Valuing improvements to coastal waters using choice experiments: an application to revisions of the EU Bathing Waters Directive.

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Abstract:

Planned changes to the European Union's Bathing Waters Directive (2006/7 EC) will force member states to produce improvements in a number of parameters of coastal water quality. This study uses the choice experiment method to estimate the economic benefits attached to such improvements, based on a sample of recreationalists on beaches in Ireland. The analysis indicates that improvements in all of the bathing water related attributes studied result in positive willingness to pay, and also show evidence of scope effects. Using random parameters and latent class modelling techniques, potential heterogeneity in preferences is then investigated and shown to be present to a significant degree. One observable determinant of this preference heterogeneity is the degree of exposure of individuals to health risks relating to water quality, as proxied by the type of recreational activity they undertake.

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1.   Introduction

This paper reports the results of a Choice Experiment (CE) study of the economic value of potential improvements to coastal water quality that may result from implementation of changes to the European Union's Bathing Waters Directive in 2015. The focus is on potential benefits to recreational users of coastal waters, and how these vary according to the extent of exposure to risks. The Choice Experiment method has been applied in a number of recent studies to coastal water quality changes [1, 2, 3], and allows the researcher to estimate separate values for different aspects, or attributes, of water quality improvements which are relevant both from a water quality management perspective, and from the viewpoint of peoples' preferences over water quality improvements and the benefits of coastal zone protection [4].

Methods such as choice experiments help build a picture of the economic values of protecting and enhancing ecosystem services, thus contributing to the evidence base for better management of marine resources, and for improved policy-making and regulation [5, 6]. For example, environmental valuation methods allow the quantification of the benefits of policies such as the EU Bathing Waters Directive, which can then be compared with the costs of implementing a policy in order to judge the overall social efficiency of new regulation and the desirability and targeting of "derogations" from uniform targets [7, 8, 9].

A new European Union Directive on bathing water (Directive 2006/7/EC) came into force on 24 March 2006. It repeals the existing 1976 Quality of Bathing Waters Directive with effect from 31 December 2014. The 2006 Directive establishes a new classification system for bathing water quality based on four water quality classifications: 'poor', 'sufficient', 'good' and 'excellent' and requires that a status of 'sufficient' be achieved by 2015 for all bathing

waters. Environmental regulators must place warning signs on beaches which fail to meet this standard. Repeated failures to meet the standard will result in beaches being de-designated. The new Directive on bathing water establishes microbiological standards for two new parameters, namely intestinal enterococci and Escherichia coli. Since 2011, these two microbiological parameters have been monitored and used to classify bathing waters. In Ireland, the Environmental Protection Agency is charged with monitoring and testing the compliance status of Irish bathing waters with EU bathing water quality standards. As can be seen from Figure 1, the quality of Ireland's bathing waters is high, with 97% of bathing areas (127 of 131 areas monitored) complying with the minimum EU mandatory values and achieving 'sufficient' water quality status [10]. However, other European countries face more of a challenge in complying with the Directive: in England, for example, around 7% of beaches currently do not comply with the new 'sufficient' standard.

- **Figure 1 here**

In what follows, the impact on marine recreationalists from implementation of changes to the EU's Bathing Waters Directive is examined using the stated preference valuation technique referred to as the CE approach. In particular three empirical models are compared; two of which account for unobserved taste heterogeneity across recreationalists. Differences in the distribution of welfare effects on recreationalists resulting in the implementation of the Directive are also estimated from the three approaches. It is argued that estimates of public willingness to pay for improvements in coastal water quality can help guide the implementation of measures such as the new Bathing Waters Directive, and can inform policy-makers and regulators of the likely distribution of benefits across social groups.

2. Materials and Methods.

2.1 Empirical Approach

Choice experiments are a stated preference method within a wider group of approaches known as choice modeling. Adopting the *characteristics theory of value*, the choice experiment method defines a good (in this instance, coastal water quality) in terms of its characteristics or attributes, which can take a number of different and often hypothetical values (levels). Respondents are asked to choose between a series of hypothetical choice alternatives where each alternative is a different combination of attribute levels. The choices respondents make indicate which attributes significantly influence their choices, the trade-off rates between the different attributes, and willingness to pay for changes in each of the non-monetary attributes [11]. The statistical analysis of choice experiment data is based on the random utility model [12]. According to this framework, the indirect utility function for each respondent i (U_i) can be decomposed into two additive and independent parts: a deterministic part (*V*) which is determined by the attributes of the alternatives in the choice experiment and characteristics of the respondent, and a stochastic part (*e*) which represents unobservable influences on individual choice:

