X 1) = 41.594

These results were used as inputs in the formula suggested by Orfanidis (2011), giving an EEI-c value of 5.95, corresponding to ‘Good-Moderate’ status.
St. George’s Bay, Malta

Coverage of each Ecological Status Group (ESGs: IA, IB, IC, IIA, IIB) present in each quadrat at St. George’s Bay.

<table>
<thead>
<tr>
<th>Quadrat</th>
<th>Corallina</th>
<th>Cladophora</th>
<th>Ulva</th>
<th>Dilophus</th>
<th>Jania</th>
<th>Stypocaulon</th>
<th>IA</th>
<th>IB</th>
<th>IC</th>
<th>IIA</th>
<th>IIB</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>49%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>8%</td>
<td>12%</td>
<td></td>
<td>20%</td>
<td>9%</td>
<td></td>
<td></td>
<td>29%</td>
<td>20%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>20%</td>
<td>24%</td>
<td></td>
<td>2%</td>
<td>46%</td>
<td></td>
<td></td>
<td>20%</td>
<td>46%</td>
<td>26%</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>75%</td>
<td>26%</td>
<td>&lt;1%</td>
<td>5%</td>
<td>&lt;1%</td>
<td></td>
<td>75%</td>
<td>5%</td>
<td>26%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>73%</td>
<td>4%</td>
<td>3%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7%</td>
<td>73%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>10%</td>
<td></td>
<td></td>
<td>30%</td>
<td>6%</td>
<td>26%</td>
<td>16%</td>
<td>56%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>15%</td>
<td>29%</td>
<td></td>
<td>22%</td>
<td></td>
<td></td>
<td></td>
<td>51%</td>
<td>15%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>37%</td>
<td>27%</td>
<td>7%</td>
<td>19%</td>
<td></td>
<td></td>
<td></td>
<td>7%</td>
<td>46%</td>
<td>37%</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>84%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>84%</td>
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<tr>
<td>10</td>
<td>92%</td>
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<td></td>
<td></td>
<td>92%</td>
</tr>
<tr>
<td>11</td>
<td>33%</td>
<td>14%</td>
<td></td>
<td>14%</td>
<td></td>
<td></td>
<td></td>
<td>14%</td>
<td>33%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>5%</td>
<td>95%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100%</td>
</tr>
</tbody>
</table>

Mean absolute coverage of ESG IA

\[
IA = \frac{\text{Sum of ESG IA macroalgal coverage in total number of quadrats}}{\text{Total number of quadrats}} = 0
\]

Mean absolute coverage of ESG IB

\[
IB = \frac{\text{Sum of ESG IB macroalgal coverage in total number of quadrats}}{\text{Total number of quadrats}} = 0
\]

Mean absolute coverage of ESG IC

\[
IC = \frac{\text{Sum of ESG IC macroalgal coverage in total number of quadrats}}{\text{Total number of quadrats}} = \frac{(49 + 20 + 75 + 16 + 7 + 14)}{12} = 15.08
\]
Mean absolute coverage of ESG IIA

\[
\frac{\text{Sum of ESG IIA macroalgal coverage in total number of quadrats}}{\text{Total number of quadrats}} = \frac{(38 + 29 + 46 + 5 + 7 + 56 + 51 + 46 + 33 + 100)}{12} = 34.25
\]

Mean absolute coverage of ESG IIB

\[
\frac{\text{Sum of ESG IIB macroalgal coverage in total number of quadrats}}{\text{Total number of quadrats}} = \frac{(20 + 26 + 26 + 73 + 15 + 37 + 84 + 92)}{12} = 31.08
\]

Using the above mean absolute coverage of ESG IA, ESG IB, ESG IC, ESG IIA and ESG IIB to calculate the mean absolute coverage of ESGI and ESGII:

