Non-Market Valuation of Coastal Ecosystem Services

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Acta Universitatis agriculturae Sueciae

2016:43

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Abstract

Marine and coastal ecosystems provide benefits to people through the provision of seafood, maintenance of water quality and several other valuable ecosystem services. The need to understand these benefits in economic terms has never been more pressing. Contingent valuation and choice experiments are survey-based non-market valuation methods that can be applied to estimate the values of these benefits.

This thesis aims to address some of the challenges facing non-market valuation of coastal ecosystem services, comprising a summary and four appended papers that are based on two separate studies designed to value coastal ecosystem services in two archipelago areas in Sweden.

Paper I addresses the challenge of creating and describing a contingent valuation scenario so as to achieve content validity. A holistic valuation scenario based on ecological measures that are well connected to policy was developed and is described and evaluated.

Sometimes when decisions have to be made and new valuation studies are impossible due to time and funding restrictions, estimates from existing studies can be transferred to a new setting, an approach referred to as benefit transfer. Including socio-economic information in choice experiment models for benefit transfer is addressed in Paper II. The findings suggest that a more 'general' model based on socio-economic information that can be easily obtained from public databases performs quite well as a model that would require the collection of more detailed information.

Paper III addresses distributional effects of environmental policies affecting coastal ecosystem services. The study presents information regarding distributional effects in both monetary terms and in terms of environmental quality for different socio-economic groups.

Paper IV addresses the important topic of model selection uncertainty for choice experiments in environmental valuation. To be able to ensure robustness of results, this study proposes an information-theoretic approach for model selection. The findings also indicate that greater attention should be paid to potential policy implications that may follow from different model specifications.

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Sammanfattning

Marina ekosystemtjänster är de produkter och tjänster som dessa ekosystem ger oss människor och som vi är beroende av. Bland annat bidrar marina ekosystem till att reglera klimatet och rena vatten men de ger oss också mat och möjligheter till rekreation. Genom att värdera ekosystemtjänster i monetära termer uppmärksammas deras värde och deras betydelse för oss människor. Många värden reflekteras inte i marknadspriser och det kan leda till att vissa värden blir förbisedda vid beslutsfattande. När vi inte uppmärksammar värdet av ekosystemtjänster riskerar vi dessutom att påverka dem negativt vilket kan leda till att ekosystemen förändras så att deras långsiktiga förmåga att producera olika ekosystemtjänster minskar. 'Contingent valuation' och 'choice experiment' är två empiriska metoder för värdering som baseras på enkäter eller intervjuer där man frågar om betalningsvilja för en förändring i tillgången av olika ekosystemtjänster. Många framsteg har gjorts inom värderingsforskningen men det kvarstår också en del utmaningar och svårigheter som behöver vidareutvecklas.

Syftet med den här avhandlingen är att försöka förbättra värdering av marina ekosystemtjänster genom att inrikta sig på några av dessa utmaningar. Avhandlingen består av fyra fristående artiklar som är baserade på två marina värderingsstudier som genomfördes 2009 i två svenska kustområden.

Den första artikeln handlar om utvecklingen av värderingsscenariot, det vill säga beskrivningen av den tänkta förändringen av tillgången av ekosystemtjänster som ska värderas. Ett holistiskt värderingsscenario som baseras på ekologisk kunskap och som är kopplat till miljöpolitiken utvecklas och utvärderas i studien som beskrivs i artikeln.

Den andra artikeln handlar om värdetransferering (så kallad 'benefit transfer'). I praktiken kan nya värderingsstudier ofta inte göras för varje nytt område och beslutsobjekt på grund av begränsningar i tid och resurser. Ett vanligt sätt att lösa detta problem har blivit att överföra värden från en primärstudie genomförd någon annanstans till det beslutsobjekt som man vill studera, ett förfarande känt som värdetransferering. I den andra artikeln utvärderas olika statistiska modeller för värdetransferering. Resultaten tyder på att en enklare och mer allmän modell som baseras på lättillgänglig socio-ekonomisk information kan ge liknande resultat som när en mer omfattande modell används. Fördelen med en enklare allmän modell är att man inte behöver tillgång till lika specifik information och det underlättar för den praktiska användningen i olika beslutssammanhang.

Den tredje artikeln handlar om fördelningseffekter som kan uppstå i samband med åtgärder av miljöpolitiken. Studien bidrar med information om fördelningseffekter i både monetära termer och i termer av miljökvalitet för olika grupper indelade efter inkomst, kön, ålder, användning av och avstånd till kustmiljöerna, bekantskap med områdena samt svensk och utländsk bakgrund.

Den fjärde artikeln handlar om analys av empiriska data från choice experiment metoden och val av statistisk modell. I artikeln presenteras och appliceras ett angreppssätt för att välja modell som baseras på informationsteori. Resultaten visar att osäkerheten kring val av modell kan vara stor och eftersom valet av statistisk modell kan påverka värdeestimaten så visar det på betydelsen av att uppmärksamma denna fråga.

Dedication

To Martin. Just to say I love you never seems enough.

To Albin with my strongest motherly love.

If I could, I would always work in silence and obscurity, and let my efforts be known by their results.
    Emily Brontë

Contents

List of Publications

This thesis is based on the work contained in the following papers, referred to by Roman numerals in the text:

I Östberg, K., Hasselström, L and C. Håkansson (2012). Non-Market Valuation of the Coastal Environment – Uniting Political Aims, Ecological and Economic Knowledge. *Journal of Environmental Management* 110: 166-178.

II Östberg, K., Håkansson, C., Hasselström, L. and G. Bostedt (2013). Benefit Transfer for Environmental Improvements in Coastal Areas: General versus Best-Fitting Models. *Canadian Journal of Agricultural Economics* 61: 239-258.

III Håkansson, C., Östberg, K. and G. Bostedt (2015). Estimating Distributional Effects of Environmental Policy in Swedish Coastal Environments – A Walk along Different Dimensions. *Journal of Environmental Economics and Policy* 5(1): 49-78.

IV Östberg, K (2016). An Information-Theoretic Approach to Model Selection for Choice Experiments in Environmental Valuation (manuscript).

Papers I-III are reproduced with the permission of the publishers.

My contribution to the papers included in this thesis was as follows:

I: The research idea for the first article was developed jointly by the authors. The planning and performance of the work was done jointly by the authors. The statistical analysis was done by me and Cecilia Håkansson. I was responsible for the main writing of the manuscript.

II: The research idea for the second article was developed jointly by the authors. The planning of the work was done jointly by the authors. I was responsible for the statistical analysis and the main body of the manuscript. All authors contributed to writing the manuscript. I am the corresponding author of the article.

III: The research idea for the third paper was developed jointly by the authors and the planning of the work as well. I was responsible for the statistical analysis. All authors contributed to writing the manuscript. I am the corresponding author of the article.

IV: I developed the research idea for the fourth paper. The planning and performance of the work was done by me. The statistical analysis and writing of the manuscript was done by me.

Abbreviations

AERE	Association of Environmental and Resource Economists
CBA	Cost-Benefit Analysis
EU	European Union
HELCOM	Helsinki Commission
IOE	Interval Open-Ended
MA	Millennium Ecosystem Assessment
MSFD	Marine Strategy Framework Directive
NOAA	National Oceanic and Atmospheric Administration (US)
SCZ	Special Consideration Zones
SEK	Svensk Krona (Swedish Krona)
SOU	Statens Offentliga Utredningar (Swedish Government Official Reports)
TEEB	The Economics of Ecosystems and Biodiversity
US	United States of America
WFD	Water Framework Directive
WISE	Water Information System for Europe
WTP	Willingness To Pay

1 Introduction

Marine and coastal ecosystems provide benefits to people through the provision of seafood, opportunities for recreation, maintenance of water quality and several other valuable ecosystem services[1]. However, the health of many of these ecosystems is negatively affected by human activities such as agriculture, fishing, climate change, pollution and industry (Naturvårdsverket 2015).

Among the pressures that marine and coastal ecosystems are facing is eutrophication one of the few pressures that is scientifically relatively well understood (Bertram and Rehdanz, 2013). Eutrophication is characterized by excessive phytoplankton and algal growth and occurs when disproportionate amounts of nutrients such as nitrogen and phosphorus are released into aquatic ecosystems (Havs och vattenmyndigheten, 2014). The consequences of eutrophication include blooms of cyanobacteria and deteriorating oxygen conditions in the water and sediments that negatively affect biodiversity (ibid.).

The need to protect marine and coastal ecosystems has favoured the creation and implementation of a range of policy measures. Legislation in the European Union (EU) has been progressively implemented in many ways. The Water Framework Directive (WFD) calls on EU member states to ensure the good ecological status of freshwater and coastal waters as its core objective. It establishes an approach to water management based on natural river basin districts and principles for the inclusion of public participation in planning and economic approaches (European Commission, 2016a). The WFD is the first piece of water legislation within the EU that integrates economics into the management of water resources. Tools that member states can use for economic analysis include non-market valuation methods and cost-benefit analysis (CBA) (WISE, 2008a).

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[1] Ecosystem services have been defined as "the benefits people obtain from ecosystems" (MA 2005, p. 53).

Closely linked to the WFD is the Marine Strategy Framework Directive (MSFD). It follows an approach that is similar to the WFD, with its main aim being to ensure the good environmental status of all coasts and marine waters (European Commission, 2016b). This involves the protection of marine ecosystems and requires physical, chemical and acoustic conditions that support healthy ecosystems. Thus noise coming from human activities should be attuned to the marine environment (WISE, 2008b).

The WFD and MSFD both support holistic management of aquatic and marine ecosystems and put special emphasis on economic analysis to inform choices about conservation and management. These two directives together provide a complete framework for the management and protection of both freshwater and marine waters in the EU (ibid.).

Sweden has set up 16 environmental quality objectives along with a generational goal and 24 milestone targets in order to safeguard the environment. The generational goal indicates what needs to be done in order to meet the environmental quality objectives within one generation and it guides environmental policy. The milestone targets are steps along the way of reaching the environmental quality objectives and the generational goal (Naturvårdsverket, 2016b). Two of the Swedish environmental quality objectives aim at ensuring that Sweden has "A balanced marine environment, flourishing coastal areas and archipelagos" and "Zero eutrophication" (Naturvårdsverket, 2016a). These objectives together illustrate the importance that is being attached to the health of marine and costal ecosystems in Sweden and the European Union.

Before any measures can be implemented to achieve a good environmental status for marine and coastal waters, they need to be assessed by examining their cost-effectiveness and by carrying out a CBA. But while the costs of improvement measures are often relatively easy to determine, the associated benefits are more challenging to estimate. The first challenge is to trace how changes in the marine biosphere affect the provisioning of ecosystem services and how these in turn affect benefits for humans. The second challenge is to estimate the benefits in monetary terms to be able to compare them to the costs of improvement measures in a CBA (Bertram and Rehdanz, 2013).

Many ecosystem services are public goods and thus tend to be undervalued or even omitted from decision making since their worth is not reflected by market prices or their values are simply unknown An understanding of the processes and functions of an ecosystem and how these are connected and/or dependent upon each other is a necessary part of any ecosystem assessment. Marine and coastal ecosystems bring human wellbeing, necessitating the integration of economic analysis within such assessments to be able to quantify

and value ecosystem services and ensure that their worth is being incorporated into policy and decision making. The value of these services can sometimes be measured by non-market valuation techniques to make values of ecosystem services visible and improve marine and coastal management.

Several methods for non-market valuation have been developed and they can be placed in one of two broad categories depending on the nature of the empirical data generated for modelling and estimation. Revealed preference methods rely on statistical inferences from data pertaining to actual choices made by people within a market. Stated preference methods, on the other hand, are based on individuals' responses to questions about hypothetical situations, often asking about willingness to pay for a proposed change in an environmental amenity. One drawback of stated preference methods is the hypothetical nature of the approach, but this is, at the same time, a strength since it allows for estimating non-use values, something that cannot be done with revealed preference methods.

Much research effort has been devoted to improving non-market valuation methods in order to increase the validity of results from valuation studies. However, there is still a variety of potential conceptual and methodological challenges to each method; the focus in this thesis is on topics specifically relevant to the application of stated preference methods for coastal ecosystem services valuation.

One challenge is to create and describe the valuation scenario so as to attain content validity. The scenario should ideally be well connected to both ecological science and to proposed policy measures (paper I). To be able to estimate coastal ecosystem services, there is a need for knowledge of how ecological shifts in coastal habitats influence the production of these ecosystem services. Many valuation studies are based on ambiguous descriptors of ecological commodities that cannot be linked to measurable outcomes (Johnston et al. 2012). Economists have only recently begun to work closely with ecologists to be able to estimate values that are connected to clearly defined ecosystem services (Börger et al. 2014).

Ecological content validity is also important for benefit transfer, an approach that amounts to applying values from already existing valuation studies to another setting. Since it is not always possible to conduct an original valuation study due to limitations of time and funding, valuation of ecosystem services will sometimes have to involve benefit transfer. However, if benefit transfer is to be an important tool for policy decisions, the gap between practices in the scholarly literature and those applied in policy analysis needs to be bridged (Richardson et al., 2015). Improvements in original research design and reporting of results can facilitate valid and reliable benefit transfers

(Loomis and Rosenberger, 2006). Providing a clear and concise definition of the character and state of the environmental amenity to be valued is the key to comparing the study site to other sites. The issue of including socio-economic and demographic information in models for benefit transfer and whether or not it will improve value transfer is also important (paper II).

