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Estimating non-compliance among recreational fishers: Insights into factors affecting the usefulness of the Randomized Response and Item Count Techniques

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ABSTRACT

Non-compliance with fishing regulations has a critical influence on the success of the associated management regime. Yet, estimating the extent of non-compliance is challenging in part because of the sensitive nature of the subject and direct questioning is likely to result in low estimates. This study tested the effectiveness of two indirect methods, Randomized Response Technique (RRT) and Item Count Technique (ICT), in providing higher and more accurate estimates of recreational fishing non-compliance than traditional direct questioning (DQ) in the Marlborough Sounds blue cod fishery, New Zealand. Although RRT provided a higher non-compliance estimate than ICT and DQ for one of the three regulations (size limit), ICT failed to provide a higher estimate than DQ for any of the three regulations. We suggest that the online mode of the survey, behaviour frequency and question sensitivity (although not measured) had a strong influence on our findings. The version of RRT used, offering increased privacy protection for respondents, is also likely to have contributed to its performance against ICT. This study is the first to use the same sample population for all methods, eliminating potentially confounding socio-demographic factors and providing more confidence in attributing differences to the method used.

1. Introduction

1.1. Measuring and monitoring non-compliance

Non-compliance with conservation regulations has become a significant problem worldwide (Eliason, 1999; Gavin et al., 2009). It threatens conservation efforts (Bose and Crees-Morris, 2009), contributes to over-exploitation of natural resources, hinders the recovery of both biological populations and ecosystems (Agnew et al., 2009), lowers genetic diversity (Whitehouse and Harley, 2001), disrupts ecosystem stability and productivity (Gubbay, 1995), and has wider consequences for food supplies (Brashares et al., 2004) and the human communities that depend on them (Pratt et al., 2004).

Fisheries are not immune to this threat (Sumaila et al., 2006), as 80% of the world's marine fish stocks are either fully exploited or overexploited (Food and Agriculture Organization of the United Nations, 2012). Illegal, unreported and unregulated (IUU) fishing is a major contributor to fisheries' collapses worldwide (United Nations General Assembly (UNGA), 2006), and IUU is often cited as one of the principal causes behind the failure of fisheries management programmes (Boonstra and Bach Dang, 2010; Sutinen et al., 1990). This non-compliance is due, at least in part, to the common property nature of the resource and the expense of monitoring and enforcing regulations (Anderson, 1989), which are often numerous and constantly changing (Jentoft, 2004).

Historically, governments and conservation organisations have been hindered by a lack of knowledge on the full extent of illegal resource use, as the number of people caught breaking the law is estimated to be only a small percentage of violators (Elffers et al., 2003). This discrepancy is important as effective management will be difficult without knowledge of the true amount of non-compliance (Smith et al., 1989). This has resulted in calls to prioritise better data collection on wildlife crimes (Wellsmith, 2011), particularly on the proportion of non-compliance and to quantify how much of the resource is being lost (Smith and Anderson, 2004). However, determining the extent of non-compliance in a fishery presents both practical and methodological challenges

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(Hønneland, 1999) due to limited data and monitoring (Gallic and Cox, 2006; Riddle, 2006). Recreational fishing also presents further challenges due to its spatial and temporal variation, the wide range of gear and practices used and the lack of reporting obligations (McCluskey and Lewison, 2008).

Information on non-compliance is often unlikely to be freely given by resource users as they may fear repercussions and/or prosecutions (Gavin et al., 2009; Keane et al., 2008; Solomon et al., 2007). Admission can also lead to either psychological consequences (e.g., guilt, shame or embarrassment) or to other consequences such as discovery and sanctions (Lee and Renzetti, 1990). In turn, asking about sensitive issues such as IUU fishing in surveys has been shown to result in high non-response rates (Tourangeau and Yan, 2007). Even with completely anonymous self-administered surveys and guarantees of anonymity, individuals would still need a high level of confidence in the confidentiality of the research to admit to the sensitive behaviour (Metzger and Dalton, 1991).