$$U_{ij} = V_{ij}(X_{ij}) + e_{ij} = \beta_{ij}X_{ij} + e_{ij} \tag{1}$$

where β_{ij} is the utility weight associated with atribute X_{ij}. Individuals are assumed to compare all of the alternatives *j* in each of the choice cards and choose the alternative which yields the highest utility. The probability that any particular respondent prefers

option "*g*" in the choice set to any other option "*h*", can be expressed as the probability that

the utility associated with option "*g*" exceeds that associated with all other options:

$$P[(U_{ig} > U_{ih}) \; \forall g \neq h] = P[(V_{ig} - V_{ih}) > (e_{ih} - e_{ig})]. \qquad (2)$$

If the random term is assumed to be independent and identically distributed (IID) extreme

value type I across individuals, alternatives and choice cards, the multinomial logit (MNL)

model (McFadden 1974) can be used to estimate the parameters of *V*. In the MNL model,

these β parameters are not individual-specific, since a single β value is estimated for each

attribute. This represents the average preference, or marginal utility, for any attribute

across the sample of choice data.

The random parameter logit (RPL) model and the latent class (LC) model extend the MNL

model by relaxing the assumption that observations are independent, and allowing the β

parameters to vary across individuals [13]. The RPL model allows the error components of

different alternatives to be correlated, and accommodates heterogeneous preferences in

the sampled population by generating a distribution of β parameters which vary randomly

over all individuals. The LC model assumes the existence of latent heterogenous groups

within the sampled population, membership of which is determined by observed

characteristics of respondents. Within each group or latent class, a single β value is

estimated for each attribute. Joint estimation of group membership parameters and utility

parameters allows one to relax the assumption that observations are independent [14], and

thus allow for error correlation.

For any of the choice models described above, "implicit prices" can be derived for each attribute. These show the willingness to pay of those in the sample for a particular change in a given attribute, and are derived by dividing the β parameter for an attribute by the β parameter for the price attribute, since the resultant term expresses the marginal utility associated with a change in an attribute in monetary units. Implicit prices show what people prefer more or less of, and how much they are willing to pay to have or avoid a particular change in an attribute [10]. They also allow the researcher to compare the relative importance of changes in one attribute to changes in another, and to understand the rate at which people would be willing to trade off less of a desirable attribute for more of an alternative, also desirable attribute within the experimental design. Their interpretation is thus both as a relative and an absolute indicator of value.

2.2. Survey design

The focus of the CE was on the valuation of changes in coastal water quality to those who use beaches in Ireland for recreation, principally "active" recreationalists such as surfers, swimmers and sea kayakers. This group of respondents are likely to be particularly affected by improvements to water quality which result from revisions to the Bathing Waters Directive, since many of the water quality parameters which the directive focuses on are linked to human health. As water quality improved, the exposure of beach users to illness from contact with water-borne pathogens such as faecal coliforms will decline.

The identification of attributes for the CE design was based upon the changes being made to the Directive. A number of other aspects of a recreational trip to a beach were identified at the piloting stage which individuals considered to be important, such as weather and surf

conditions, crowding on the beach and the use being made of the beach by other users. However, these were excluded from the CE design as they will not be directly changed by implementation of the Directive. Verification that the attributes included in the analysis were appropriate and understandable was carried out through a pilot survey of a sample of 40 active beach recreationalists.

The attributes chosen for the CE describe three aspects of coastal water quality: benthic health, human health risks, and beach debris. Each attribute is described in more detail below.

Benthic Health

Measures taken as part of complying with the revised directive will impact upon the 'health of the seas' through improvements at the benthic level. However, the concept of benthic health is not likely to be understandable to most members of the public, and so was related here to probable outcomes on vertebrate populations (birds, fish and marine mammal species). In particular, the likely impacts were related to the levels of protection of rare and endangered species and the likelihood of seeing more animals. Levels selected were:

- **No Improvement** to the current situation, which will mean no changes to the numbers or chance of seeing fish, birds and mammals.

- **Small improvement in Benthic Health,** which will mean that there will be more fish, birds and mammals. This will mean that endangered species will be less likely to disappear from the seas around Ireland. However, respondents were told that it was unlikely that they would see more fish, birds or mammals on a typical visit to the beach.