Another topic that needs to be addressed in valuation studies is that of distributional effects. The environmental economics literature has tended to focus on efficiency of environmental policy measures, but the distributional effects they may have are seldom analysed (Serret and Johnstone 2006a). Traditionally, income has been used to assess distributional effects of environmental policy even though there are a number of other possibilities. An alternative could be to focus on the distribution of environmental quality as well as examining the possible effects on different groups within society (paper III).

Concerning the analysis of responses to valuation surveys is the topic of model specification and model selection. The 'choice experiment' is a stated preference method that is commonly used in environmental valuation. However, empirical estimates of welfare change measures such as willingness to pay depend on the model specification and can be sensitive to even minor changes (see for example Johnston and Bergstrom, 2011 and Andreopoulos et al. 2015.) This is something that often seems to go unnoticed since it is not mentioned in much of the published literature, even though it may have a bearing on policy guidance. Some sort of model selection criteria are thus needed to be able to ensure robustness of the results (paper IV).

The work described in this thesis was based on two separate valuation studies that were part of the research project PlusMinus – Economic assessment for the environment, funded by the Swedish Environmental Protection Agency. The survey-based studies were designed to value the benefits of reducing eutrophication effects, noise and littering in two archipelago areas in Sweden. One study area is located on the west coast and surrounds the islands of Orust and Tjörn. The other study area is located on the east coast in the area between Södertälje and Landsort.

The aim and intended contribution of the thesis is to elaborate on non-market valuation methods and seek to improve the validity of empirical results with a special focus on the challenges mentioned above. Emphasis is placed on the application of the choice experiment method.

The challenges were addressed in four studies, presented in the appended papers:

➢ The first study aimed to develop and apply a holistic valuation scenario based on ecological science and policy-determined measures. The scenario

was designed in collaboration with ecologists and a follow-up study was carried out to evaluate the applicability of the approach.

➢ The second study aimed at addressing choice experiment modelling for benefit transfer. The issue of including socio-economic information into choice experiment modelling was examined by specifying different choice models to be used for benefit transfer between the two study areas. The accuracy and reliability of benefit transfer was then assessed by means of equivalence tests.

➢ The third study addressed distributional effects of environmental policies aimed at improving marine coastal environments. The choice experiment method was applied to study distributional effects in monetary terms and in terms of environmental quality. The study examined whether monetary preferences and distributional effects in terms of environmental quality vary between different groups of respondents; income, gender, age, non-users versus users, distance, familiarity and Swedish versus non-Swedish background were considered.

➢ The fourth study aimed at addressing model selection uncertainty for choice experiments. To be able to ensure robustness of empirical benefit estimates, an information-theoretic approach is proposed as an alternative to traditional statistics involving null hypothesis significance testing as a basis for model selection criteria.

The remainder of this thesis is organized as follows. Section two introduces non-market valuation using stated preference methods and describes some of the challenges that require more research and that were addressed in the four papers. It also includes a short review of stated preference valuation of reducing eutrophication effects in marine and coastal ecosystems in Northern Europe. The third section provides information on the study areas and the valuation studies. The appended papers are briefly summarized in section four while section five is a concluding discussion. The English translation of the valuation surveys are presented in the appendix and the four papers are appended to the summarizing chapter.

2 Non-Market Valuation

In this section I introduce non-market valuation methods and, since my thesis focuses on stated preference methods, I only give a very brief introduction to revealed preference methods.

The nature of ecosystem services makes valuation of these amenities a challenge in many ways. Since people's valuation of the environment is generally not conveyed in the marketplace, there is a need for non-market valuation approaches as a basis for environmental decision-making. Many of the non-market valuation methods have not been applied to ecosystem services since they were developed before the concept of ecosystem services was introduced. However, non-market valuation approaches are directly applicable to valuing ecosystem services (Börger et al. 2014). To estimate non-market values, one has either to ask people about their preferences for the 'good' in question, or use existing data to infer the values.

Stated preference approaches mainly rely on answers to carefully designed survey questions and thus use primary data.

Revealed preference methods, on the other hand, often rely on secondary data. The hedonic method is a revealed preference method that relies on market transactions for 'differentiated goods' to infer the value of underlying characteristics. An example is the choice of housing location. In a hedonic study that aims at valuing an environmental amenity (such as a scenic view or the proximity to a lake for instance), one could infer the value based on the price of different houses that are all located near the amenity of interest.

Because stated preference methods are based on surveys about hypothetical scenarios, they are properly questioned and the subject of controversy. But the complementary relationship between an environmental good and a market does not always exist, although such a link is necessary to be able to use revealed preference methods. So if important issues concerning many non-market goods

are to be addressed, stated preference methods are needed and the approaches need to be refined continuously (Brown, 2003).

2.1 Contingent Valuation

Contingent valuation is commonly used to value a single good, even though it may also be used for valuing a number of closely related goods that differ with respect to one key attribute. The 'good' in question may be some environmental amenity, a policy programme or an environmental change, while an 'attribute' is a characteristic of a good. This approach is based on surveys for eliciting the values that people place on environmental amenities by asking respondents how much they are willing to pay for a specific good or service (in some cases people are asked for the amount of compensation they would be willing to accept in order for them to give up a specific good or service).

The initial demand for the method came from federal government agencies in the US beginning in the 1940s (Haab et al. 2013). However, the first published study was conducted by Davis (1963). At the beginning, early applications of the contingent valuation method were questioned and criticized (Boyle 2003). During a period of intense methodological advances that began in the 1970s and lasted until the end of the 1990s, the contingent valuation method gained increased acceptance. The Exxon Valdez oil spill in Alaska in 1989 brought contingent valuation to the awareness of many economists, government agencies and courts (Haab et al. 2013). This was the first time that contingent valuation was used for quantitative damage assessment. The US National Oceanic and Atmospheric Administration (NOAA) assembled a blue ribbon panel in 1993 to assess the credibility of using contingent valuation to estimate non-use values and to develop recommendations on how a contingent valuation study should be designed and conducted. Their recommendations spurred an interest in testing a number of hypotheses that emerged in the literature during the 1990s and 2000s (Haab et al. 2013). Exxon responded by supporting the publication of a book that criticised the method (Hausman 1993).

Following the BP Deepwater Horizon oil spill in 2010, the debate about contingent valuation that followed the Exxon Valdez oil spill surfaced once again (Haab et al. 2013).

Notwithstanding the criticisms on contingent valuation, the method continues to be applied for policy analyses and damage claims. A positive consequence of the criticisms is that they have helped focus the research

agenda in a way so as to achieve more credible welfare estimates (Boyle, 2003).

2.2 Choice Experiment

Contingent valuation was the first stated preference method to be developed, followed more recently by the choice experiment approach; this is an attribute-based method[2]. Both contingent valuation and choice experiments are based on surveys that use constructed hypothetical markets, the former is commonly used to value a single good or scenario, whilst the latter allows for estimating values of several characteristics of a good or scenario. Individuals are confronted with several choice sets, each consisting of a group of mutually exclusive alternatives, and are asked to choose their preferred one. Each alternative is described by a set of attributes, or characteristics at one or several levels. By comparing the alternatives and evaluating the relative importance of the different attributes, an individual will arrive at a choice outcome. Besides choice, responses in the form of rankings and ratings are also available for attribute-based methods. Estimates of willingness to pay for marginal changes of the different attributes can be obtained if a cost or price attribute is included in the choice sets. By combining different attribute changes, one can assess economic welfare measures such as compensating variation (Hoyos, 2010).

The choice experiment approach has its origins in advances in many different social science disciplines and this is why the terminology and classification sometimes differ between different contexts of its application (Holmes and Adamowicz, 2003). The theoretical basis that underlies economic applications of choice experiments can be found in Lancaster's (1966) characteristics theory of consumer demand, meaning that consumers evaluate attributes of commodities and then use these evaluations to choose between commodities. An approach for predicting choices in the market place based on the idea of random utility was provided by McFadden (1974). By proposing that an individual makes choices to maximize his or her utility, McFadden placed choice theory on an economic foundation (Holmes and Adamowicz, 2003). He developed an econometric model that combined hedonic analysis of alternatives and random utility maximization, known as the multinomial logit (or conditional logit) model.

The first application of an attribute-based method for environmental valuation was reported by Rae (1983), who used rankings to estimate the value

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2. The choice experiment approach is also known as 'choice modelling', 'choice analysis', or more generally 'attribute-based methods'.

to visitors of improving visibility at Mesa Verde and Great Smoky National Parks. This was followed by a number of applications using ranking models for non-market valuation of environmental amenities (Holmes and Adamowicz, 2003). Attribute-based methods that applied ratings data began to appear in the 1990s with Mackenzie's (1993) comparison of contingent rating, contingent ranking and paired comparison methods to the contingent valuation method.

The first application of an attribute-based method for environmental valuation based on choice as the response format was reported by Adamowicz, Louviere and Williams (1994) and since then the number of studies has increased. The choice experiment approach is now widely used for environmental valuation.

2.3 Challenges to Non-Market Valuation

Non-market valuation methods have become more and more accepted and over the last fifty years they have been improved and refined (Kriström and Johansson, 2015).

An increasing acceptance of non-market valuation methods has led to the acknowledgement of the capability of both revealed and stated preference approaches to inform policymaking and CBA. However, there are still many sources of uncertainty regarding the methods and areas that need more research. In this thesis, I consider the following four aspects of stated preference methods more deeply: designing and applying holistic valuation scenarios; benefit transfer; distributional effects; and model selection for choice experiments.

2.3.1 Holistic Valuation with Ecological, Policy-Determined Measures

Sustainable management of marine and coastal ecosystems requires knowledge of the costs as well as the benefits of different policy alternatives.

Valuation of ecosystem services is a means of showing how human wellbeing and society's welfare are dependent upon a healthy marine and coastal environment. Securing the values from ecosystem services to ensure that their benefits are included in decision making is a well-recognized policy function. The Economics of Ecosystems and Biodiversity study (TEEB), is a global example of an initiative focused on emphasizing the values of ecosystem services and biodiversity in decision-making, while the EU's Water Framework Directive and the Marine Strategy Framework Directive are European examples.

Notwithstanding a growing valuation literature, the health and productivity of the world's coastal ecosystems continues to decline (Nursey-Bray et al. 2014). Contemporary research points to a gap or separation between science and the ways it is incorporated into policy and management frameworks relating to coastal environments. Commonly, scientific research is being conducted without considering the needs of policymakers or coastal stakeholders (Nursey-Bray et al. 2014).

A number of measures for bridging the science-policy gap have been put forward. Avishek et al. (2012) recommend encouraging policy oriented research, developing research on fragile ecosystems, supporting capacity building and developing strategies for community participation. Börger et al. (2014) outline several challenges that hinder the use of ecosystem services values in marine planning and suggest a number of concrete approaches to overcome these. Among them are the needs for an improved understanding of the ecological underpinning of ecosystem service provision and methodological developments of stated preference approaches to improve ecological content validity. The estimated values must also be credible and connected to the key elements of marine policy. Researchers also note that good governance can play an important role when it comes to incorporating scientific information into decision-making (Nursey-Bray et al. 2014).

Based on a literature review and interviews, Waite et al. (2015) identified three categories of key enabling conditions that seemed to affect whether or not coastal ecosystems valuations successfully influenced policy, management or investment decisions in the Caribbean. Contextual enabling conditions, such as good governance or a study area's economic dependence on coastal resources, are often outside a valuation practitioner's control. Procedural enabling conditions, on the other hand, are largely within a valuation practitioner's control and include identification of causal links between different management scenarios and the health of ecosystems and ecosystem services and resource users, clearly presenting the methods, assumptions and limitations as well as communicating strategically. But the most important thing a valuation practitioner can do to increase the influence of a study, is to have a clear policy question and engage stakeholders in the planning and implementation of the valuation effort.

2.3.2 Benefit Transfer

Original valuation studies in support of marine and coastal planning may not be possible due to financial restrictions and limitations of time. Benefit transfer is an alternative approach in these situations. The approach amounts to

transferring economic estimates from existing studies (often referred to as study sites) of similar changes in environmental quality to a new area (referred to as the policy site).

What seems to be the first application of an environmental value transfer approach is a calculation of lost recreational value due to the Hell's Canyon hydroelectric project as described by Krutilla and Fisher (1975, chapters 5 and 6). The United States Forest Service was the first large-scale user of value transfer. A comprehensive effort to assemble value estimates of recreational use of forest lands was made in preparation for the 1980 Resource Planning Assessment, in order to balance these against timber production and other uses (Navrud and Ready, 2007a). A special issue of *Water Resources Research* with a focus on benefit transfer that appeared in 1992 along with the 1992 Workshop on Benefit Transfer of the Association of Environmental and Resource Economists (AERE) in Snowbird, Utah were of importance for questioning the current practice of benefit transfer as well as emphasizing the uncertainty of the method. Since then the number of applications to estimate both use and non-use values has been growing and efforts have been made to improve benefit transfer methods and the validity of results (Navrud and Ready, 2007a).