ESG I = (ESGIA x 1) + (ESGIB x 0.8) + (ESGIC x 0.6) = 15.08 x 0.6 = 9.048

ESG II = (ESGIIA x 0.8) + (ESGIIB x 1) = (34.25 x 0.8) + (31.08 x 1) = 58.48

These results were used as inputs in the formula suggested by Orfanidis (2011), giving an EEI-c value of 2.63, corresponding to ‘Bad’ status.
Xlendi, Gozo

Coverage of each Ecological Status Group (ESGs: IA, IB, IC, IIA, IIB) present in each quadrat at Xlendi

<table>
<thead>
<tr>
<th>Coverage of every identified species</th>
<th>Coverage of each Ecological Status group present</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corallina</td>
<td>IA</td>
</tr>
<tr>
<td>Callithamnion</td>
<td>20%</td>
</tr>
<tr>
<td>Dictyopteris</td>
<td>10%</td>
</tr>
<tr>
<td>Dictyota</td>
<td>11%</td>
</tr>
<tr>
<td>Cystosera compressa</td>
<td>30%</td>
</tr>
<tr>
<td>Cystosera amentacea</td>
<td>30%</td>
</tr>
<tr>
<td>Jania</td>
<td>6%</td>
</tr>
<tr>
<td>Laurencia</td>
<td>6%</td>
</tr>
<tr>
<td>Amphirhoa</td>
<td>12%</td>
</tr>
</tbody>
</table>

Mean absolute coverage of ESG IA

\[
\text{Mean absolute coverage of ESG IA} = \frac{\text{Sum of ESG IA macroalgal coverage in total number of quadrats}}{\text{Total number of quadrats}} = \frac{(13 + 37 + 25 + 63 + 5 + 17)}{12} = 13.3
\]

Mean absolute coverage of ESG IB

\[
\text{Mean absolute coverage of ESG IB} = \frac{\text{Sum of ESG IB macroalgal coverage in total number of quadrats}}{\text{Total number of quadrats}} = \frac{(10 + 11 + 30 + 96 + 83 + 84 + 89 + 82)}{12} = 47.67
\]

Mean absolute coverage of ESG IC

\[
\text{Mean absolute coverage of ESG IC} = \frac{\text{Sum of ESG IC macroalgal coverage in total number of quadrats}}{\text{Total number of quadrats}} = \frac{(36 + 3 + 6)}{12} = 3.75
\]
Mean absolute coverage of ESG IIA = \[
\frac{\text{Sum of ESG IIA macroalgal coverage in total number of quadrats}}{\text{Total number of quadrats}} = \frac{20 + 31 + 39 + 21 + 36 + 15 + 26 + 8 + 6 + 12 + 6 + 18}{12} = 19.83
\]

Mean absolute coverage of ESG IIB = \[
\frac{\text{Sum of ESG IIB macroalgal coverage in total number of quadrats}}{\text{Total number of quadrats}} = \frac{9}{12} = 0.75
\]

Using the above mean absolute coverage of ESG IA, ESG IB, ESG IC, ESG IIA and ESG IIB to calculate the mean absolute coverage of ESG I and ESG II:

ESG I = (ESGIA \times 1) + (ESGIB \times 0.8) + (ESGIC \times 0.6) = (13.3) + (47.67 \times 0.8) + (3.75 \times 0.6) = 53.7

ESG II = (ESGIIA \times 0.8) + (ESGIIB \times 1) = (0.75) + (19.83 \times 0.8) = 16.614

These results were used as inputs in the formula suggested by Orfanidis (2011), giving an EEI-c value of 8.59, corresponding to ‘Good-High’ status.
Xwejni Bay, Gozo

Coverage of each Ecological Status Group (ESGs: IA, IB, IC, IIA, IIB) present in each quadrat at Xwejni Bay.