- **Large improvement in Benthic Health** mean that there will be many more fish, birds and mammals, resulting in an increased chance of seeing them on a typical visit to the beach.

Health Risks

Health risk was included as a design attribute since faecal coliform and faecal streptococci bacteria concentrations are expected to be reduced under the new directive standards. These bacteria will always be present in marine systems; however, it is the level of untreated or poorly treated waste and agricultural runoff within the system which is most associated with increased risk of human infections from bathing in the sea. The levels of faecal coliforms under current standards, the future 'good' (current excellent) standards, future 'excellent' standards and, as a point of reference, the levels allowed in swimming pools were identified to respondents. These were then related to the risk of a stomach upset or ear infection, based upon dose response relationships. Levels selected for this attribute were:

- **10% Risk -** No Change to the current risk of a stomach upset or ear infection from bathing in the sea (current risk as assessed by the EU).

- **5% Risk –** Good Water Quality achieved with a somewhat reduced risk of stomach upsets and ear infections, although risks would still be present for vulnerable groups such as children.

- **Very Little Risk -** Excellent Water Quality achieved with a larger reduction in the risk of stomach upsets and ear infections.

Debris Management

In addition to the likely direct impacts of upcoming changes to the Directive, it was identified that management could impact upon the amount of litter and other debris found on the beaches and coastal waters of Ireland. This was related to the amount of debris (such as cans, bottles, cotton buds, plastic bags, sanitary products etc.) on the beach and in the water. It was identified in focus groups that some of this waste could be prevented from reaching the beach, for example by cleaning filters at sewage plants and storm drains more often, so that in times of high rainfall debris such as cotton buds are not washed into the sea; or by better policing of people dumping rubbish in or near the sea. Respondents were also asked to consider additional collection of debris which is deposited on beaches. Three levels were selected:

- **No Change –** current levels of debris on beaches and in coastal waters will remain.

- **Prevention –** more filtration of storm water, more regular cleaning of filters and better policing of fly tipping, which will all reduce the generation of new debris.

- **Collection and Prevention –** debris collected from beaches more regularly in addition to filtration and policing.

Finally, in order to estimate measures of economic benefit (value) from changes in the environmental attributes listed above, a cost attribute was included in the design. Choices would then show how much people are willing to trade off improvements in an environmental attribute for a decrease in their income. The per visit travel cost to the individual of visiting a beach with a given set of characteristics was used as this cost attribute. Travel costs have been used before as the price attribute in several choice experiments relating environmental quality changes to recreational behaviour [15, 16], and

in this case avoided the problem of using income tax payments as the bid vehicle. This was an important consideration in this study since many respondents were students who paid no taxes. Six levels of cost were selected, ranging from 90 cent to €16.

The design of the experiment was generated using efficient design principles[1]. In the case of this study with three attributes with three levels and one attribute with 6 levels, a full factorial design would have had 162 combinations of attributes (3x3x3x6) and so a total of 81 choice cards. This was too many to be a practical sampling proposition. Through the use of efficient design principles it is possible to break this down into a smaller number of cards designed in such a way as to generate results as efficiently as a full factorial design (the final design had a d-error[2] of 0.2). With three blocks this meant that each individual responded to 8 choice cards. In each choice card, respondents were asked to choose the option they preferred from three choices. A sample choice card is presented in Figure 2.

- **Figure 2 here**

3. Results

Survey interviews were conducted face-to-face at beaches on the west coast of Ireland from June to August 2011. The surveys were conducted both during the week and at weekends. A total of 382 individuals were interviewed, yielding 365 observations which could be used in the final analysis. Each interview lasted approximately 20 minutes. Respondents were interviewed after they undertook their water-based activities. Recreationalists were questioned about the distance they had travelled to the beach, the activities undertaken, trip duration, number of trips annually to all beaches to undertake such activities, and their

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[1] NGENE Software was used for the design.
[2] D error is a measure of the efficiency of the design with lower levels showing a more efficient design.

opinions on beach quality where they were sampled. The survey also contained the choice cards as described above. Finally, all respondents were asked a series of questions on household characteristics in order to determine whether socio-economic variables affected the options chosen.

- **Table 1 here**

Table 1 presents some summary statistics for the sample. Some 83% of the sample was male, and 53% of the sample was surfers, 24% sea kayakers and 9% windsurfers. The recreationalists interviewed would appear to represent the more active in their sports with an average number of visits to the beach of 92 trips per year. The average age in the group was 31 and the average income was €56,611. It was also interesting to note that 85% of the sample indicated that they or a member of their household had at some time in the past experienced illness (stomach bug, ear infection etc.) due to bathing in the sea in Ireland.

