



Using a novel survey technique to predict fisheries stakeholders' support for European eel (*Anguilla anguilla* L.) conservation programs

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ABSTRACT

A novel variation of a multivariate stated preference method (the maximum difference conjoint approach) is presented in a survey designed to elicit the preferences of a fisheries stakeholder group (recreational anglers fishing in northern Germany) for a portfolio of measures to conserve European eel (*Anguilla anguilla* L.). Unlike other survey methods, our approach allows the separation of weight (i.e., relative importance of different conservation actions) and scale (i.e., perceived utility associated with different levels within one action) ascribed by stakeholders to conservation measures. The method also allows for trade-off decision-making and joint preference articulation for various conservation actions, and thus provides more realistic decision situations than other survey methods can achieve. We found that anglers prefer tighter than current eel fishing regulations but object to highly restrictive temporal closures. Confronted with an integrated eel conservation program, anglers were overwhelmingly willing to compromise, accepting tighter angling regulations provided that other sources of eel mortality are regulated concomitantly and eel stocking increased. Willingness to accept stricter regulation increased further when the suite of regulations delivered success in terms of increased eel escapement. We encourage the replication of the presented survey technique with other eel stakeholders groups, but also in other conservation contexts, to see if similar patterns of response behaviour emerge that would not have been visible in traditional opinion-type preference assessments. Our results suggest that implementation of eel conservation policies should consider joint regulation of sectors that potentially affect eel stock negatively. Otherwise, management failure and conflict is likely.

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1. Introduction

1.1. The need for quantitative surveys to help conservation planning

Many issues in conservation management require consideration of both ecological and societal issues (Groom et al., 2006; Carpenter et al., 2009). Understanding the social aspects of conservation planning such as the willingness of different stakeholders to participate in conservation programs is particularly important when (1) an urgency for conservation action exists, (2) the biological mechanisms about a natural resource decline are unclear resulting in uncertainty about the success of conservation actions, and (3) a high social and economic importance is associated with the resource. The latter two points facilitate that stakeholders are less

prepared to accept personal restrictions on exploitation (Granek et al., 2008). In these situations, neglecting the views (i.e., attitudes and values) of affected stakeholders can, and most likely will, result in opposition to tight conservation measures (Stoll-Kleemann, 2001a,b), rule-breaking behaviour (Salz and Loomis, 2005), loss of management credibility (Arlinghaus, 2005), and collectively, failure of conservation policies.

While most modern conservation planning processes account for the perceptions of various stakeholders via formal participatory processes or public hearings, quantitative social science methods can unravel the preferences and attitudes of diffusely organized stakeholder groups providing decision-makers an objective view on stakeholder's attitudes towards conservation programs (e.g., Arlinghaus and Mehner, 2005; Cooke et al., 2009). This can add credibility when establishing conservation policies and generally improve conservation management planning by for example proactively predicting conflicts.

When conservation issues become socially and biologically complex (e.g., migrating species affected by multiple anthropogenic

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factors) assessing stakeholder preferences for particular conservation measures may require multivariate modeling approaches (Cooke et al., 2009), in which a large sample of survey participants are asked to trade-off between multiple management tools. Results of such studies lead to predictive integrative models (Cooke et al., 2009). Layers of complexity arise around divergent preferences between different stakeholders as well as stakeholders' perceptions of strategies that are appropriate to other stakeholder groups. Unraveling this complexity in quantitative surveys is challenging, yet possible with novel quantitative survey approaches.

1.2. The context of eel (*Anguilla anguilla*) conservation

An urgent resource conservation issue that shares the characteristics expounded above currently exists around the catadromous European eel (*Anguilla anguilla*), which is an economically and culturally important fishery resource throughout Europe (Feunteun, 2002; Ringuet et al., 2002). Recently, the panmictic eel population (Dannewitz et al., 2005) has dramatically declined (Dekker, 2008). A range of potential causes have been discussed, including oceanic-climatic factors, overexploitation, pollution, parasite infection, predation by piscivorous birds, obstacles to migration (e.g., hydropower plants), and habitat loss (Feunteun, 2002; FAO and ICES, 2007; Dekker, 2008). These factors act simultaneously, and their relative contribution to the eel decline is unknown (Starkie, 2003). This biological uncertainty hampers identification of effective eel conservation actions. However, the socio-economic and cultural importance of this species for many commercial fisheries and the recreational fishery in Europe also need to be considered in conservation programs to balance biological and socio-economic management objectives (Bevacqua et al., 2007). Conserving the European eel population at a Pan-European scale involving multiple stakeholders and nations hence constitutes a considerable challenge given the large uncertainty about the causes of the decline and the conflicting interests of various stakeholders in different life-stages of eel across Europe (Ringuet et al., 2002).