| Quadrat 1 | 4% | 38% | 52% | 38% | 56% |
| Quadrat 2 | 21% | 85% | 5% | 85% | 5% | 21% |
| Quadrat 3 | 26% | 55% | 19% | 55% | 45% |
| Quadrat 4 | 92% | 4% | 17% | 92% | 4% | 17% |
| Quadrat 5 | 53% | 5% | 40% | 5% | 93% |
| Quadrat 6 | 7% | 95% | 95% | 7% |
| Quadrat 7 | 4% | 87% | 87% | 4% |
| Quadrat 8 | 40% | 52% | 6% | 52% | 6% | 40% |
| Quadrat 9 | 50% | 44% | 44% | 50% |
| Quadrat 10 | 25% | 76% | 101% |
| Quadrat 11 | 100% |
| Quadrat 12 | 17% | 90% | 107% |

Mean absolute coverage of ESG IA = \[ \frac{\text{Sum of ESGIA macroalgal coverage in total number of quadrats}}{\text{Total number of quadrats}} = \frac{(85 + 55 + 92 + 95 + 87 + 52 + 44)}{12} = 42.5 \]

Mean absolute coverage of ESG IB = \[ \frac{\text{Sum of ESGIB macroalgal coverage in total number of quadrats}}{\text{Total number of quadrats}} = \frac{38}{12} = 3.17 \]

Mean absolute coverage of ESG IC = \[ \frac{\text{Sum of ESGIC macroalgal coverage in total number of quadrats}}{\text{Total number of quadrats}} = \frac{(5 + 4 + 5 + 6)}{12} = 1.67 \]
Mean absolute coverage of ESG IIA

$$\frac{\text{Sum of ESG IIA macroalgal coverage in total number of quadrats}}{\text{Total number of quadrats}} = \frac{56 + 21 + 45 + 17 + 93 + 7 + 4 + 40 + 50 + 101 + 100 + 107}{12} = 53.41$$

Mean absolute coverage of ESG IIB

$$\frac{\text{Sum of ESG IIB macroalgal coverage in total number of quadrats}}{\text{Total number of quadrats}} = 0$$

Using the above mean absolute coverage of ESG IA, ESG IB, ESG IC, ESG IIA and ESG IIB to calculate the mean absolute coverage of ESG I and ESG II:

$$\text{ESG I} = (\text{ESGIA } \times 1) + (\text{ESGIB } \times 0.8) + (\text{ESGIC } \times 0.6) = (42.5 \times 1) + (3.17 \times 0.8) + (1.67 \times 0.6) = 46.038$$

$$\text{ESG II} = (\text{ESGIIA } \times 0.8) + (\text{ESGIIB } \times 1) = 53.41 \times 0.8 = 42.73$$

These results were used as inputs in the formula suggested by Orfanidis (2011), giving an EEI-c value of 6.14, corresponding to ‘Good-Moderate’ status.
Dwejra, Gozo

Coverage of each Ecological Status Group (ESGs: IA, IB, IC, IIA, IIB) present in each quadrat at Dwejra.

<table>
<thead>
<tr>
<th>Quadrat 1</th>
<th>Dilophus</th>
<th>Cystoseira compressa</th>
<th>Cystoseira amentacea</th>
<th>Laurencia</th>
<th>IA</th>
<th>IB</th>
<th>IC</th>
<th>IIA</th>
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<td>Quadrat 3</td>
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<td>Quadrat 12</td>
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<td>70%</td>
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</tbody>
</table>

Mean absolute coverage of ESG IA

$$\text{Mean absolute coverage of ESG IA} = \frac{\text{Sum of ESG IA macroalgal coverage in total number of quadrats}}{\text{Total number of quadrats}} = \frac{(100 + 69 + 95 + 66 + 78 + 47 + 22 + 45 + 22 + 44)}{12} = 53.92$$

Mean absolute coverage of ESG IB

$$\text{Mean absolute coverage of ESG IB} = \frac{\text{Sum of ESG IB macroalgal coverage in total number of quadrats}}{\text{Total number of quadrats}} = \frac{(43 + 30 + 5 + 18 + 42 + 64)}{12} = 16.83$$