Benefit transfer is quite common in practical analyses and it is being used in different policy settings such as cost-benefit analysis of environmental projects and policies, green accounting, environmental costing and to calculate compensation payments because of pollution accidents (for example natural resource damage assessment) (Navrud and Ready, 2007b). Nonetheless, there remain important methodological issues around benefit transfer and there is no agreed protocol for how to apply the method (Johnston and Rosenberger 2010). Among the issues that surround the practice of benefit transfer are some of more importance. First, how should it be conducted? Several different classifications of methods can be found in the literature relating to benefit transfer, but essentially unit value transfer and function transfer are the two main approaches. The first one is based on a single value estimate while the second one transfers an estimated model.

A general agreement found in the literature is that function transfers often outperform unit value transfers, although the opposite has also been reported. Empirical evidence does not say anything about what kind of function transfer is best, although models that allow for greater flexibility when it comes to changing environmental resource and site characteristics seem to be favoured, for example choice experiment approaches (Johnston and Rosenberger 2010). A topic that has seen limited presence in choice experiment applications of benefit transfer is the importance of including socio-economic and

demographic variables. Beyond the general observation that the quality of function-based transfer is dependent upon the quality of primary research studies, there is not much agreement on the performance and validity of different types of function transfer.

Second is the question of how much additional uncertainty is introduced when estimated values are transferred, relative to the inherent uncertainty that is present in welfare estimates from environmental valuation studies. The interest lies in assessing the statistical validity of benefit transfer and measuring the transfer errors in different contexts. Benefit transfer is associated with several potential errors that can be divided into three groups: measurement errors that are associated with estimating the original values at the study site; transfer errors that are associated with the transfer process; and publication selection bias (TEEB, 2010). In the economics literature there is often a general preference to publish studies providing methodological advances and there is a lack of studies providing high quality and policy relevant empirical estimates that are replicable, and this may result in publication bias. The importance of primary studies for the performance of benefit transfer should be obvious and selection effects are an area that requires more research. TEEB (2010) notes that the scope for using benefit transfer to estimate values for ecosystem services is limited due to the availability of high quality primary studies and stresses that data from poorly conducted studies will, indeed, compromise the robustness of the approach.

Third, what could be an acceptable level of transfer error for policy applications? This is a question of how reliable the transferred values are.

2.3.3 Distributional Effects

Environmental policy is naturally associated with distributional effects. Since the very essence of environmental policies lies in some kind of change, it often involves 'winners' and 'losers'.

The environmental economics literature has mainly focused on efficiency of environmental policies while distributional effects are seldom analysed (Serret and Johnstone 2006a). Policy-makers, however, are requesting that distributional effects of environmental policies are investigated. In compliance with the Swedish Government Official Report (SOU 2003:2), the recommendation to the Swedish Environmental Protection Agency is to complement economic analyses of environmental policies with an analysis of the associated distributional effects. The EU Water Framework Directive (European Parliament and Council 2000) requires that economic analyses of water use should include efficiency as well as distributional aspects.

Several arguments can be presented as to why distributional effects need to be taken into account when assessing environmental policies (Serret and Johnstone 2006b, Kriström 2006):

➢ Efficiency and fairness are not necessarily separable, so both aspects need to be elucidated
➢ Concerning public goods, it is impossible to ensure that those who will benefit from an environmental policy are also the ones who will bear the cost
➢ Information about distributional effects can be useful as a decision basis for designing environmental policies that make undesirable distributional effects as small as possible
➢ If the distributional effects are not marginal, there may be a need to introduce compensatory measures in order to ensure that the policy is acceptable
➢ By presenting efficiency concerns for a project together with information about which groups in society will win or lose, the decision basis becomes more transparent
➢ Information about who wins or loses as a result of a project can also promote a more constructive debate on environmental policy impacts
➢ An understanding of distributional effects facilitates designing environmental policies that are more likely to be accepted by the public

Thus, there can be a tension between social equity and economic efficiency that is not easily resolved. Traditionally, the environmental economics literature has mainly focused on efficiency (Kriström 2006). A standard measure for assessing practical policy relevance within the economic literature is the Kaldor-Hicks criterion. This states that a policy is worthwhile when the sum of benefits exceeds the costs and it is socially beneficial if the winners can potentially compensate the losers (Serret and Johnstone 2006b). Whether or not the compensation actually takes place is an issue of less importance according to the criterion, and it should be handled separately.

However, while economic theory provides a clear definition of an efficient environmental policy, it gives no clear guidance concerning distributional issues such as how the various costs and benefits of a project should be divided among different socio-economic groups. Nor is it apparent what we should measure in distributional studies. Traditionally, income is the most frequently used, but other alternatives such as wealth or environmental quality could just as well be adopted (Kriström 2006). Among the different approaches available for addressing distributional effects, I will consider impacts in monetary terms

and in terms of environmental quality, since these two are relevant in this work.

Presenting distributional effects in monetary terms is the most common approach and studying how different income groups are affected by a policy is the most common dimension to focus on (Serret and Johnstone 2006a). However, it can be equally important to look at how different socio-economic groups are affected, so other possible criteria could include age, ethnicity, geographical or temporal distribution. By looking at how different groups are affected by a project, we can illustrate how people's preferences differ and show that other reasons besides income can affect willingness to pay. For example, people who live in sparsely populated areas with a high density of large carnivores can have preferences for carnivore conservation that are very different compared to people who live in cities and areas where there are only few or no carnivores (Håkansson, Bostedt and Ericsson 2011).

Distributional effects of an environmental policy are commonly presented in monetary terms. However, this could be complemented by a presentation of the distributional effects in environmental quality terms, meaning the degree of access or exposure to a specific environmental amenity. When an environmental 'good' is being studied, such as improved water quality, this means analysing access, and if it is an environmental 'bad', such as air pollution, then it means analysing exposure. To conform with studies of distributional effects in monetary terms, the focus of most studies addressing distributional effects in terms of environmental quality has been differences between different income-groups. Little attention has been paid to differences in preferences between different socio-economic groups (Serret and Johnstone 2006a), although this can be an important issue since preferences can vary widely across different socio-economic groups.

Since it is not obvious what should be distributed, it is important to study distributional effects in monetary terms as well as in terms of environmental quality. It will then become more transparent that different groups in society can win or lose from an environmental policy depending on what perspectives on distributional issues are chosen.

2.3.4 Choice Experiment and Model Selection

Choice experiments are commonly used as a stated preference method for environmental valuation. The aim of modelling is often to obtain empirical estimates of welfare change measures, and one benefit of the approach is the ability to estimate willingness to pay for marginal changes to different attributes of an environmental amenity. The opportunity to elicit a deeper

understanding of possible trade-offs between the attributes is another benefit that this approach can deliver (Jin, Wang and Ran 2006).

The research on choice experiments in environmental valuation has been intense but it can still be seen as a young research field and many issues require more attention (Hoyos 2010).

A topic that needs to be embraced is model uncertainty. The choice experiment approach is, indeed, flexible and the econometric techniques are continuously developing, presenting an analyst with many different options so several choices have to be made during the modelling stage. Many choice experiment studies deal with methodological aspects and estimation issues (see for example Feibig et al. 2010, Salisbury and Feinberg 2010, Campbell, Hensher and Scarpa 2014, Haghani, Sarvi and Shahhoseini 2015), but relatively little can be found concerning model specification and model selection, notwithstanding the importance of these matters.

One concern is that empirical estimates can be sensitive to even minor changes in modelling choices and assumptions. Some authors have emphasized this issue (for example Johnston and Bergstrom 2011, and Torres, Hanley and Riera 2011) but it seems to go unnoticed or at least unmentioned in much of the published literature. Johnston and Bergstrom (2011) characterize the sensitivity of welfare estimates for minor econometric specification changes of the mixed logit model and emphasize the need for robustness checks to gain policy makers' confidence in the results. Layton and Lee (2006) note that it is quite common to present willingness to pay estimates from a single or a small number of models with little indication of any robustness concerns. A problem with this common practice is that it can obscure large variations in willingness to pay estimates from different reasonable model specifications.

Since welfare estimates from choice experiments can be an important part of the basis for decisions in environmental policy planning, it is important that environmental economists and analysts ensure that potential robustness concerns related to common variations in statistical models are transparent. This is an important issue, not only for policy. Being clear and transparent when presenting modelling procedures and robustness concerns will benefit all readers of the reported study, as well as aid in gaining their confidence in the results presented.

However, since there are so many modelling options, it is not that easy to know how to choose between them. Some model selection criteria are needed to convey the robustness of the results. New modelling approaches and advancements of econometric choice models tend to intensify more than reduce the concerns over the sensitivity of welfare estimates (Johnston and Bergstrom, 2011). Layton and Lee (2006) write that the many flexible and

sophisticated models that are now available to a researcher make it more troublesome to know which model to choose. Therefore, to be able to address model selection uncertainty for choice experiments, more research is needed on this important topic.

2.4 Stated Preference Valuation of Reducing Eutrophication Effects in Marine and Coastal Ecosystems in Northern Europe

The non-market valuation literature on eutrophication effects is quite small compared to the literature on scientific aspects of eutrophication (Bertram and Rehdanz, 2013). Several studies have been undertaken to value eutrophication effects in marine and coastal ecosystems in Northern Europe. Some of these studies have based their assessment of willingness to pay on changes of one single attribute. Atkins and Burdon (2006) examine the costs and benefits of reduced eutrophication in the Randers Fjord in Denmark. They focus on assessing individual preferences for water quality improvements by applying the contingent valuation method to estimate benefits from higher water transparency. Soutukorva (2005) applies sight depth as a single attribute for examining how improved water quality affects the demand for recreation in the Stockholm archipelago. Söderqvist and Scharin (2000) also use sight depth as an indicator for water quality when they apply the CV method to estimate recreational benefits of reduced eutrophication in the same region.

Some studies have considered valuation scenarios that are based on several attributes and thus capture a more holistic eutrophication valuation.

Eggert and Olsson (2009) apply a choice experiment approach to value improved water quality along the Swedish west coast. They consider the attributes biodiversity, bathing water quality and cod stock level. Bathing water quality is connected to the EU Bathing Water Directive (EC, 2006) but the ecosystem's ecological status was only loosely linked to the different levels of water quality and biodiversity is ambiguously described by the levels low, medium and high with little further definition.

Kosenius (2010) estimates the benefits of improving water quality in the Gulf of Finland by using a choice experiment. The study incorporates information from an ecological simulation model but the connection to policy is merely vaguely defined.

Ahtiainen, Pouta and Artell (2015) also apply a choice experiment to estimate values for eutrophication-related water quality attributes in Finland. The study proposes an approach where current and future conditions of water

quality are based on the respondents' own perceptions and the valuation scenario is tied to the water body closest to each respondent's summer house.

A large-scale contingent valuation study performed in all nine Baltic Sea coastal countries was carried out by Ahtiainen et al. (2014). The aim of the study was to estimate the benefits of reducing eutrophication in the Baltic Sea according to the targets of the Helsinki Commission (HELCOM) Baltic Sea Action Plan for the Baltic Sea marine environment. The action plan is a programme of measures for the protection and management of the marine environment with the aim of restoring the Baltic Sea to a good ecological status by 2021 (HELCOM, 2016). The findings reported in the study showed considerable differences in mean WTP between countries and the most important determinants of WTP were found to be attitudes and personal experience of eutrophication.

Concerning noise from boat traffic and recreational activities in coastal areas, it seems that no valuation studies have been carried out in Northern Europe, and only one study seems to address littering. Mourato et al. (2010) applied choice experiment to estimate the benefits of revising the Bathing Water Directive to England and Wales. The study examined 49 different bathing sites in both coastal and inland locations and considered improvements in water quality, advisory notice systems, litter and dog mess, safety and amenities.

3   The Empirical Setting

3.1   The Study Areas

This thesis is based on two separate valuation studies that were part of the research project PlusMinus – Economic assessment for the environment, funded by the Swedish Environmental Protection Agency. The regions that the empirical studies concern are two coastal archipelago areas in Sweden. The west coast study area covers the waters surrounding the islands of Orust and Tjörn in the county of Västra Götaland (see Figure 1). The east coast study covers the area between Södertälje and Landsort in the county of Stockholm (see Figure 2). They are both popular areas for many recreational activities such as fishing, bathing, and boating, and they have a mix of permanent residents and visitors. However, the areas also face
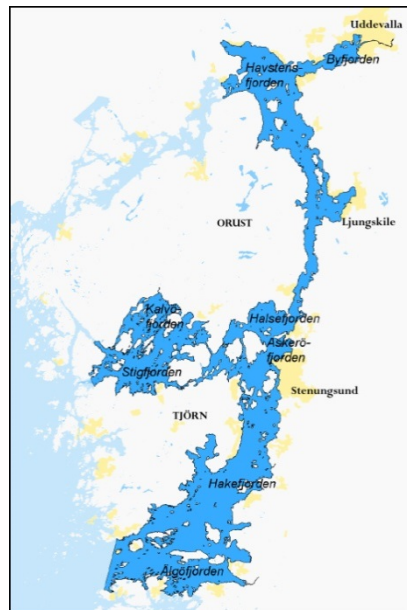

Figure 1. The west coast study area.

three main kinds of environmental problems: eutrophication; decreasing fish populations and littering and noise particularly from speeding boats. The problems of decreasing fish populations are not addressed in this thesis.