- **Table 2 here**

Table 2 gives results from a simple Multinomial Logit (MNL) model. It may be seen that all improvements are positively valued by respondents, are statistically significant, and show positive scale effects. For example, a "small improvement" in benthic health gives a lower increase in utility than a "large improvement", whilst a reduction in risks from 10% to 5% is

valued lower than a reduction from 10% to virtually zero. Debris management which involves collection and prevention is more highly valued that management which involves collection alone. Gross income, a dummy variable for the status quo alternative in the choice set, a dummy variable for having a third level education and for whether the respondent's chosen sport involved immersion in the water or not were interacted with the zero cost option (the no change alternative - beach C in figure2) and were also included in the model. The negative sign on the gross income interaction parameter indicates that recreationalists with higher gross income are significantly less likely to choose the zero cost option and more likely to choose an improvement scenario, while those with a third level education are significantly more likely to make such a choice. Being involved in an activity that involves being immersed in the water had no significant impact on the choice of the average respondent. Overall, the model has good explanatory power relative to other published choice experiments with a pseudo-R^2 of 0.39.

Tables 3 and 4 show results from a Random Parameters Logit (RPL) estimation and Latent Class (LC) model, respectively. As explained in Section 2, these are two alternative ways of modelling preference heterogeneity and for clustering errors across responses [17]. For the RPL model in Table 3, the statistical significance of the standard deviation estimates for all of the water and beach quality attributes shows the presence of considerable preference heterogeneity. This can also be seen by comparing the mean effect for any attribute change with its standard deviation coefficient (for example, comparing the mean effect of 1.001 for a move from no improvement to a small improvement in benthic health compared to a standard deviation of 0.82). All mean effects are still significant, and show the same preference patterns as the MNL model. The gross income interaction parameter is now

found to be insignificant but those with a third level education are still significantly more likely to choose the zero cost option as was the case in the basic MNL model.

- **Table 3 here**

While the RPL model demonstrates whether heterogeneity exists around the mean population parameters through the estimation of a standard deviation parameter associated with each random parameter estimate, it is also possible to examine the possible sources of the heterogeneity that exists by interacting the random parameters with a variable that the researcher suspects may be a possible driver of variation in values. In this case that variable is whether the recreationalist is immersed in the water while carrying out her sporting activity. However, and as can be seen in table 3, only the interaction of this variable with the parameter presenting an improvement in health risks to virtually 0% was found to be significant. The heterogeneity in the mean parameter estimate for the *In water - Health Risk: virtually zero* of -0.697 suggests that across the sampled population, the sensitivity associated with going from a 10% health risk to a health risk of virtually zero decreases for those involved in sports that involve immersion, *ceteris paribus*.

For the LC model in Table 4, it was found that a 2-class model fitted the choice data best, based on a number of criteria including the BIC and AIC statistics. The two-class model specification allocated 59% of respondents to class one and 41% to class two. Latent class membership probabilities were specified to be conditional on the type of recreation respondents were involved in, as shown by the variable "in water activities". The class

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membership coefficients for the second segment are normalised to zero in order to identify the remaining coefficients of the model. The coefficients related to class 1 are interpreted relative to this normalised segment. The segment membership coefficients reveal that being a recreationalist who spends most of his or her time immersed in water as part of their recreation (i.e. a surfer, kite-surfer or swimmer) significantly increases the probability that the respondent belongs to latent class 1, and the size and significance of the variable coefficients in this segment implies that this group have different preferences for beach attributes and water quality improvements than those who spend more time on top of the water (e.g. sea kayakers, wind surfers), who are more likely to belong to latent class 2.

For class 1, the utility coefficients for all of the beach and marine attributes are significant. Also, latent class 1 respondents have a stronger preference for improvements in the health of the seabed and for improvements in debris management. As in the RPL model, it would appear that the recreationalists represented by this class are less sensitive to the health risk that those respondents represented by class 2. For the second segment all attribute coefficients are also of the expected sign and significant. However, except for the health risk attribute level dummies; this group would appear to be less sensitive to changes away from the no change levels for debris management and the health of the seabed than their counterparts represented by class 1. Interestingly, only in class 2 does the negative sign on the gross income interaction parameter indicate that recreationalists with higher gross income are significantly less likely to choose the zero cost option while those with a third level education are significantly more likely to choose it.These interaction terms are insignificant in class 1. Finally it would appear that class 2 exhibits stronger 'price' sensitivity

than those represented by class 1, given the higher absolute value associated with the cost coefficient in class 2.