Mean absolute coverage of ESG IC

$$\text{Mean absolute coverage of ESG IC} = \frac{\text{Sum of ESG IC macroalgal coverage in total number of quadrats}}{\text{Total number of quadrats}} = 0$$
Mean absolute coverage of ESG IIA

\[
\text{Mean absolute coverage of ESG IIA} = \frac{\text{Sum of } ESG\text{IA macroagal coverage in total number of quadrats}}{\text{Total number of quadrats}} = \frac{26 + 43 + 50 + 12 + 15 + 38 + 47 + 19 + 4 + 70}{12} = 27
\]

Mean absolute coverage of ESG IIB

\[
\text{Mean absolute coverage of ESG IIB} = \frac{\text{Sum of } ESG\text{IB macroagal coverage in total number of quadrats}}{\text{Total number of quadrats}} = 0
\]

Using the above mean absolute coverage of ESG IA, ESG IB, ESG IC, ESG IIA and ESG IIB to calculate the mean absolute coverage of ESGI and ESGII:

ESG I = (ESGIA X 1) + (ESGIB X 0.8) + (ESGIC X 0.6) = (53.92 X 1) + (0.8 X 16.83) = 67.38

ESG II = (ESGIIA X 0.8) + (ESGIIB X 1) = (27 X 0.8) = 21.6

These results were used as inputs in the formula suggested by Orfanidis (2011), giving an EEI-c value of 8.93, corresponding to ‘Good-High’ status.
Appendix VI: Recommendations regarding seawater management
Recommended management plan elements

The management plans that follow were inspired and are based on EU LIFE funded or co-funded projects which are found in two publications by the European Union (2012a and 2012b), “LIFE and coastal management” and “LIFE’s Blueprint for water resources”. The European Union has placed great importance on projects concerning water and 900 out of 3,708 LIFE co-funded projects were related to water with a third aimed at contributing to the implementation of the Water Framework Directive (European Union, 2012b).

The recommended management plan elements that follow refer to management plans that enhance seawater quality and the communities (such as certain macroalgae) that thrive in better environments as well as increasing the participation of citizens and bringing science closer to the general public.

1. Identification of climate impacts on water bodies under different climate scenarios via modelling and simulation; the main objective of identification of such impacts would be to aid in developing the most appropriate mitigation measures (based on project LIFE07 ENV/IT/000475).

2. Analysis using Global Monitoring for Environment and Security (GMES) satellite services (European Union, 2012b) with regards to the ecosystem services’ vulnerability to climate change. This would include a study on eutrophication due to its impacts on the ecosystem services provided by seawater such as fishing, clean water and recreation (European Union 2012b) (based on project LIFE07 ENV/FIN/000141).
3. Introducing Sewage Urban Drainage Systems (SUDS) in problematic areas such as St. George’s Bay where there was a sewer overflow in September 2012 as a result of the weather conditions at that time of year. SUDS act like natural systems rather than concrete or other material that increase flooding (European Union, 2012b). SUDS drain water by collecting, storing and cleaning it before the water is released back to the natural environment (European Union, 2012b). What is favourable of such a system is that apart from preventing sewage overflow, it also improves the quality of rain water that enters the sea (European Union, 2012b) (based on project LIFE08 ENV/000099).

4. Researching various agricultural methods and organizing farmers’ workshops that promote zero till techniques and conservation agriculture with regards to water reduction (European Union 2012b) (based on project LIFE03 ENV/UK/000617).

5. Developing “a computer based model that can determine emission sources, map the pathway of emissions to surface waters and generate emission maps at high spatial resolution” (WEISS, 2013). This tool could help environmental managers here in Malta determine where there are problems and to combat them accordingly (based on project LIFE08 ENV/B/000042).

6. Investigation of the environmental footprint of tourists and its management through Integrated Coastal Zone Management. Such studies could benefit Malta since sustainable tourism is a pressing issue and activities such as transport sharing for tourists and publishing Ecolabels guides for hoteliers (European Union, 2012a) could benefit Malta (based on project LIFE00 ENV/IT/000167).