Eutrophication effects, such as reduced water clarity and a decline in bladder wrack (Fucus vesiculosus) populations (Kautsky et al. 1986), as well as overgrowth with filamentous macroalgae and increased blooms of cyanobacteria, are caused by high concentrations of nutrients in the water (Pihl

Figure 2. The east coast study area.

et al. 1996, Sundbäck et al. 1996). Water clarity is measured in terms of sight depth, or "secchi depth". Due to the growth of phytoplankton, the sight depth decreases with increasing nutrient concentrations. The presence of bladder wrack stands can be considered to be an indicator of good water conditions with respect to eutrophication. The abundance is highly correlated with the sight depth, since bladder wrack is dependent on light from the surface (Kautsky et al. 1986). A high nutrient concentration also leads to the growth of algae that compete with the bladder wrack. Abundant growth of filamentous macroalgae may cause algal mats to form in shallow bays and on beaches. In some parts of the west coast study area, this is a severe problem (see for example Harlén and Zackrisson

2001). The east coast study area has more severe problems with cyanobacterial blooms. These blooms are a natural phenomenon in the Baltic Sea, but increasing concentrations of nutrients in the water can lead to increased frequency and extent of occurrence (Finni et al. 2001).

A policy response to these kinds of problems caused by eutrophication was introduced by the EU's Water Framework Directive. Coastal and inland waters have to be classified according to a scale to describe their ecological status and the aim is then that all these waters should have a "good ecological status". Because of ecological variability within the community, it is impossible to set absolute standards, so the formal requirement for good status is specified so as to allow "only a slight departure from the biological community which would be expected in conditions of minimal anthropogenic impact" (EC, 2010). This means that the necessities for each status level may vary both between and within countries. The Swedish Environmental Protection Agency (Naturvårdsverket 2007) has developed norms for classifying ecological status based on different representative geographical areas in Sweden. One potential

measure for improving the problems stemming from eutrophication is to reduce the amount of nutrient effluents from, for example, sewage treatment plants around the area.

With respect to littering and noise that may cause nuisances to visitors and residents in coastal areas, as well as interfering with the coastal ecosystem, county administrative boards in Sweden have responded by introducing Special Consideration Zones (SCZs). In these zones there are restrictions regarding littering, boat traffic and different sources of noise, among other things. Administering these SCZs has an associated cost in terms, *inter alia*, of information and installing recycling bins and sewage collection points for boats. This policy measure is also a step towards fulfilling the Swedish environmental target regarding noise in coastal areas, which is a part of the environmental quality objective "A balanced marine environment, flourishing coastal areas and archipelagos" (Regeringskansliet, 2000).

3.2   The Valuation Studies

In autumn 2009 two separate but nearly identical valuation surveys were conducted to study the preferences for different policy actions aimed at improving the environmental conditions in the study areas[3]. The surveys were tested in focus groups and pilot studies and were then further refined before they were administered as web-based panel surveys. The panels consisted of randomly selected adults, 18 years and older, and were supplied by the survey company Norstat. The panellists are invited to participate in the panel and regularly receive enquiries to participate in surveys on different topics. They are also compensated for their efforts. The survey was aimed at both local and more distant populations.

The questionnaire consisted of five parts. The first part concerned familiarity with and use of the study area. The second part described the present status of the coastal environment in the two areas and included questions about the respondents' attitudes towards and familiarity with environmental problems in the coastal environment. Conceivable measures for environmental improvements in the areas were presented in the third part along with their expected results. The valuation scenarios presented various improvements in the two coastal areas with respect to reducing eutrophication effects, noise and littering. Status quo for the scenarios was established in collaboration with ecologists who have good knowledge of the ecological conditions in the study areas. Concerning water quality, the respondents were

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[3] An English translation of the surveys are presented in the appendix.

told that the water quality in the study area could be described according to five different quality classes depending on different ecological indicators, such as the sight depth and different types of vegetation present. They were also shown underwater photographs representing the different quality classes, accompanied by written explanations and a map indicating the current water quality status in different parts of the study area.

Valuation scenarios involving cyanobacterial blooms were only presented to the respondents of the east coast survey. Status quo concerning cyanobacterial blooms was defined as 'high risk for one large-scale bloom in the study area every year'.

Concerning noise and littering in the areas, status quo was defined as 'no specific policy action is taken to address the problems'.

The proposed policy measures for improving the water quality, reducing cyanobacterial blooms, noise and littering in the areas were developed with assistance from ecologists and county administrative boards in the respective counties. The proposed measure for being able to reduce eutrophication effects was enhanced technology in municipal sewage treatment plants. Concerning noise and littering, the proposed measure was the introduction of SCZs in certain parts of the study areas. Three SCZs would be established on the west coast and three on the east coast.

If these policy measures were to be implemented, they should lead to improvements in the coastal environments. Regarding eutrophication effects, two potential levels of improvement were presented, while concerning noise and littering, the improvement scenario was specified as 'less noise and littering'. The water quality scenarios were presented as an improvement of one or two classes in each part of the study areas. Regarding cyanobacterial blooms, the scenarios were presented as a high risk of one large-scale bloom in the study area every third, or every tenth year.

The financing of the proposed policy measures was described as a monthly fee to be collected from the citizens of the surrounding municipalities between the years 2010 and 2029. The collected fee would support a government fund aimed at implementing the proposed measures for achieving the environmental improvements in the two areas. The proposed measures would be implemented if their benefits to the public exceeded the costs.

The fourth part of the survey presented willingness to pay questions and the surveys contained both choice experiment and contingent valuation questions. The respondents were first presented with a number of choice sets, to allow for choice modelling. Each choice set was made up of three alternatives that were combinations of different attributes: water quality and noise and littering were present in both survey versions, while reference to cyanobacterial blooms was

only included in the east coast survey. The respondents were asked to choose between the three alternatives, where the first alternative was always the status quo, offering no environmental improvements and no extra costs. The other two alternatives offered various levels of improvements along with a cost to the household, with the amounts of 0, 20, 100, 500, or 1000 SEK per month. An example of a choice set from the east coast survey is provided in Table 1.

Table 1. Example of a choice set.

	Option A	*Option B*	*Option C*
Water quality	As today	Improvement of two classes	As today
Cyanobacterial blooms	As today	As today	Every 3rd summer
Noise and littering	As today	As today	Less noise and less littering
Cost to your household	0 SEK/month	100 SEK/month	500 SEK/month

☐ I would choose Option A
☐ I would choose Option B
☐ I would choose Option C

Following the choice sets, the respondents were then presented with contingent valuation scenarios where only one attribute was changed at a time while the other ones remained at the status quo. Since previous valuation studies have shown that many respondents find it difficult to state their WTP as an exact number, we used the 'interval open-ended' (IOE) question approach (Håkansson, 2008). This question format allows the respondents to state their WTP as an interval, so possible valuation uncertainty can be captured as well. Thus it is assumed that respondents only have one true point of valuation, but they are not always certain about the location of this point so they can only place it within an interval (see also Hanley, Kriström and Shogren 2009). An example of a contingent valuation question using IOE is presented in Figure 3. The survey concluded with socio-economic questions.

Question:

How much would your household be willing to pay for a change from today's situation where no specific actions are taken against noise and littering, to a situation where there is less noise and littering according to the presented restrictions?

We know from previous studies that many people are uncertain regarding their willingness to pay, but try to answer the question as well as you can (answer with an interval).

Answer:

My household is willing to pay between _____SEK and _____SEK every month between 2010 and 2029 for this change.

Figure 3. Example of a willingness-to-pay question using IOE.

4   Overview of the Appended Papers

The appended papers are briefly summarized in this chapter along with the methods used and the main results. Please see the specific papers for more information.

4.1   Non-Market Valuation of the Coastal Environment – Uniting Political Aims, Ecological and Economic Knowledge (Paper I)

The aim in this study was to address the challenge of creating and describing a holistic contingent valuation scenario based on ecological science that is well connected to policy, so as to achieve content validity. Two scenarios were applied and evaluated. They were designed in collaboration with ecologists and were based on improving water quality according to the EU Water Framework Directive and reducing noise and littering by introducing Special Consideration Zones in the two coastal areas. We wanted to examine whether the respondents were able to relate to, understand and attach a monetary value to these types of holistic scenarios connected to actual policy and ecological science. A follow-up study was also conducted in order to examine issues such as the credibility of the scenarios, whether or not the respondents found the questionnaire to be complicated, and if they thought that the scenarios were easy to understand.

The 'interval open-ended' question format resulted in a certainty interval for willingness to pay. Mean monthly WTP per household for the water quality improvement scenario was estimated to be in the interval 51-153 SEK on the east coast and 32-110 SEK on the west coast. The corresponding intervals for less noise and littering were estimated to be 24-67 SEK per month and household on the east coast and 19-58 SEK per month and household on the west coast. So the respondents on the east coast expressed a greater willingness to pay on average compared to the respondents on the west coast. The

estimated values were also higher for improving the water quality than for reducing noise and littering in the coastal areas, irrespective of region.

The willingness to pay was also connected to socioeconomics and the variables found to be important in influencing its size were: membership of a green Non-Governmental Organization, whether or not the respondent considers marine issues to be very important, how often the respondent visits the study area and will be visiting the area if the scenarios are implemented, gender, children in the household and income.

The follow-up study showed that the respondents did not seem to find the language in the survey difficult and they thought the scenarios were easy to understand and found them to be credible. However, the majority of the respondents also found the questionnaire to be complicated and time-consuming even though they thought that the results would be used. There seems to be a possible trade-off between describing a policy-anchored holistic scenario and imposing too complex a burden upon the respondents who might be discouraged from responding to a survey.

The results are promising, paving the way for valuation studies that employ this kind of approach. The benefits of a holistic valuation approach can be seen as reflecting more of the full values of policy measures when the scenarios are not based on one single indicator and they are directly applicable to decision-making, being based on actual policy. This study also provides data on the willingness to pay estimates for noise and littering in archipelago areas, being one of the first of its kind.

4.2   Benefit Transfer for Environmental Improvements in Coastal Areas: General versus Best-Fitting Models (Paper II)

The aim in this study was to elaborate on the choice experiment approach for benefit transfer models and compare the performance between a 'general' model including only easily available socio-economic information and a statistically 'best-fitting' model requiring the collection of more detailed information. The 'choice set' questions from the valuation surveys were used to estimate willingness to pay values for the attributes *improved water quality* and *less noise and littering*. Value transfers between the two study areas and between local and more distant populations were then evaluated by equivalence tests, in which value estimates are assumed to be different unless the hypothesis demonstrates that the difference is smaller than a specified tolerance level.

The results showed that there were differences in estimated willingness to pay values between the two study areas. The transfer error varied between 5%

and 80% for the best-fitting models and between 2% and 88% for the general models depending on the direction of transfer. The transfer errors were larger when the value transfer related to *less noise and littering* compared to *improved water quality*. The results showed that the transfer error not only varied between attributes but also between different population groups. The equivalence tests for the different models revealed quite similar results. This indicates that the general models could be used for benefit transfer between the two study areas without any large differences as compared to using the best-fitting models. Using a general model would save both money and time since the information needed can be easily obtained from public databases.

This study also examined the issue of including socio-economic information in a choice experiment for benefit transfer. Since the model specification will determine the type of information that needs to be collected at a policy site, this is an important topic, but the results were inconclusive as to whether it improved benefit transfer or not.

4.3 Estimating Distributional Effects of Environmental Policy in Swedish Coastal Environments – A Walk along Different Dimensions (Paper III)

The study presented in the third paper examined distributional effects of environmental policies in the east coast study area, in both monetary terms and in terms of environmental quality for different groups. Emphasis was placed on the choice experiment part of the survey. Latent class modelling was used to analyse the effects of improved water quality, less frequent cyanobacterial blooms and less noise and littering. A latent class model amounts to dividing the respondents into different preference classes and allows for incorporating individual characteristic data.

The main focus was the analysis of distributional effects in monetary terms and the dimensions studied were: income, gender, age, origin (in terms of Swedish and non-Swedish background), non-users and users, distance (meaning living close to the study area or not) and familiarity with the environmental amenity. To be able to study distributional effects in terms of environmental quality, we examined the respondents' use of the study area with different levels of environmental quality. A special focus was also placed on potential differences in preferences depending on background.

The results showed that the local population spends more time in the study area than the more distant population, and they also expressed higher WTP for improved water quality improvements and less frequent cyanobacterial blooms. Introducing SCZs seemed to be of greater concern to some of the respondents

from the more distant population who expressed higher WTP for less noise and littering.

The results indicated that the respondents with a non-Swedish origin would benefit more from less noise and littering as compared to the respondents with a Swedish origin, while no distributional effects in terms of environmental quality could be found for improvements in water quality or less frequent cyanobacterial blooms.