Various political initiatives have been undertaken to halt the eel decline. The European eel was recently included in the IUCN (International Union for Conservation of Nature) red list as critically endangered (Freyhof and Kottelat, 2008). In 2007, the European eel was also listed by CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) to control its international trade. In the same year, the European Union (EU) adopted an eel recovery action plan (EC, 2007), requiring each member state to develop eel management plans at a river basin scale to guarantee the escapement of adult silver eels (mature life stage) at a rate of 40% relative to undisturbed conditions. If no management plan was submitted for approval to the European Commission (EC) by the end of 2008, temporal closures on eel fishing could be implemented, endangering the livelihood of many small-scale inland fisheries in Europe (Bevacqua et al., 2007).

Most recent studies on eel conservation across Europe have had a biological focus, largely ignoring the social, psychological and cultural dimensions of eel conservation. However, as discussed above, by taking the human factor into account, eel managers could more easily implement measures that agree with the preference structure of stakeholders or alternatively react proactively if opposition to biologically needed intervention is identified.

Unfortunately, no scientifically robust information exists on the preferences for eel conservation measures by any stakeholder group (e.g., fishery sector, conservationists) anywhere in Europe, leaving eel conservation managers with subjective "gut feelings" about the views of various stakeholder groups. One of the most important, yet constantly undervalued (Arlinghaus et al., 2002; Lewin et al., 2006), user group of eel in Europe are recreational anglers (Dorow

and Arlinghaus, 2008; ICES, 2008). As a vocal stakeholder group, anglers are instrumental in supporting conservation in aquatic habitats in general (Granek et al., 2008), and the EU eel recovery legislation (EC, 2007) explicitly requests consideration of recreational eel harvest in the design of eel management plans.

Given that the recreational take of eel can be substantial (Dorow and Arlinghaus, 2009; ICES, 2008), understanding eel anglers' preferences for conservation measures can help identify management actions that both contribute to eel conservation and also receive the support of recreational fishers. Two different types of management-related preference questions emerge: preferences for management of recreational eel fishing, and preferences for the control of other potential sources of eel mortality. Traditionally, human dimensions research has assessed stakeholder preferences with opinion-type questions using Likert-scales, wherein each action is evaluated independent of all other options (Aas et al., 2000). To consider the much more realistic trade-offs that stakeholders are willing to make between individual management tools, one requires a multivariate approach, because traditional attitudinal measurements cannot capture such trade-offs (Aas et al., 2000; Oh et al., 2005).

To solve this challenge, multi-attribute survey research techniques such as conjoint and discrete choice experiments are advisable (Aas et al., 2000; Oh et al., 2005). In these approaches, respondents are forced into making trade-offs by evaluating an entire scenario described by several management measures, each measure providing essential context for the whole, adding realism to the task and thereby contributing to the reliability and validity of the results. Multi-attribute survey techniques also allow predictive modeling of stakeholders' support for future management policies (Oh et al., 2005), thus providing crucial information for integrative models (Cooke et al., 2009) and proactive decision-making.

1.3. Objectives

The objectives of this study were twofold. The first general methodological aim was to test an innovative survey design that forces the participants to make trade-offs decisions between possible conservation tools and policies and that may be applied in other complex conservation problems where preferences of one or several stakeholder groups need to be estimated for solving contentious conservation issues. This approach allowed the separate estimation of weight (=importance given by the stakeholders to a particular management action or policy) and scale (=importance given to variation within each management action or policy). The second more specific aim was to assess the preferences of recreational anglers for a suite of eel conservation measures so as to inform European eel conservation planning.

2. Methods

2.1. Study area

We studied angler preferences for possible eel management actions in the German State of Mecklenburg-Vorpommern (M-V), north-eastern Germany. Eels are found in all running and most standing waters as well as in the coastal area of M-V, and they are exploited by both commercial and recreational fisheries. In 2007, the commercial eel landings amounted to approximately 136 t in M-V. In Germany and elsewhere in Europe as in France, Poland and The Netherlands, eel is also targeted by recreational anglers because it is highly valued for personal consumption (ICES, 2008). Nearly 50% of all resident anglers ($N = 153,000$) in the study area targeted eel at least once during the 2006 season (Dorow

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