8. Preservation of coastal areas that have been exposed to mass tourism and other economic activities that were managed through a fragmented and unsustainable way by involving stakeholders such hotel owners, tour guides and tour operators (European Union, 2012a). Such a project including the production of a code of conduct that includes alternative activities to the traditional tourist activities would benefit Malta since mass tourism is one of the major impacts on coasts and the coastal resources such as water here in Malta (based on project LIFE ENV/GR/000751).

9. Minimising marine waste from boats such as lightning devices or batteries and fishing nets since this can impact all levels of the ecosystem be it fish or seabed habitats (European Union, 2012a) (based on project LIFE07 ENV/E/000814).

10. Improving aquaculture practices and mitigating negative aspects that are associated with it such as eutrophication, antibiotics and loss of ecological status (European Union, 2012a) (based on project LIFE07 ENV/D/000229).

11. Minimizing agricultural run-off by methods such as ‘natural attenuation’ that use natural processes to stop contaminants (European Union, 2012a). Natural processes include reed beds which have a low impact on the environment but which are effective in stopping or reducing penetration of contaminants.(based on project ENV/GR/000245).

12. Production of real-time data regarding coastal pollutants through monitoring sites such as a floating platform (based on project LIFE00 ENV/IT/000090).
Such a project could benefit Malta too since having real-time data could help in detecting levels of pollutants or other substances present.

From the above list of recommended projects, one can see that Coastal management involves many aspects and the concept behind ICZM is to resolve conflicts from a systems perspective rather from a traditionally fragmented manner. The projects above include the following list of aspects: agriculture, tourism, fishing, aquaculture, boating, eco-labeling, sewage management, involving stakeholders and climate change. Although the mentioned list is a wide-ranging list, it is not complete since the issues that can be managed are more extensive. However, the above list gives the issues of priority that the researcher would suggest provided that time and money are available.
Appendix VII: Recommendations regarding educational activities
Potential educational activities on environmental issues at the rocky coast

Most of the following activities were designed for use on sandy beaches, however they can be adapted to rock shores since the problems that exist at sandy beaches with regards to discarded waste and other human activities also exist at rocky coasts. Many of the activities included here were inspired by, and based on, the ‘Blue Flag Programme Environmental Education Activities Handbook 2013’ (FEE, 2013). The activities are categorized into major themes (e.g. beach, biodiversity, events, marina, marine life and waste) and generally involve much interaction with the end-user and may be adapted to meet the needs of various age-groups, accessibilities and abilities.

Activities for children and adolescents

1. “Animals Instead of Garbage!” (FEE, 2013) involves a lecturer explaining the problems that discarded waste causes in nature and then the children use a board such as the one shown in Figure 1, to remove the pictures of waste and replace them with the pictures of fauna. This activity could also be adapted for rocky coasts and instead of a board depicting a sandy beach one could use one representing a rocky shore.

Figure 1: Image used in the activity that took place in Brazil (Source: FEE, 2013).
2. “Scanning the Beach for Cleanliness” (FEE, 2013) is based on the integration of theory and practice, where participants are given both lectures and outdoor activities. Children can scan the area and identify waste such as cigarette butts. The plenary session then involves making the participants aware of such issues and getting them to involve their parents in discussions about what they have learnt.

3. “Beach Paintings Exhibition” (FEE, 2013) is an activity that begins with a lecture (given to the participants) with regards to the importance of keeping the environment clean and how our human impacts have a bearing on such cleanliness. Participants are then asked to portray their views by means of a painting of the environment that must be protected. The paintings are then exhibited on the beach as shown in Figure 2. The paintings could also be given a theme on which the participants should focus on.

Figure 2: Painting exhibited on a beach in Greece (Source: FEE, 2013).

4. “Amateur Lifeguards” (FEE, 2013) involves volunteer students who get chosen from schools working with lifeguards whilst also learning about the hazards and safety precautions that must be taken in order to protect people, wildlife and marine life (FEE, 2013).

5. “Water Quality Sampling Demonstration” (FEE, 2013) is an activity where students get to sample water and prepare beach profiles in order to learn about
modern analysis of bathing water and the importance of protecting the coastal
zone (FEE, 2013).