The choice experiment analysis indicated that latent class modelling can assist in identifying how preferences vary between different groups of respondents. Socio-economic and individual characteristics can help in assigning membership to the different groups or classes, and identifying these factors can provide a better understanding of the sources of preference heterogeneity, as well as giving insights into the distributional effects of policy measures.

The results showed that respondents who are familiar with the study area since childhood and those who spend a lot of time there had a higher WTP than less frequent users and respondents who did not spend time there during childhood. Age and gender were other factors found to be significant in assigning class membership. No general patterns of distributional effects were found in relation to either income or background dimensions. The results suggest that familiarity with a certain recreational area is more important for preference formation than background.

4.4 An Information-Theoretic Approach to Model Selection for Choice Experiments in Environmental Valuation (Paper IV)

The aim in the fourth study was to address model selection uncertainty for choice experiments in environmental valuation. An information-theoretic approach based on Kullback-Leibler information was applied as a basis for model selection, namely the Akaike Information Criterion (Akaike 1973) along with associated statistics. Kullback-Leibler information denotes the information lost when a model is used to approximate full reality (Burnham and Anderson, 2002, pp. 50-60). This approach was chosen because it provides quantitative measures of the strength of evidence for different models considered and it can also cope with non-nested models. Three econometric model forms, specified with different socio-economic and demographic variables were set up as a candidate set for model selection: the conditional logit model, the conditional latent class model and the error components model. The analysis was based on the 'choice set' part of the west coast survey.

The results from the conditional logit models alone indicated that there is a high degree of model selection uncertainty present since the model estimated to be best did not have convincingly strong support. Instead there were a number of models that seemed to be equally good candidates. The error components models were all superior to the conditional logit models, but again there was a high degree of model selection uncertainty among them. If the candidate set of models had involved only these two model specifications, the best model to use would have been unclear. Thus, the model selection uncertainty should be accounted for in some way, for example by model averaging or some other kind of multimodel inference.

The results also showed that when the latent class model specifications were added to the comparison, one single model stood out as convincingly the best in the set. Notable in this case is that the empirical data support one model to base inferences on and there seems to be little need for multimodel inference.

This study emphasizes the importance of model specification and model selection, an issue that has received little attention in the published choice experiment literature for environmental valuation. If there is a high degree of model selection uncertainty present, it may also have a bearing on policy guidance since welfare estimates can be sensitive to different model specifications. The approach proposed for model selection in this study is relatively easy to understand and apply and could be a valuable tool in choice experiments.

5 Concluding Discussion

The main aim of the studies that this thesis is based upon was to elaborate on stated preference valuation methods in an attempt to improve the validity of empirical results. Emphasis was placed on four different topics that are important for non-market valuation.

To encourage recognition of ecosystem services and their benefits to human well-being, valuation can be a valuable tool in policy guidance. However, since the quality of empirical welfare estimates is only as good as the data they are based on, good survey design and implementation are essential. A well designed valuation survey communicates relevant information in a clear and concise way and presents questions and valuation scenarios in an unambiguous manner (Champ, 2003). The topic of validity in non-market valuation studies concerns whether the estimated values measure the theoretical construct that the study aims to examine (Brown, 2003).

The appended papers in this thesis are all based on the same two valuation surveys. The scenarios used in the surveys were developed in collaboration with ecologists who have good knowledge of the local conditions in the study areas. This was important to provide an accurate representation of the ecological changes being valued as well as the status quo. There are many challenges associated with ecosystem services valuation and one of them is a difficulty of connecting planning scenarios to ecological outcomes and values (Börger et al., 2014). Identifying and communicating realistic baseline scenarios is another important task (Ledoux and Turner, 2002). To gain coastal and marine planners' confidence, as well as that of policymakers, when using non-market valuation to support their planning efforts, it is also important that valuation scenarios are tailored to the actual policy context (Börger et al., 2014). The health of the ecosystems with respect to eutrophication is scientifically well understood in the two study areas. This knowledge

facilitated the development of valuation scenarios that were connected to what could be reasonably achieved by policy measures.

The follow-up study showed that our application of a holistic, ecological, policy-determined valuation scenario is promising. Even though the respondents found the questionnaire to be time-consuming and complicated, they thought that the measures and their results were easy to understand. This indicates that the scenarios were described in a way that was understood by the respondents while still providing an accurate representation of the ecological changes. As noted by Börger et al. (2014), valuation surveys should be able to describe complex ecosystem information in order to attain "ecological content validity". Applying a holistic ecosystem service approach to valuation may also reduce any double-counting risks, since no aggregating of values is needed.

Preparing the valuation scenarios may require more effort by researchers, but if content validity is improved it may be worthwhile. The respondents found the survey to be time-consuming and this is a drawback that needs to be considered, since it could have an effect on response rates. These two surveys provide methodological information that may be useful when new valuation studies are planned. These are also two of the first studies that present value estimates for less noise and littering in coastal areas.

Ecological content validity is equally important for benefit transfer. A potential lack of similarity between coastal sites is an important concern for the validity of value transfers (Johnston and Rosenberger, 2010). The study areas that this thesis is based upon were chosen because of their similarity, plus they have also been subject to ecological research concerning eutrophication[4]. Since many of the advances recommended by researchers focusing on benefit transfer would not be possible to implement in policy analyses, there is a need for more policy relevant alternatives. The choice modelling approaches examined in Paper II showed that a more general model performed quite well as compared to a model with a superior statistical fit. The general model was specified so as to allow for adjustments to a new setting with new socio-economic information. The characteristics included in the general model can be found in public records, so this type of model would be easier to adjust to different policy sites. Transfer errors were found to be higher for less noise and littering in the study areas compared to improving the water quality. Maybe this depends on the presentation of these two scenarios. An important aim when designing the valuation studies was to develop reality-based valuation scenarios. However, this also amounted to difficulties in defining the baseline

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4. See the research programs SPICOSA (www.spicosa.eu), Himmerfjärden Eutrophication Study (http://www2.ecology.su.se/dbHFJ/index.htm) and 8 Fjordar (http://www.8fjordar.se).

and improvement scenarios of noise and littering in the study areas. Thus the corresponding value estimates may be more sensitive to respondent-specific assessments of status quo and possible effects from proposed policy measures. In a real policy setting the transfer errors would be unknown. A minimum acceptable reliability level might best be selected by those in need of the results. Most likely it will depend on the context. Since non-market valuation is inevitably associated with uncertainty regarding value estimates, so is benefit transfer. Hence, the aim of improving benefit transfer is not necessarily perfection but rather usefulness.

Besides the focus on valid and reliable value estimates, the issue of distributional effects of environmental policies, a topic that is addressed in the third paper, is also important. The local population was found to spend more time in the study area compared to the more distant population surveyed, and they also expressed greater willingness to pay for improved water quality and less frequent cyanobacterial blooms. These findings were in line with our expectations and similar results can also be found in previous studies. However, the findings also suggest that respondents from the more distant population who have a non-Swedish origin would benefit more from implementing SCZs that would lead to less noise and littering in the study area. The limitation of this study for being able to look into the importance of background for distributional effects is the sample size. The results may indicate a difference in preferences but it may equally well be a spurious artefact in this dataset.

There are different ways of accounting for unobserved heterogeneity in choice models. Latent class modelling may be a valuable tool when distributional effects need to be highlighted. Observed socio-economic and demographic information may assist in assigning membership to the different preference classes while unobserved heterogeneity is also accounted for. The findings in the third paper indicate that familiarity with and ties to the study site are more important for preference formation than more commonly used socio-economic variables like income. This is a rather intuitive result since many people have a special connection to the place where they grew up and to their present place of residence. It should be noted that more research is needed in non-market valuation that examines possible distributional effects in both monetary terms and in terms of environmental quality.

The last part, concerning content validity of a stated preference study, has to do with choosing an appropriate statistical model on which to base inferences. This is also the topic of the fourth paper. The analysis of empirical data is an important part of a valuation study. Model formulation and model selection are essential aspects of the analysis and they merit thoughtful attention.

In the fourth paper, I propose an information-theoretic approach, based on Kullback-Leibler information, to model selection for choice experiments. Many of the approaches applied for choosing between different model specifications are based on null hypothesis significance testing using test statistics and associated P values. However, an information-theoretic approach provides a researcher with formal measures of the strength of evidence for both the null and alternative hypotheses (Burnham, Anderson and Huyvaert 2011). The findings in the paper provide indications of the importance of specifying a set of plausible candidate models based on the science of the situation. If only a few models are considered, there may be a lot of model selection uncertainty present. But how good a final chosen model will be in approximating the underlying process that generated the data will naturally depend on the model specifications available in the candidate set. The findings also indicate that great care should be taken when reporting research results, so that the empirical analysis approach becomes transparent to the readers. More reliable information is needed to ensure confidence in reported welfare estimates. Since different model specifications can have considerable effects on value estimates it will also lead to various advices for policy guidance.

5.1 Future Studies

Many marine and coastal valuation studies tend to look at changes in tangible benefits like recreation while studies that examine changes in more intangible benefits derived from the functioning and resilience of these ecosystems are mostly missing. But sound water protection and management requires a comprehensive assessment of the characteristics and functioning of marine and coastal ecosystems, thus warranting additional research. While this thesis focuses on the benefits of reducing eutrophication effects and implementing special consideration zones in coastal areas, there is limited knowledge of the benefits of achieving a good environmental status with regard to many other descriptors in the EU Marine Strategy Framework Directive, such as biological diversity, sea-floor integrity and non-indigenous species. Value estimates for these ecosystem services are also needed in order to obtain a truly holistic approach to ecosystem assessments and management.

Concerning choice experiment modelling, it is common to base inferences on a single or a few models. It would be interesting to examine multimodel inference approaches, in the meaning of basing inferences on several plausible models, since it is reasonable that more than one model can serve almost equally well in approximating the information from a sampled population. This approach might also be appropriate for benefit transfer.

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Acknowledgements

First of all I would like to thank my main supervisor Göran Bostedt for generously sharing your knowledge with me. You have always had time for me and I truly appreciate your support and encouragement.

I am greatly thankful to my co-supervisor Cecilia Håkansson. Your support and guidance have been valuable and you have always had time to read and comment on my manuscripts.

I would also like to thank my co-supervisor Bengt Kriström for insightful comments and thoughtful advice.

My thanks also go to Anna Adevi for valuable support at a difficult time for me and for being a good friend.

I would like to thank my colleagues at CERE and the Department of Forest Economics, especially Tharshini Thangavelu and Jurate Jaraite who have become good friends of mine.

I would also like to thank the peer-reviewers of the thesis; Thomas Broberg, Jesper Stage and Camilla Widmark for valuable comments.

My family and my friends outside the academia deserve a big thank you for supporting me, especially my closest friends Linda Fjellström, Eugenia Baranda and Marie-Louise Frohm.

Thank you Mum and Dad and my dear sisters Marica and Helena for all your love and for always being there and supporting me in ways only you can do.

My most valuable support receives my greatest gratitude. Martin, for your endless love and for always believing in me. My lovely son Albin, you are truly a gift and I am so proud to be your mother.
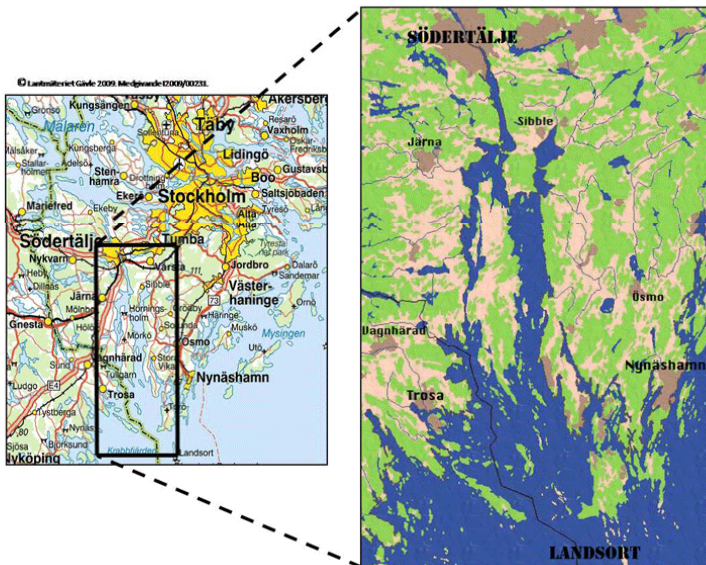

Umeå, April 2016

Katarina

Appendix. The English Translation of the Valuation Surveys

This is the English translation of the survey version for the east coast. The formatting of the survey presented here is somewhat different than in the original survey since it was presented as a web-based questionnaire, but the pictures and the text are the same. Since the west coast survey looked almost the same, it is not presented here in its entirety but rather the parts that were specific to that survey version.

An improved coast- and archipelago environment – what does it mean to <u>you</u>?

Hello! You have, together with approximately 1500 other inhabitants of the southern part of the county of Stockholm and the eastern parts of the county of Södermanland, been chosen to get this survey. The survey is, among other things, about what it means to you to have a coast- and archipelago environment that is cleaner with less noise.