- **Table 4 here**

Implicit prices were estimated for each of the attributes for all of the models reported. These are presented in table 5. The implicit prices show the marginal willingness to pay for a particular change in each attribute valued independently of all other attributes. Class 1 of the latent class model results in the highest marginal values across all attributes. Recall that class 1 is more likely to be made up of those participating in an activity which involves being submerged, and thus are more exposed to health risks per trip. In particular, respondents in class 1 have the highest marginal willingness to pay for a change from having a 10% risk of illness to having a health risk of virtually zero from being in the water, whilst they also place the highest value (as measured by willingness to pay) on reducing risks from the current 10% level to a 5% level.

- **Table 5 here**

Finally, welfare measures (compensating surplus (CS)) were estimated for multiple changes in the coastal quality attributes in the design. Mean willingness to pay for a programme that improves benthic heath from "no improvement" to a "large improvement", reduces health risks from 5% to virtually 0%, and changes beach debris management from prevention only to prevention and collection was estimated. The estimated value of this policy change and associated standard errors are presented in table 6 for all models. As in the case of the implicit prices, the policy welfare estimation procedure for the RPL model requires integration over the taste distribution in the population. Based on the RPL model, this implies a mean willingness to pay per recreationalist for these improvements of €6.78 per beach visit (with a 95% confidence interval of €6.17 - €7.39). Table 6 also reports the 25th, 50th and 75th CS percentile estimates for the RPL. Since the simulated distribution of the welfare estimates from a RPL model can have extreme tail values the median is often reported rather than the mean. In this case however the median and mean welfare estimates are almost identical. The equivalent mean willingness to pay figures for latent class 1 and 2 from the latent class model were €9.19 and €2.53 respectively with the weighted average (calculated using the respective probability of class membership for segment 1 and 2 of 0.59 and 0.41) equal to €6.45 (with a 95% confidence interval of €4.14 - €8.76).

- **Table 6 here**

4. Discussion and Conclusions

In this paper, the Choice Experiment (CE) method has been used to estimate the welfare impact on recreational users of coastal areas in Ireland resulting from implementation of changes to the EU's Bathing Waters Directive. Three modelling techniques were compared; namely, the multinomial logit model, the random parameter logit model and the latent class model. These were used to explain the preferences of marine recreationalists in Ireland for a number of beach and water related attribute levels that can be associated with the recent changes to the EU's Bathing Waters Directive. Results showed that people are willing to pay for all of the improvements modelled, since they were willing to incur higher travel costs to access "hypothetical" beaches with these higher quality levels compared with the status quo choice of recreational location. Whilst it is not possible at present to aggregate these numbers to a national benefits figure – due to a lack of reliable national data on participation in coastal water-based recreation – the economic benefits of implementing the Directive would clearly be substantial.

Should national participation data become available, per-trip estimates such as this could be combined with such data and count models of participation change as a function of the higher utility from improved beach quality to generate national willingness to pay estimates. Non-use and "informal" recreational use values for these improvements would also need to be estimated (for an example of the former for coastal water quality in the context of the original Bathing Waters directive, see Hanley et al [18]). National benefit estimates could then be compared to national cost figures for making these improvements in water quality, for example through modifications of sewage treatment, storm water overflows and pathogen run-off from farmland. As Pearce pointed out, such benefit-cost comparisons are essential to more informed policy making [8]. Whilst the Irish government does not have

choice over whether to implement the revised directive, it could use such information at the regional level in targeting water quality improvements at sites of high use in terms of on-water recreational activity. Benefit estimates at the level of specific beaches could be used to help make decisions on which beaches should be targeted for improvements, and which should be no longer designated as bathing waters. This would be the case if the economic costs of improving a site to a "sufficient" water quality level outweighed the benefits. A national, aggregate benefits figure substantially less than aggregate costs would imply more attention needing to be paid to finding more cost-effective ways of achieving target improvements in water quality.