6. “Secrets of the Coast Management” (FEE, 2013) is a role-play activity where
children are given different roles of stakeholders of coastal management such
as, “general population, fishermen, municipality workers, and politicians”
(FEE, 2013, p.45). Discussions regarding good practices and bad practices
also take place during this activity. This activity can take place anywhere
including rocky coasts (FEE, 2013).

7. “Paintings for World Environmental Day” (FEE, 2013) includes a painting
contest amongst school children where a jury evaluates the paintings that
represent environmental issues, this takes place “on a public beach on World
Environmental Day (5th of June)” (FEE, 2013, p.47). This could work both at
sandy beaches or even at rocky coasts and it will help students learn in a fun
way.

8. “Home of Marine Mammals” (FEE, 2013) includes a workshop where
children learn about marine mammals, why they should be protected and also
how humans can help in protecting such marine mammals (FEE, 2013). After
the workshop, the participants are divided into groups and they go round the
beach or rocky coast wearing the same t-shirts and carrying photos/drawing
whilst explaining to bathers what they have learnt.

Activities for all age groups

1. “Conscious Behaviour on Beaches” (FEE, 2013) involves printing posters
with easily understandable material that promotes conscious behaviour at the
beach; this could also be done for rocky coasts.

2. “Beaches Without Cigarette Butts!” (FEE, 2013) involves students looking for
smokers on the shore and giving them information leaflets explaining how
cigarette butts are problematic since they can persist for 15 years in the sea.
This activity also involves giving the bathers a specially designed beach
ashtray. This could also be adapted for rocky coasts since cigarette butts are
still a problem for the sea whether it be at beaches or rocky coasts.

3. “Recycled Art Workshop” (FEE, 2013) is an activity that consists of two parts.
The first part is a discussion about recycling where participants learn about
different materials and how long it takes to decompose each and then the
second part consists of different groups creating sculptures from recycled material (FEE, 2013).

4. “Environmental Relay Race” (FEE, 2013) involves different groups competing against each other in order to get the largest amount of correct answers to question cards (regarding sustainable tourism) (FEE, 2013). The cards are retrieved by overcoming obstacles as shown in Figure 3. This is ideal for sandy beaches since the risk of hurting is less but it can be adapted to rocky coasts since the activities can be done on smooth slopes or sandy beaches if there are such slopes or sandy beaches close by to the rocky coasts which is the case with some rocky coasts.

5. “Spring Feelings” (FEE, 2013) is an action-oriented activity where the public is invited to clean the beach or the rocky coast whilst a lecturer explains the consequences of waste on the shore and how it ends up at the shore.

6. “Junior Naturalist Programme” (FEE, 2013) can be adapted to rocky coasts in a way that participants are given a naturalist passport at the beginning of summer. Participants attend activities once every week at the rocky coast, and they record what they learn in the naturalist passport where they are also given confirmation of attendance by the organizers. At the end of the season, the best passport and the one with most attendance gets a prize. Some exploration

7. “Beach Hiking Trips” (FEE, 2013) could be adapted to include both beaches and rocky coasts, where participants go on hiking trips and explore different flora and fauna that they see on the way.

8. “Map of Environmental Miracles” (FEE, 2013) involves creating maps around rocky coasts or sandy beaches where different fauna and flora are labeled as well as best sustainable transportation methods are suggested (FEE, 2013). Such maps could also be shown close to bus stops near shores in Malta so that whilst the people waiting for the bus (both Maltese and non-Maltese) have nothing to do, they could be learning about things such as Natura 2000 sites and other information that makes people conscious of their activities.

9. “Nature trail” (FEE, 2013) consists of evaluating the Ecological Footprints of different activities as well as at different levels e.g. individual, city and so on (FEE, 2013), this can be done at various shores.

10. “Windows on the Coast” (FEE, 2013) includes the use of smaller pictures to create a bigger picture which is like a puzzle activity and then turning the pictures over for discussion topics which could keep the participants busy for about an hour (FEE, 2013). One such big picture employed in South Africa is shown in Figure 4.