The survey is aimed at the water areas between Södertälje and Landsort. Even if you don't usually visit these areas, it is important that we get your answers to the questions in the survey.

The survey is part of a research project lead by the Swedish University of Agricultural Sciences and financed by the Environmental Protection Agency. You can read more about the research project on the following webpage: http://plusminus.slu.se. Here, the results of the survey will be published. The results will also be spread to e.g. authorities and decision-makers.

Please observe!

Many of the questions in the survey are about the water areas between Södertälje and Landsort, see map. But the survey is also for you who don't know or don't usually visit these areas – your answers are of equal importance for us!

If any of the questions is hard to answer exactly, try to answer with an approximation. With "the area" we mean the water areas between Södertälje and Landsort and its beaches. When you answer the questions regarding your visits to the area, please have the last 5 years in mind.

1. Do you sometimes visit the area? (yes/no)

2. How many of the days in a year do you usually visit the area, at least for a while? *Answer with an interval, days per year.*
Approximately_____to_____days

3. Did you visit the area during your childhood?
 ➢ Yes, more frequently than nowadays
 ➢ Yes, about as often as nowadays
 ➢ Yes, but less frequently than nowadays
 ➢ No

4. What parts of the area do you usually visit? Mark on the MAP which water areas and/or beaches you visit by making one or several clicks at these places.
If you chose the wrong part of the area by accident and want to restart the question, click here.

5. What do you do when you visit the area? *Choose one or several alternatives.*
- ➢ Work
- ➢ Be in the residence where I live permanently
- ➢ Be in an own holiday cottage
- ➢ Visit relatives or friends
- ➢ Be in a rented cottage
- ➢ Visit a camping (in e.g. caravan or tent)
- ➢ Sail
- ➢ Use motor boat with an engine effect of less than 10hp

- ➢ Use motor boat with an engine effect of 10hp or more
- ➢ Use jet-ski
- ➢ Water-ski
- ➢ Row or paddle
- ➢ Windsurf or surf
- ➢ Bathe
- ➢ Sunbathe
- ➢ Walk, hike or jog
- ➢ Watch birds
- ➢ Dive or snorkel
- ➢ Barbecue
- ➢ Ice-skate or ski
- ➢ Go fishing
- ➢ Other activity, state which:_____

Questions 6-9 were only showed to respondents who stated that they usually fish in the area

6. What equipment do you use when fishing in the area? *(Choose one or two alternatives)*
- ➢ Hand-held equipment (e.g. fishing rod, hand-line)
- ➢ Other equipment than hand-held (e.g. net, cage, hoop net)

7. What type of fishing do you consider yourself to mainly practice?
- ➢ Leisure fishing
- ➢ Commercial fishing

8. What type of leisure fishing do you consider yourself to mainly practice?
- ➢ Recreational fishing
- ➢ Sport fishing
- ➢ Fishing to fulfill the needs of your household

9. For how many of the days in a year do you usually go fishing in the area, at least during a while? *Answer with an interval, days per year.*
Approximately____to_____days

10. Are there any other water areas in the vicinity (less than approximately 20 minutes further off by car) except the waters between Södertälje and Landsort that you visit or could equally well visit?
- ➢ No

> Yes, 1-2 areas
> Yes, 3-5 areas
> Yes, more than 5 areas

THE COASTAL ENVIRONMENT TODAY
Read on the following pages about the present situation in the coastal environment regarding:
> Turbid water
> Algae blooms
> Noise and littering
After each description follows a question to be answered.

FACTS ABOUT SIGHT DEPTH
The sight depth is measured during the summer. A white disc is lowered into the water, and the depth at which it is no longer visible is registered. The perceived sight depth when bathing etc. can differ though from this result.

Turbid water:
Turbid water implies that the sight depth is low. In turbid water, the living conditions for the bladder wrack decrease. Large stands of bladder wrack are thus a sign of good water quality. Turbid water is caused by large effluents of the nutrients Nitrogen and Phosphorus.
The water quality can be divided into five classes, depending on, among other things, the sight depth and the amount of bladder wrack.
Below, you see examples of what the water looks like at different status classes. In the boxes below each picture, the requirements for each status class are described more thoroughly. You will need this info later on in order to proceed with the survey. The water quality status classes are called *very low, low, moderate, good* and *very good*.

VERY LOW:

Sight depth max 2 meters. Bladder wrack does not exist at all, or very rarely. On the other hand, fine-threaded green algae are common.

LOW:

Sight depth 2-4 meters. Bladder wrack might exist on very shallow water, very sparsely, or not at all. Fine-threaded green algae are common.

MODERATE:
Sight depth 4-6 meters. Sparse bladder wrack stands from a depth of 0,5 to 2-3 meters. Different fine-threaded algae grow on the bladder wrack. From the surface to a few meters down, green algae are dominant.

MODERATE

GOOD:
Sight depth 6-8 meters. Bladder wrack forms dense populations from a depth of 0,5 to 2-3 meters. Some brown algae grow on the bladder wrack.
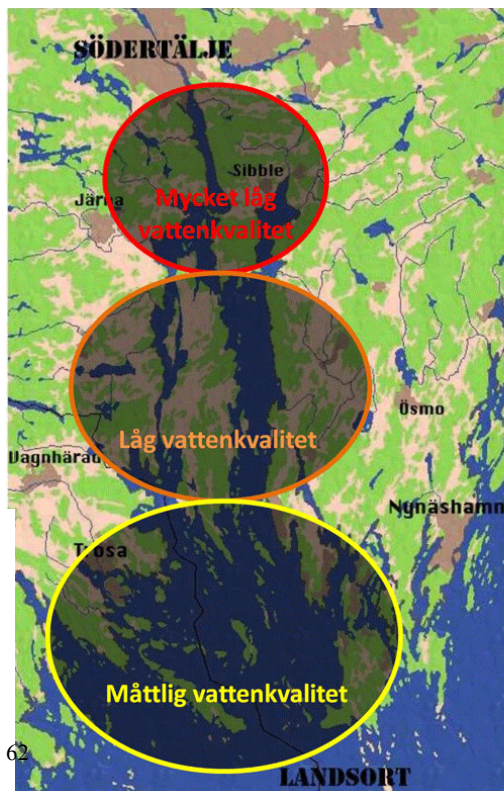

GOOD

VERY GOOD:

Sight depth more than 8 meters. Bladder wrack forms very dense populations from a depth of 0,5 to 3-4 meters.

VERY GOOD

The present water quality between Södertälje and Landsort:

On the map, the present water quality is shown in different parts of the area. "Mycket låg vattenkvalitet" = very low (red color), "Låg vattenkvalitet" = low (orange color) and "Måttlig vattenkvalitet" = moderate (yellow color), respectively.

11. Have you experienced turbid water in the coastal environment? *Choose one or several alternatives:*
  ➢ Yes, in the waters between Landsort and Södertälje
  ➢ Yes, somewhere else along the Swedish coast
  ➢ Yes, along some other coast than the Swedish
  ➢ No

Algae blooms
High concentrations of nutrients lead to blooms of blue-green algae (also called cyanobacteria). Some algae-blooms emerge in the archipelago and other in the open sea. The winds can make them drift to the beaches. Algae blooms are unpleasant when bathing, and can also cause nuisances such as itches. Some algae blooms cause toxins which are harmful to fish and other aquatic animals. They can also be harmful to pets.

The present situation in the waters between Södertälje and Landsort: Each summer, there is a high risk for ONE large scale algae bloom. Whether or not an algae bloom is striking the area between Södertälje and Landsort depends on many factors which are unpredictable. Among other things, the temperature and the winds affect this.

Foto: Magnus Dybeck

Picture: Algae bloom at Rangstabadet, Sorunda.

12. Have you experienced algae blooms in the coastal environment?
Choose one or several alternatives.

- ➢ Yes, in the waters between Landsort and Södertälje
  - ➢ Yes, somewhere else along the Swedish coast
  - ➢ Yes, along some other coast than the Swedish
  - ➢ No

Noise and littering

Some people experience that for example motor boats cause a lot of noise in the coastal environment and that people litter too much in the water and on the beaches.

The present situation between Södertälje and Landsort: The authorities have not taken any specific actions to reduce noise and littering in these water areas.

13. Have you, experienced noise and littering in the coastal environment? *Choose one or several alternatives.*
  - ➢ Yes, in the waters between Landsort and Södertälje
  - ➢ Yes, somewhere else along the Swedish coast
  - ➢ Yes, along some other coast than the Swedish
  - ➢ No

Your attitude to the coastal environment

14. How important do you think the coastal- and marine environment is, in comparison to other societal issues such as healthcare, childcare, education and the job market?
  - ➢ Much more important

> ➢ More important
> ➢ As important
> ➢ Less important
> ➢ Much less important
> ➢ Don't know

15. Do you follow what is being reported about the environmental situation in the Swedish coastal and marine areas? *Choose one or two answers.*
> ➢ Yes, through membership of an environmental organization
> ➢ Yes, through other means, namely _____
> ➢ No

16. Rank the following environmental improvements in the waters between Södertälje and Landsort by their relative importance to you. *Write 1 in front of the improvement that is the most important to you, 2 in front of the second most important, and so on.*
__ Greater sight depth and thereby more bladder wrack
__ Fewer algae blooms
__ Less noise
__ Less littering
__ Larger fish populations
__ Preserved beach protection
__ Other, namely _____
__ Other, namely _____

WHAT IS YOUR POSITION TOWARDS ACTIONS FOR A BETTER ENVIRONMENT?
With help of different actions it is possible to improve the coastal environment in the waters between Södertälje and Landsort. Below <u>two possible actions are presented that we want you to consider</u>: (1) decrease the emissions of nutrients and (2) implementing special consideration zones.
Later we will ask you to reveal whether you think it is worth to pay for the outcomes of these actions or not.

Action 1: Decrease emissions of nutrients
The problems with low water clarity and algae blooms can decrease if emissions of nutrients decrease. The waters between Södertälje and Landsort is very affected by emissions from for example the sewage treatment plant in Himmerfjärden, which is a big sewage plant that takes care of sewage from approximately 250 000 people.

Assume that in 2010, with the help of for example new technology, will be possible to decrease the emissions of nutrients from the sewage plant in Himmelfjärden as well as from other sewage plants the affects the water between Södertälje and Landsort.

For the water quality the action can given one of the following RESULT:

➢ <u>Like today</u>: No change from current water quality condition.
➢ <u>Better water quality:</u> A water quality improvement with one class in every part of the area.
➢ <u>Much better water quality:</u> A water quality improvement with two classes in every part of the area.

What will happen if actions are taken for improving the water quality?

On the map, ones more, we present the current water quality in different parts of the area ("Mycket låg vattenkvalitet" = very low, "Låg vattenkvalitet" = low, and "Måttlig vattenkvalitet" = moderate, respectively) and what will happen if the actions to improve the water quality with one and two classes, respectively, are undertaken.

<u>Current water quality in different parts of the area:</u>

VERY LOW

Sight depth, maximum 2 meters. Bladder wracks do not exist or only to a very limited extent. In contrast, filamentous macroalgae are common.

LOW

Sight depth, approximately between 2 to 4 meters. Bladder wracks can exist in very shallow waters, but grow sparse. Filamentous macroalgae are common.

MODERATE

Sight depth, approximately between 4 to 6 meters. Sparse stands of bladder wracks on 0.5 to 2-3 meters depth. The bladder wracks have overgrowth with filamentous macroalgae and from the surface to a couple of meters depth green algae dominates.

<u>If actions are taken to improve the water quality with one class:</u>

LOW

Sight depth, approximately between 2 to 4 meters. Bladder wracks can exist in very shallow waters, but grow sparse. Filamentous macroalgae are common.

MODERATE

Sight depth, approximately between 4 to 6 meters. Sparse stands of bladder wracks from 0.5 to 2-3 meters depth. The bladder wracks have overgrowth with filamentous macroalgae and from the surface to a couple of meters depth green algae dominates.

GOOD

Sight depth, approximately between 6 to 8 meters. Bladder wracks forms belts from 0.5 to 2-3 meters depth. The bladder wracks have overgrowth with brown algae.

If actions are taken to improve the water quality with two classes:

MODERATE

Sight depth, approximately between 4 to 6 meters. Sparse stands of bladder wracks from 0.5 to 2-3 meters depth. The bladder wracks have overgrowth with filamentous macroalgae and from the surface to a couple of meters depth green algae dominates.

GOOD

Sight depth, approximately between 6 to 8 meters. Bladder wracks forms belts from 0.5 to 2-3 meters depth. The bladder wracks have overgrowth with brown algae.

VERY GOOD

Sight dept, larger than 8 meters. Bladder wracks form thick belts from 0.5 to 3-4 meters depth.

panel

Supported by Norstat

Åtgärd 1, minska utsläpp av näringsämnen

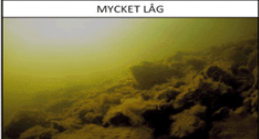Vad händer om åtgärder införs för att förbättra vattenkvaliteten?