Mixed findings were found on the interplay of measures of exposure to risks (defined by the type of activity respondents are engaged in) and their willingness to pay to reduce health risks related to water use. The RPL displays a negative sign on the interaction between the mean value of a reduction in risk from 10% to virtually zero and a dummy variable for in-water activities, implying surfers, swimmers, etc. are less sensitive to health risk reductions than others and also place a lower value on this risk reduction than others. Similarly, in the LC analysis, in-water recreationalists are more likely to be in class 1, which has a lower positive coefficient value for health risk reduction to zero than class 2. However, the smaller coefficient for cost (in absolute terms) for class 1 than class 2 results in a higher marginal valuation of reductions in health risks relative to latent class 2. This result is being driven by the sensitivity of the participants in each class to the price associated with a management option rather than their preference for the actual health attribute level.

The reduced sensitivity to health risk reductions, as shown by the preference parameters in both the LC and RPL models echoes results found by Hynes et al. [17] and Boeri et al. [19]

who suggest that water quality and the implied health risk is not generally an important aspect of a dedicated water sports recreationalist's choice of site, unless the level of water pollution is extreme. These water users, and especially those with the higher skill levels, are more interested in the recreational experience that the site can offer rather than the marginal health risks involved from using the site. However, there may be a complex relationship between selection in type of activity, subjective assessment of personal risk and valuation of risk reduction underlying these potentially contradictory findings.

Results from the RPL and LC models also showed considerable variation in preferences across the different recreational user groups. This suggests that beach and coastal recreation site managers and policy makers in charge of such sites should think carefully about the particular type of recreationalist utilising any site and the attributes and facilities that such users value, in developing site-specific management plans. Finally, at a more general level, Ronnback et al. [6] have argued that "the evaluation of ecosystem goods and services from both economic and ecological perspectives is a necessary ingredient in practical policy". Stated preference methods, such as that used here, provide one important means of arriving at such economic evaluations.
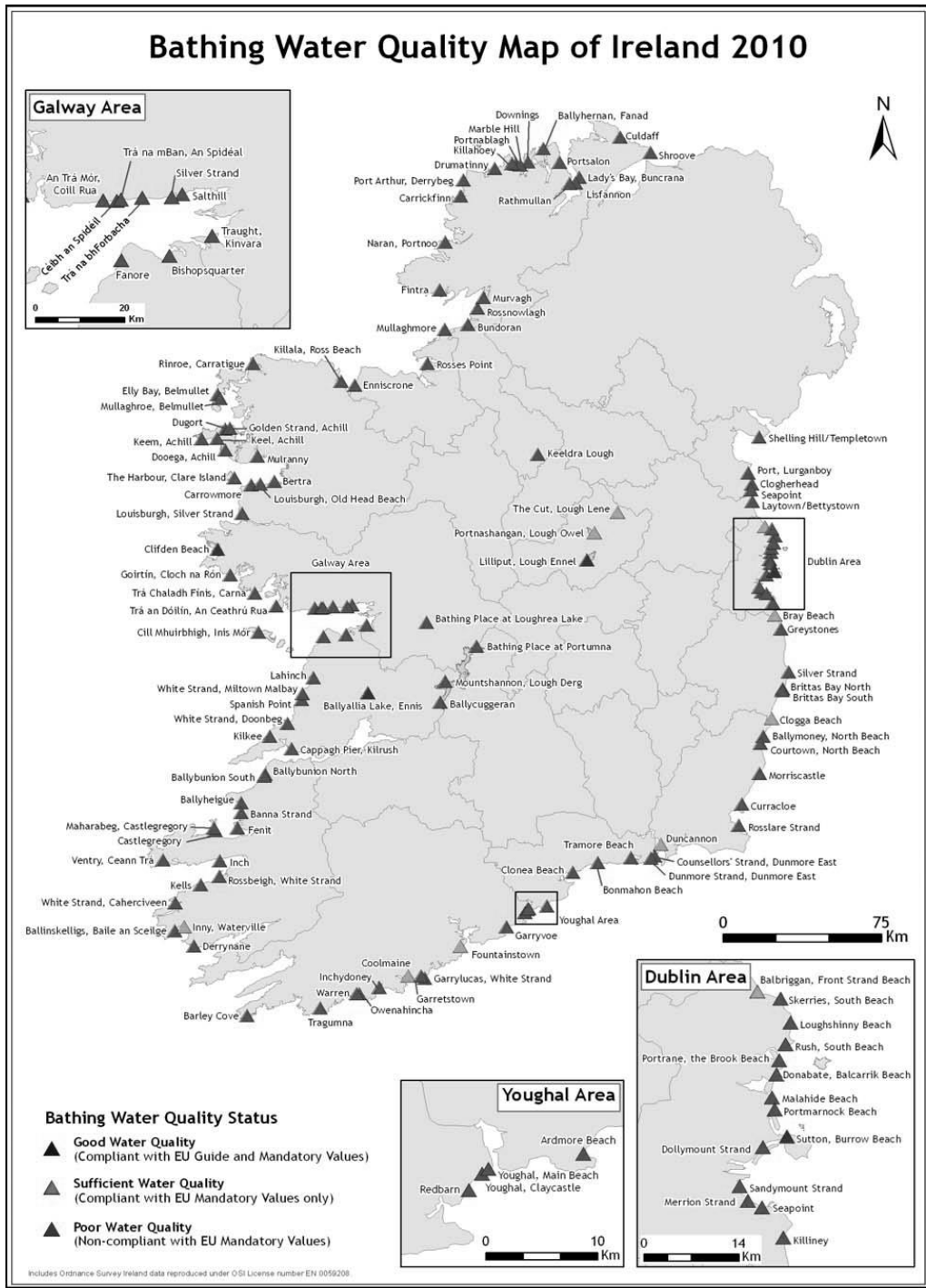
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Figures