![Figure 4: “Windows on the Coast” activity used in South Africa (Source: FEE, 2013).](image)
11. “Birds on the Beach” (FEE, 2013) consists of an explanation about different local birds and different measures being undertaken in order to protect them and the participants are then taken around the coast to try and spot some of the birds.

12. “The Big Jump” (FEE, 2013) is an activity that encourages people to swim in the same hour to raise awareness about the Water Framework Directive (Figure 5) and stressors on the water quality such as pollution, it is targeted at Rivers and Lakes, however it can be adapted to coastal waters.

13. “Water Days” (FEE, 2013) is another activity in which the participants are taken on a guided tour around a sewage treatment plant (the participants can be recruited from various places including rocky shore areas), “Learning that pollution not only comes from chemicals or industry is a very important step for people to be aware of water use at home (reducing the quantity of cleaners and detergents, choosing a labelled one that is biodegradable, thinking of dry toilets facilities as a true solution)” (FEE, 2013).

14. “Environmental Education Festival” (FEE, 2013) is a one day outdoor activity with benefits claimed to be better than any theoretical biology lesson that involves students, parents and teachers in interpreting a topic related to
protecting nature and biodiversity with activities such as, “painting, singing, dancing and acting” (FEE, 2013, p. 36) which turns into an outdoor classroom with various lessons (FEE, 2013). This activity could take place at public rocky shore areas or beaches and the activities could be tied to taking care and improving water quality as well as sustainable tourism.

15. “Europeans’ Green Holiday” (FEE, 2013) is a 5 day awareness raising activity in Lithuania where a topic such as renewable energy (chosen in 2012) is chosen, and related activities are used to raise awareness, for example in 2012, “The visitors could test the electrical bicycle, create small wind mills, sun cooker or see the presentation about environmentally friendly sea transportation” (FEE, 2013, p. 38). This activity would be ideal especially during the summer time where both locals and tourists could interact and share ideas about such topics.

16. “Mobile Information Unit” (FEE, 2013) is a mobile trailer (shown in Figure 6) that moves from one beach to another during summer, it includes a solar-powered DVD player that shows local biodiversity as well as other leaflets and guidelines of behaviour (FEE, 2013). Such a trailer could be used in Malta to portray local biodiversity.
17. “Seaweed Exploration” (FEE, 2013) involves two parts: the first part is a classroom session and the second part takes place at the beach (FEE, 2013), or at rocky coasts since we can adapt this activity. The class session involves such topics such as, “the make-up of seaweeds with diagram; protection for marine life; human uses of seaweeds (Figure 7)” (FEE, 2013, p. 58). Then the second part which is a beach clean is a way in which observing seaweeds is integrated to cleaning rubbish and a competition that uses the washed-up seaweeds in order to make sand-sculptures is another part of the activity.
18. In “Minifish boat” (FEE, 2013) participants are shown fish on ice and then they are given a talk about sustainable fishing (FEE, 2013).

19. “Dark Secrets of Marine World” (FEE, 2013) is an activity where two boxes such as the ones shown in Figure 8 and Figure 9 are installed at the beach (FEE, 2013), this could also be done at a rocky coast. On each box there should be a description of the items and their decomposition time (FEE, 2013).
20. In “Recycled Raft Race” (FEE, 2013) participants make sustainable rafts from recyclable material as shown in Figure 10, then after construction the participants have to race within the race route (FEE, 2013).

21. “Waste Eco Quiz” (FEE, 2013) is a quiz organized for all voluntary participants at the coast and at the end all participants are awarded prizes
(related to waste management such as sharpeners in the shape of bins) for their participation (FEE, 2013).

22. “Fishing Line Bins” (FEE, 2013) involves the placement of fishing line bins as shown in Figure 11 together with a poster with information regarding the negative effects that discarded fishing lines thrown in the sea have on marine life.
Figure 11: Fishing Line Bin (Source: FEE, 2013).
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