Utvecklingen till följd av en kvalitetsförbättring, TVÅ KLASSER

Nuvarande vattenkvalitet

Om åtgärder genomförs som förbättrar vattenkvaliteten en klass
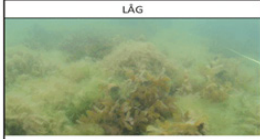
Om åtgärder genomförs som förbättrar vattenkvaliteten två klasser

MYCKET LÅG

Siktdjup högst 2 meter. Blåstång finns inte alls eller bara undantagsvis. Däremot är fintrådiga gröna alger vanliga.   Foto: Jerker Lokrantz
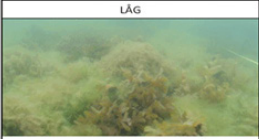
LÅG

Siktdjup ca 2-4 meter. Blåstång finns mycket grunt och i glesa bestånd eller är helt försvunnen. Fintrådiga grönalger är vanliga.   Foto: Anders Wallin

MÅTTLIG

Siktdjup ca 4-6 meter. Glesa bestånd av blåstång från 0,5 till 2-3 meters djup. Tångplantorna har påväxt av olika fintrådiga alger. Från ytan och några meter ner dominerar grönalger.   Foto: Robert Kautsky

LÅG

Siktdjup ca 2-4 meter. Blåstång finns mycket grunt och i glesa bestånd eller är helt försvunnen. Fintrådiga grönalger är vanliga.   Foto: Anders Wallin

MÅTTLIG

Siktdjup ca 4-6 meter. Glesa bestånd av blåstång från 0,5 till 2-3 meters djup. Tångplantorna har påväxt av olika fintrådiga alger. Från ytan och några meter ner dominerar grönalger.   Foto: Robert Kautsky

GOD

Siktdjup ca 6-8 meter. Blåstång bildar bälten från 0,5 till 2-3 meters djup. Tången har påväxt av brunalger.   Foto: Jerker Lokrantz
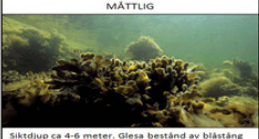
MÅTTLIG

Siktdjup ca 4-6 meter. Glesa bestånd av blåstång från 0,5 till 2-3 meters djup. Tångplantorna har påväxt av olika fintrådiga alger. Från ytan och några meter ner dominerar grönalger.   Foto: Robert Kautsky

GOD

Siktdjup ca 6-8 meter. Blåstång bildar bälten från 0,5 till 2-3 meters djup. Tången har påväxt av brunalger.   Foto: Jerker Lokrantz

MYCKET GOD

Siktdjup större än 8 meter. Blåstång bildar kraftiga bälten från 0,5 till 3-4 meters djup.   Foto: Forststyrelsen, 2005

<< >>

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Action 1, Decrease emissions of nutrients
Regarding algae blooms we can expect the action to have one of the following effects:

➢ <u>Like today:</u> No change from current situation, i.e. high risk for one large scale algae bloom every summer.

- ➢ Every third summer: High risk for one large scale algae bloom every third summer.
- ➢ Every tenth summer: High risk for one large scale algae bloom every tenth summer.

Facts about sight depth and algae blooms: Blue green algae/cyanobacteria have the ability to some extent to compensate for reductions in emissions of nutrients by using the nitrogen in the atmosphere. Because of this, it is not certain that we can achieve improved sight depth and less algae blooms at the same time.
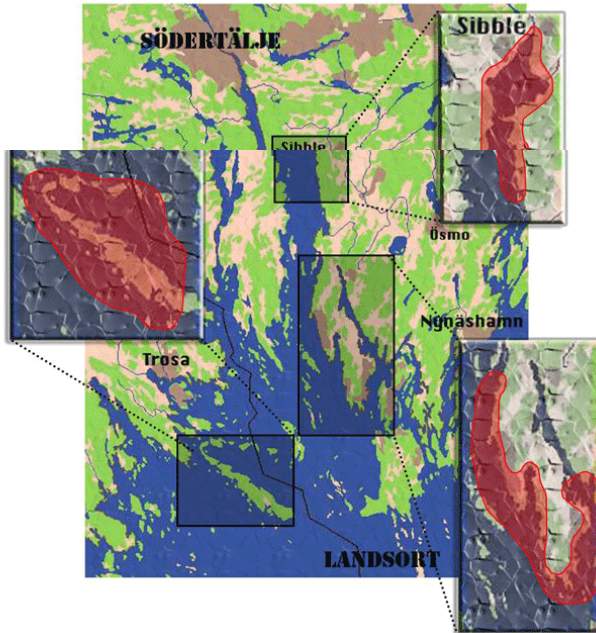Also assume the following:
- ➢ The actions will start to get an effect after 1-3 years
- ➢ The results of the actions will mainly be in the waters between Södertälje and Landsort. The effects of the actions in other marine areas will be very small
- ➢ If no actions are undertaken the situation will remain as today

Action 2, Introduction of special consideration zones
In a special consideration zone the visitors are encouraged to:
- ➢ Keep low speed, maximum 5 knots
- ➢ Use the engine as little as possible and avoid leaving the engine running
- ➢ Not drive jolly boats or rubber boats with outboard engine (if not necessary)
- ➢ Avoid to drive jet-skis or to do other noisy water activities
- ➢ Not play loud music
- ➢ Not cause swells for anchored boats or for people that are swimming
- ➢ Not litter
- ➢ Not discharge sewage into the water

In connection to that the special consideration zones are established, collection points for recycling will be set out. Also, possibilities to take care of sewage will be arranged.

Assume that in 2010 it is possible to introduce three special consideration zones in the waters between Södertälje and Landsort at the locations marked on the MAP.
Three special consideration zones are introduced (marked in red).

Regarding noise and littering one of the following situations can take place:
- ➢ Like today: The special consideration zones will *not* be introduced and there will therefore *not* be less noise and littering in the area. The situation will basically be the same as today.
- ➢ Less noise and littering: The special consideration zones will be introduced and hence there will be less noise and littering in the area. The special consideration zones will be working according to plan after 1-3 years

17. What is your position towards introducing three special consideration zones as presented on the map?
- ➢ Very positive
- ➢ Positive
- ➢ Do not know/have not yet decided
- ➢ Negative
- ➢ Very negative

Financing of decreased emissions and special consideration zones (action 1 and 2)
Assume that the actions will be financed by the inhabitants in Stockholm county and Södermanland county during the years 2010-2029. The money will be collected through a fee to a public fund. The money will be earmarked for these actions. The actions will be carried out if the benefits of doing so can be estimated to be larger than the costs.

How would you choose between different alternatives?
Above we presented how the actions can give different results in the waters between Södertälje and Landsort. On the following six pages you will be asked to choose between three different alternatives (A, B and C). Alternative A is always equal to the current situation, that is, no fee and no actions. Alternative B and C consist of different results of the actions and a fee that your household would have to pay every month between 2010 and 2029.

- ➢ You should imagine that you have the possibility to choose between these alternative. Mark the alternative that you would choose.
- ➢ You should make the six chooses independently of each other. For example, when you make choice number 2, you should not compare it with choice number 1.
- ➢ When you make your choices, assume that nothing else changes, besides the changes that are presented in the alternatives. That is, do only consider the changes that are presented to you.
- ➢ We have used a special method for varying the size of the fee and the results in the alternatives. Sometimes the size of the fee may vary in a way that you consider to be unrealistic. Even if this is the case, we ask you to choose alternative based on the fees presented in the alternatives. In this manner you help us to understand what you value and what you find important.
- ➢ Experience from earlier studies show that people sometimes tend to answer one thing, but in reality they would act differently. For example, some people might state that they are willing to pay a lower amount than they are actually willing to pay, for example 0 SEK. We believe that one reason for this behavior is that some people might think that they have the right to good water quality. Other people might state that they are willing to pay a higher amount than they are actually willing to pay. We do not want you to think in this manner when you answer our questions. We want you to reveal your true willingness to pay. There are probably other reasons to why some people do not reveal their true willingness to pay. If you have any thoughts regarding this issue, please, write them in the end of the questionnaire.

The respondents were presented with six choice questions each. An example of such a question follows below.

18. Which of the alternatives below would you choose? *If you want to see the pictures of the different water qualities again klick <u>Here</u>.*

	Alternative 1A	Alternative 1B	Alternative 1C
Water quality	Like today	Like today	1 class improvement
Algae blooms	Like today	Every 10th summer	Like today
Noise and littering	Like today	Like today	Less noise and littering
Cost	0 SEK/month	20 SEK/month	100 SEK/month

- ➢ I would choose alternative 1A
- ➢ I would choose alternative 1B
- ➢ I would choose alternative 1C

Four scenarios
In the following you will be presented with four different scenarios for environmental improvements in the area. After each scenario you will be asked to answer two questions.

Scenario 1

Water quality	2 classes improvement
Algae blooms	Like today
Noise and littering	Like today

24. If scenario 1 would become real, would it affect your frequency of visits to the area compared to your answer to question 1: "About 25-45 days per year"?
- ➢ Yes, I would visit the area more often
- ➢ Yes, I would visit the area more seldom
- ➢ No, it would not affect my number of visits

25. How many more days, compared to your previous answer (about 25-30 days per year) would you visit the area if scenario 1 became real? *Answer with an interval, number of more days per year.* Approximately____to_____days

26. Would you be willing to pay for measures that will lead to scenario 1? (Yes/no)

27. How much would you be willing to pay for measures that will lead to scenario 1? *We know from previous surveys that many are unsure about their willingness to pay, but please try to respond as well as you can (answer with*

an interval). SEK per month to be payed by my household during the years 2010-2029 that will lead to scenario 1. Between____and____

Scenario 2

Water quality	Like today
Algae blooms	Every 10th summer
Noise and littering	Like today

28. If scenario 2 would become real, would if affect your frequency of visits to the area compared to your answer to question 1? "About 25-45 days per year".
  ➢ Yes, I would visit the area more often
  ➢ Yes, I would visit the area more seldom
  ➢ No, it would not affect my number of visits

29. How many more days, compared to your previous answer (about 25-30 days per year) would you visit the area if scenario 2 became real? *Answer with an interval, number of more days per year.* Approximately____to_____days

30. Would you be willing to pay for measures that will lead to scenario 2? (Yes/no)

31. How much would you be willing to pay for measures that will lead to scenario 2? *We know from previous surveys that many are unsure about their willingness to pay, but please try to respond as well as you can (answer with an interval).* SEK per month to be payed by my household during the years 2010-2029 that will lead to scenario 2. Between____and____

Scenario 3

Water quality	Like today
Algae blooms	Like today
Noise and littering	Less noise and littering

32. If scenario 3 would become real, would if affect your frequency of visits to the area compared to your answer to question 1? "About 25-45 days per year".
  ➢ Yes, I would visit the area more often
  ➢ Yes, I would visit the area more seldom
  ➢ No, it would not affect my number of visits

33. How many more days, compared to your previous answer (about 25-30 days per year) would you visit the area if scenario 3 became real? *Answer with an interval, number of more days per year.* Approximately____to_____days

34. Would you be willing to pay for measures that will lead to scenario 3? (Yes/no)

35. How much would you be willing to pay for measures that will lead to scenario 3? *We know from previous surveys that many are unsure about their willingness to pay, but please try to respond as well as you can (answer with an interval).* SEK per month to be payed by my household during the years 2010-2029 that will lead to scenario 3. Between____and____

Scenario 4

Water quality	2 classes improvement
Algae blooms	Every 10th summer
Noise and littering	Less noise and littering

36. If scenario 4 would become real, would if affect your frequency of visits to the area compared to your answer to question 1? "About 25-45 days per year".
- ➢ Yes, I would visit the area more often
- ➢ Yes, I would visit the area more seldom
- ➢ No, it would not affect my number of visits

37. How many more days, compared to your previous answer (about 25-30 days per year) would you visit the area if scenario 4 became real? *Answer with an interval, number of more days per year.* Approximately____to_____days

38. Would you be willing to pay for measures that will lead to scenario 4? (Yes/no)

39. How much would you be willing to pay for measures that will lead to scenario 4? *We know from previous surveys that many are unsure about their willingness to pay, but please try to respond as well as you can (answer with an interval).* SEK per month to be payed by my household during the years 2010-2029 that will lead to scenario 4. Between____and____

40. Refer to your previous responses in the survey. Were you willing or not willing to pay for reduced pollution and/or the implementation of special consideration zones?
- ➢ I was always willing to pay.
- ➢ I was never willing to pay.
- ➢ I was willing to pay in some cases but not in other cases.