Figure 1. Bathing Water Quality Map of Ireland 2010

Source: Environmental Protection Agency (2011)

Figure 2. Sample Choice Card.

	Beach A	Beach B	Beach C
Benthic Health and Population	**Small Increase** More fish, mammals and birds. Limited potential to notice the change in species numbers.	**Large Increase** More fish, mammals and birds and an increased potential of seeing these species.	**No Improvement**
Health Risk (of stomach upsets and ear infections)	**5% Risk** – good water quality	**10% Risk** – no improvement	**10% Risk** – no improvement
Debris Management	**No Improvement**	**Collection and Prevention** debris collected from beaches more regularly in addition to filtration and policing.	**No Improvement**
Additional cost of travelling to each beach.	€0.60	€12.00	€0
Please tick the **one** option you prefer.	☐	☐	☐

Tables

Table 1. Sample Summary Statistics

Variable	Mean	Std. Dev.
Gross Income (€)	56,611	25,833
Age	31.35	10.44
Number of Children in Household	0.74	1.34
Number of Adults in Household	2.69	1.29
Household member who have at some time in the past experienced illness (stomach bug, ear infection etc.) due to bathing in the sea (%)	85	36
Female (%)	17	38
Sea Kayaker (%)	24	43
Windsurf (%)	9	29
Kitesurf (%)	1	9
Swimmer (%)	13	34
Surfer (%)	53	50
Visits to beach per Year	92.31	130.24
Average Distance Travelled	48.97	79.41

Table 2. Multi-Nomial Logit Model

Variable	Coefficient
Health of the Seabed (benthic health): Small improvement	0.735 (0.078)***
Health of the Seabed (benthic health): Large improvement	0.746 (0.091)***
Health Risk: 5%	0.628 (0.083)***
Health Risk: virtually zero	1.391 (0.088)***
Debris Management: Prevention	1.016 (0.083)***
Debris Management: Collection and Prevention	1.109 (0.078)***
Cost	-0.155 (0.006)***
No change Alternative	0.052 (0.121)
In water activities (surf, kitesurf, swim)	0.122(0.166)
Gross Income	-0.005 (0.002)***
University Educated	0.754 (0.191)***
Log likelihood function	-3158
F Statistic [11d.f.]	2221
McFadden Pseudo R-squared	0.39

Notes: Figures in parenthesis indicate the values of the standard errors. *** indicates significant at 1%, ** indicates significant at 5%, * indicates significant at 10%.In Water Activities, Gross Income and University Educated are interacted with the No Change Alternative.