41. Why were you willing to pay for these measures? *Mark the responses that suites you the best.*
- ➢ My own nature- and recreation experiences in the water areas

- ➢ Other people, now living, can enjoy the water areas
- ➢ For the sake of the coastal environment
- ➢ Future generations can be able to enjoy the water areas
- ➢ The coastal environment is a supplier of food
- ➢ Other motives, namely____

42. Why were you not willing to pay for these measures? *Mark the responses that suites you the best.*
- ➢ There is no need for special consideration zones
- ➢ The current water quality level is acceptable
- ➢ The current situation regarding algal blooms is acceptable
- ➢ It is wrong that I should have to pay
- ➢ The measures do not seem believable
- ➢ The costs should be covered by existing taxes
- ➢ I cannot afford to pay
- ➢ The water areas of the study are of no interest to me
- ➢ I have received too little information
- ➢ Other motives, namely___

Concluding general questions

43. State your gender
- ➢ Female
- ➢ Male

44. What year were you born?

45. In what country were you born?
- ➢ Sweden
- ➢ Another country, namely___

46. In what country was your mother born?
- ➢ Sweden
- ➢ Another country, namely___

47. In what country was your father born?
- ➢ Sweden
- ➢ Another country, namely___

48. Where do you live today?
- ➢ In the countryside or in a district with less than 200 residents
- ➢ In a district with 200-10000 inhabitants

> ➢ In a district with 10001-50000 inhabitants
> ➢ In a district with 50001-180000 inhabitants
> ➢ In the municipality of Stockholm

49. How many people live in your household?
> ➢ Number of children 0-12 years old___
> ➢ Number of adolescents 13-17 years old___
> ➢ Number of adults, 18 years or older (don't forget to include yourself!)___

50. What is your highest level of education?
> ➢ Compulsory school
> ➢ Vocational training
> ➢ High school
> ➢ University

51. Approximately what is <u>your household's</u> total income per month <u>after taxes</u>? Include all sources of income including child benefits, unemployment benefits, study allowances, pensions etc. Write the amount or mark a box. *N.B if the household consists of more than one adult. Be sure to specify the household's total income and not just your own. Write the amount or chose one of the pre-specified answers.*
> ➢ Write___
> ➢ Less than SEK 10000.
> ➢ 10 000 – 19 999 SEK
> ➢ 20 000 – 29 999 SEK
> ➢ 30 000 – 39 999 SEK
> ➢ 40 000 – 49 999 SEK
> ➢ 50 000 – 59 999 SEK
> ➢ 60 000 – 69 999 SEK
> ➢ 70 000 – 79 999 SEK
> ➢ 80 000 SEK or more

52. If you have any comments or suggestions, please write them here.

****

Presented below are the information and questions from the west coast survey that differed from the east coast survey.

THE COASTAL ENVIRONMENT TODAY
Read on the following pages about the present situation in the coastal environment regarding:

> ➤ Reduced fish populations
> ➤ Turbid water and algae mats
> ➤ Noise and littering

After each description follows a question to be answered.

Reduced fish populations

The present situation for the waters inside of Orust and Tjörn: Populations of popular species such as plaice and cod have diminished during the last decades, among other things as an effect of general environmental pressures and overfishing.

11. Have you experienced reduced fish populations? *Choose one or several alternatives:*
> ➤ Yes, in the waters inside of Orust and Tjörn
> ➤ Yes, somewhere else along the Swedish coast
> ➤ Yes, along some other coast than the Swedish
> ➤ No

Turbid water and algae mats

Turbid water means that the sight depth is low. In combination with turbid water, algae mats may be common on sea beds and along the beaches, which among other things affects the possibility to fish and bathe. *Picture: Algae mats in shallow bays.*

Algae mats are caused by fine-threaded algae which grow on the bottom of shallow bays. The presence of fine-threaded algae is favored by human's effluents of nutrients, and therefore the algae mats become more common and more abundant when there are much effluents.

Turbid water and algae mats are caused by large effluents of the nutrients Nitrogen and Phosphorus. In more turbid water, bladder wrack and eelgrass has worse living conditions. Large stands of bladder wrack and eelgrass are thus signs of good water quality.

The water quality can be divided into five classes, depending on, among other things, the sight depth and the amount of algae mats.

Below, you see examples of what the water looks like at different status classes. In the boxes below each picture, the requirements for each status class are described more thoroughly. You will need this info later on in order to proceed with the survey. The water quality status classes are called *very low, low, moderate, good* and *very good*.

The respondents were then shown the same pictures of water quality status classes as presented in the east coast survey.

VERY LOW:
Sight depth max 2,5 meters. Bladder wrack does not exist at all, or very rarely. The environment is very poor in species. Drifting algae mats are common.

LOW:
Sight depth 2,5-3,5 meters. Bladder wrack might exist on very shallow water, very sparsely, or not at all. Drifting algae mats can be common.
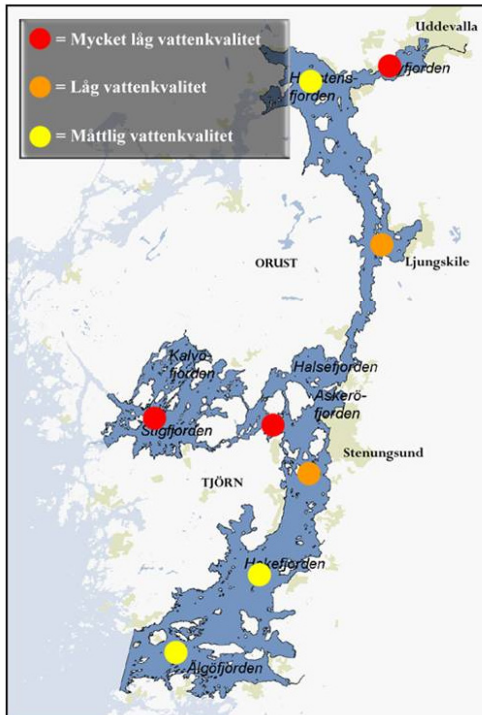
MODERATE:
Sight depth 3,5-5 meters. Sparse bladder wrack stands from a depth of 0,5 to 2-3 meters. Different fine-threaded algae grow on the bladder wrack. Drifting algae mats are uncommon.

GOOD:
Sight depth 5-6,5 meters. Bladder wrack forms dense populations. Some brown algae might grow on the bladder wrack. There are no algae mats.

VERY GOOD:
Sight depth more than 6,5 meters. Bladder wrack forms dense populations. No growth of fine-threaded algae on the bladder wrack. There are no drifting algae mats.

The present water quality inside Orust and Tjörn:

On the map, the present water quality is shown in some example areas. "Mycket låg vattenkvalitet" = Very low (red color),"Låg vattenkvalitet" = low (orange color) and"Måttlig vattenkvalitet" = moderate (yellow color), respectively.

What is your position towards actions for a better environment?

With help of different actions it is possible to improve the coastal environment in the waters inside Orust and Tjörn. Below three possible actions are presented that we want you to consider: (1) regulating fishing (2) decrease the emissions of nutrients and (3) implementing special consideration zones. You will be asked to evaluate different actions for regulating fishing. Regarding decreased emissions of nutrients and special consideration zones, you will be asked to evaluate the results from possible actions and whether it is worth the cost of implementing them.

Action 1: Regulated fishing
The fish stocks are expected to recover if actions are made to regulate the fishing. These actions could be of various kinds, but they would affect both anglers and professional fishermen.
17. What do you think about the following statements? (Very negative / Negative / Do not know / Have not yet decided / Positive / Very positive)
  ➢ Fishing should not be allowed during certain periods of the year
  ➢ Fishing should not be allowed in certain areas
  ➢ Fishing with some equipment should not be allowed
  ➢ Fishing quotas (only allowed to catch a certain amount of fish per day/week)
  ➢ Fishing fee (fee for sport fishing, recreational angling and fishing for household use only)

Action 2: Reduced emission of nutrients
Problems with water clarity and algae mats can decrease if the emissions of nutrients are reduced. The waters inside of Orust and Tjörn are very affected by emissions from example sewage plants owned by the municipalities in the area.
Assume that in 2010 with for example new technology will be possible to reduce the emissions from the municipalities'' sewage plants in the waters inside of Orust and Tjörn.
For water quality, actions will lead to one of the following RESULTS:
  ➢ Like today: No difference from the current situation.
  ➢ Improved water quality: The water quality is improved with one class in every part of the area.
  ➢ Very improved water quality: The water quality is improved with two classes in every part of the area.

What happens if actions for improving the water quality are implemented?
Here are pictures presented, ones more, that show the water quality in some example areas. To the right of the map the requirements for each status class are described.
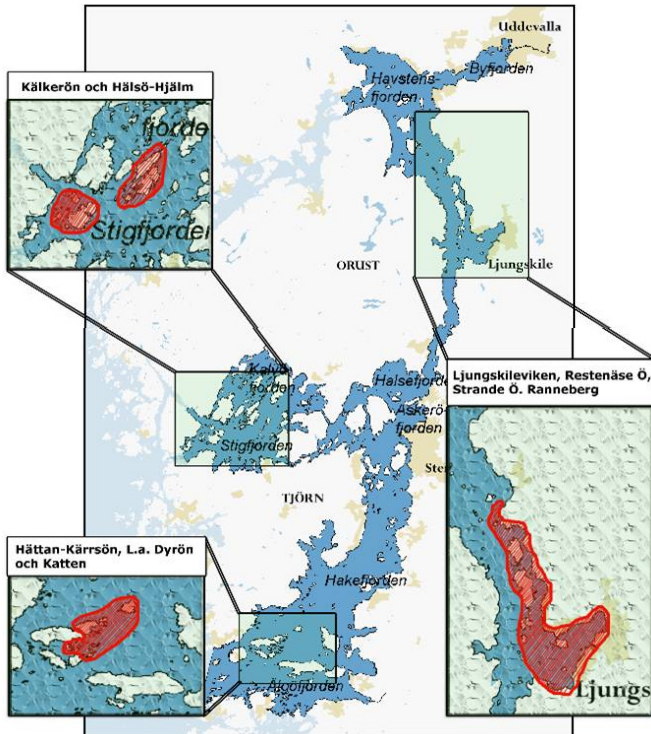
Action 3: Introduction of special consideration zones
Assume that in 2010 it is possible to introduce three special consideration zones in the waters inside of Orust and Tjörn at the locations marked on the MAP.
Three special consideration zones are introduced (marked in red).
Regarding noise and littering one of the following situations can take place:

> ➢ Like today: The special consideration zones will *not* be introduced and there will therefore *not* be less noise and littering in the area. The situation will basically be the same as today.
> ➢ Less noise and littering: The special consideration zones will be introduced and hence there will be less noise and littering in the area. The special consideration zones will be working according to plan after 1-3 year

The respondents in the west coast survey were presented with seven choice questions each. An example of such a question follows below.

19. Which of the alternatives below would you choose? *If you want to see the pictures of the different water qualities again klick Here.*

	Alternative 1A	Alternative 1B	Alternative 1C
Water quality	Like today	2 classes improvement	Like today

Noise and littering	Like today	Like today	Less noise and littering
Cost	0 SEK/month	20 SEK/month	100 SEK/month

> ➢ I would choose alternative 1A
> ➢ I would choose alternative 1B
> ➢ I would choose alternative 1C

Three scenarios
In the following you will be presented with three different scenarios for environmental improvements in the area. After each scenario you will be asked to answer two questions.

Scenario 1

Water quality	2 classes improvement
Noise and littering	Like today

26. If scenario 1 would become real, would if affect your frequency of visits to the area compared to your answer to question 1: "About 25-45 days per year"?
> ➢ Yes, I would visit the area more often
> ➢ Yes, I would visit the area more seldo.
> ➢ No, it would not affect my number of visits

27. How many more days, compared to your previous answer (about 25-30 days per year) would you visit the area if scenario 1 became real? *Answer with an interval, number of more days per year.* Approximately____to____days

28. Would you be willing to pay for measures that will lead to scenario 1? (Yes/no)

29. How much would you be willing to pay for measures that will lead to scenario 1? *We know from previous surveys that many are unsure about their willingness to pay, but please try to respond as well as you can (answer with an interval).* SEK per month to be payed by my household during the years 2010-2029 that will lead to scenario 1. Between____and____

Scenario 2

Water quality	Like today
Noise and littering	Less noise and littering

30. If scenario 2 would become real, would if affect your frequency of visits to the area compared to your answer to question 1? "About 25-45 days per year".
- ➢ Yes, I would visit the area more often
- ➢ Yes, I would visit the area more seldom
- ➢ No, it would not affect my number of visits

31. How many more days, compared to your previous answer (about 25-30 days per year) would you visit the area if scenario 2 became real? *Answer with an interval, number of more days per year.* Approximately____to____days

32. Would you be willing to pay for measures that will lead to scenario 2? (Yes/no)

33. How much would you be willing to pay for measures that will lead to scenario 2? *We know from previous surveys that many are unsure about their willingness to pay, but please try to respond as well as you can (answer with an interval).* SEK per month to be payed by my household during the years 2010-2029 that will lead to scenario 2. Between____and____

Scenario 3

Water quality   2 classes improvement
Noise and littering   Less noise and littering

34. If scenario 3 would become real, would if affect your frequency of visits to the area compared to your answer to question 1? "About 25-45 days per year".
- ➢ Yes, I would visit the area more often
- ➢ Yes, I would visit the area more seldom
- ➢ No, it would not affect my number of visits

35. How many more days, compared to your previous answer (about 25-30 days per year) would you visit the area if scenario 3 became real? *Answer with an interval, number of more days per year.* Approximately____to____days

36. Would you be willing to pay for measures that will lead to scenario 3? (Yes/no)

37. How much would you be willing to pay for measures that will lead to scenario 3? *We know from previous surveys that many are unsure about their*

willingness to pay, but please try to respond as well as you can (answer with an interval). SEK per month to be payed by my household during the years 2010-2029 that will lead to scenario 3. Between____and____