Table 3 Random Parameters Logit model

Random Parameters in Utility Function	Mean of Coefficient	Standard Deviation of Coefficient
Health of the Seabed (benthic health): Small improvement	1.001 (0.173)***	0.815 (0.139)***
Health of the Seabed (benthic health): Large improvement	1.049 (0 .214)***	1.023 (0.108)***
Health Risk: 5%	0.821 (0.155)***	0.051 (0.163)***
Health Risk: virtually zero	2.074 (0.193)***	1.031 (0.139)***
Debris Management: Prevention	1.251 (0.157)***	0.458 (0.196)**
Debris Management: Collection and Prevention	1.299 (0.159)***	0.705 (0.107)***
Non Random Parameters in Utility Function		
Cost	-0.194 (0.008)***	
No Change Alternative	-0.081 (0.145)	
Gross Income	-0.002 (0.003)	
University Educated	1.021 (0.250)***	
Heterogeneity in mean, Parameter: Variable		
Health of the Seabed : Small improvement: In water activities (surf, kite surf, swim)	-0.228 (0.205)	
Health of the Seabed: Large improvement	-0.083 (0.252)	
Health Risk - 5%: In water activities (surf, kite surf, swim)	-0.114 (0.182)	
Health Risk - virtually zero: In water activities (surf, kite surf, swim)	-0.697 (0.225)**	
Debris Management: Prevention: In water activities (surf, kite surf, swim)	-0.059 (0.183)	
Debris Management: Collection and Prevention: In water activities (surf, kite surf, swim)	0.169 (0.187)	
Log likelihood function	-2123	
Likelihood Ratio Chi squared Statistic [22 d.f.]	2071	
McFadden Pseudo R-squared	0.328	

Notes: Figures in parenthesis indicate the values of the standard errors. *** indicates significant at 1%, ** indicates significant at 5%, * indicates significant at 10%.Gross Income and University Educated are interacted with the No Change Alternative.

Table 4. Latent Class Model (2 Classes)

	Class 1	Class 2
Variable	Coeff.	Coeff.
Health of the Seabed: Small improvement	0.802 (0.108)***	0.514 (0.176)***
Health of the Seabed: Large improvement	0.839 (0.13)***	0.769 (0.197)***
Health Risk: 5%	0.487 (0.105)***	0.932 (0.217)***
Health Risk: virtually zero	1.357 (0.124)***	1.463 (0.231)***
Debris Management: Prevention	1.132 (0.106)***	0.972 (0.198)***
Debris Management: Collection and Prevention	1.257 (0.103)***	1.215 (0.171)***
Cost	-0.112 (0.009)***	-0.405 (0.028)***
No change Alternative	-1.582 (0.247)***	0.954 (0.317)***
Gross Income	0.002 (0.005)	-0.024 (0.004)***
University Educated	0.582 (0.651)	1.004 (0.309)***
Segment function: Respondents' characteristics		
Constant	-0.059 (0.230)	-
In water activities (surf, kite surf, swim)	0.710 (0.279)**	-
Average Class Probabilities	0.59	0.41
Log likelihood function	-1926	
Likelihood Ratio Chi squared Statistic [22 d.f.]	2463	
McFadden Pseudo R-squared	0.39	

Notes: Figures in parenthesis indicate the values of the standard errors. *** indicates significant at 1%, ** indicates significant at 5%, * indicates significant at 10%. Gross Income and University Educated are interacted with the No Change Alternative.

Table 5. Attribute Marginal Willingness to Pay Across Models (€ per Person per Year)

	Conditional Logit	Latent Class Model			Random Parameter Logit
		Class 1	Class 2	Weighted average of classes	
Health of the Seabed (benthic health): Small improvement	4.77	7.13	1.27	4.72	4.41
Health of the Seabed (benthic health): Large improvement	4.84	7.46	1.90	5.18	5.11
Health Risk: 5%	4.08	4.33	2.30	3.50	3.91
Health Risk: virtually zero	9.03	12.06	3.61	8.60	8.58
Debris Management: Prevention	6.60	10.06	2.40	6.92	6.31
Debris Management: Collection and Prevention	7.20	11.18	3.00	7.82	7.04

Table 6. Attribute levels and compensating surplus value estimates for Policy Change scenario (€ per person per year)

Attribute	Business as usual	Policy Change
Health of the Seabed (benthic health)	Small improvement	Large improvement
Health Risk	5%	virtually zero
Debris Management	Prevention	Collection and Prevention
Compensating Surplus (€/ person/year)		
Conditional Logit	5.59*** (0.86)	
Latent Class 1	9.19*** (1.59)	
Latent Class 2	2.53*** (0 .59)	
Latent Class Weighted Average	6.45***(1.18)	
Random Parameter Logit (mean)	6.78***(0.31)	
Random Parameter Logit (25th Percentile, median and 75th Percentile)	0.47, 6.76, 13.29	

Notes: Figures in parenthesis indicate the values of the standard errors. *** indicates significant at 1%, ** indicates significant at 5%, * indicates significant at 10%.