Other methods of estimating non-compliance such as field observations (Ainsworth and Pitcher, 2005), observer programs (Gubbay, 1995) and logbooks (Hatcher and Gordon, 2005) suffer from drawbacks that limit their usefulness (e.g., Gavin et al., 2009; Witmer, 2005). More recently, attention has turned to alternative ways of asking sensitive questions on self-administered surveys. Examples include randomized response (Warner, 1965), item count (Miller, 1984), nominative (Miller, 1985) and three-card (Droitcour and Larson, 2001) techniques. These techniques guarantee anonymity and also minimise the respondent's feeling of risk/level of threat associated with revealing sensitive or potentially incriminating information; thereby increasing both the response rate and reliability when including sensitive subjects on questionnaires or during interviews (Lee, 1993). Moreover, these indirect methods do not reveal sensitive behaviour at the individual level, but still allow for interpretation at the aggregate level (Fox and Tracy, 1986). Previous studies (Lensvelt-Mulders et al., 2005b) have shown the potential for these methods to elicit higher estimates of sensitive behaviours than the traditional model of direct questioning.

Here we test the effectiveness of two indirect questioning methods, the Randomized Response Technique (RRT) (Warner, 1965) and Item Count Technique (ICT) (Miller, 1984), at providing more accurate estimates of recreational fishery regulation violations when compared with traditional direct questioning. Since the introduction of these methods numerous studies have shown that both can provide significantly higher estimates of illegal resource use than direct questioning (i.e., when the individual is directly asked if they have broken a law) (e.g., Krebs et al., 2011; Solomon et al., 2007). RRT has been successfully used in the marine environment to examine non-compliance with trout fishing in the USA (Schill and Kline, 1995), abalone (*Haliotis rufescens*) collection in California (Blank and Gavin, 2009), and fly-fishing in Wales (St John et al., 2010). However, ICT has yet to be tested in the field of natural resource management, despite the pressing need to quantify wildlife crimes (Wellsmith, 2011).

Although both RRT and ICT have the advantage of their indirect approach, this is also a disadvantage because it introduces another source of random error into the responses, resulting in a larger standard error which requires a larger sample size to obtain statistically significant results (Himmelfarb, 2008). Additionally, recent studies (e.g., Tsuchiya et al., 2007) have called for further research into the characteristics, such as data collection method, method version, research subject and sensitivity, of both RRT and ICT and modifications that may influence their usefulness. To that end the present research offers useful insights into how to maximise the potential of these two indirect techniques.

1.2. Randomized Response Technique (RRT)

The Randomized Response Technique, developed by Stanley Warner (Warner, 1965) has been shown to provide higher estimates than direct questioning in multiple fields including social security fraud (Lensvelt-Mulders et al., 2005a), abortion (Abernathy et al., 1970) and illegal resource use in a National Park (Solomon et al., 2007). Although RRT still usually underestimates the proportion of the population participating in the sensitive behaviour, it often has a smaller deviation from the known proportion than direct questioning, making it a more accurate method (Lensvelt-Mulders et al., 2005b). RRT underestimation of the occurrence of a sensitive behaviour may be due to a number of possibilities, including respondents either not following the instructions or still refusing to answer the question truthfully (van der Heijden et al., 2000), respondents not fully understanding how their privacy is being protected or suspecting a trick (Clark and Desharnais, 1998), or respondents taking this method less seriously than direct questioning and not answering honestly. It has been suggested that this last possibility is especially true for 'innocent' respondents (Fox and Tracy, 1980), although a study on Dutch social security fraud found no basis for this view (Landsheer et al., 1999).

This study used the paired-alternative version of the RRT, also known as the 'two unrelated questions model' (Fox and Tracy, 1986). The respondent begins by performing a randomizing event, such as flipping a coin. She then randomly chooses one of two questions, either the sensitive question of interest or a question regarding the randomizing event (e.g., "did you see the head of the coin?"). The answer is recorded as either "yes" or "no" without revealing the question selected. The researcher can then use the probabilities of choosing the sensitive question and the outcome of the randomising event (e.g., 50% chance of seeing head of coin), along with the number of "yes" responses to estimate the number of individuals who have performed the sensitive behaviour. Because responses can never be directly linked to the respondent or sensitive question, the method encourages higher response rates and more truthful answering.

1.3. Item Count Technique (ICT)

First proposed by Miller (1984) and first formally tested by Dalton et al. (1994), ICT has mainly been used in the social sciences to investigate socially desirable attitudes, such as voter turnout (Holbrook and Krosnick, 2010b) and attitude towards immigration (Janus, 2010), as well as estimating sensitive topics such as sexually risky behaviour (LaBrie and Earleywine, 2000), sexual assault (Krebs et al., 2011) and shoplifting (Tsuchiya et al., 2007). A meta-analytical review found that ICT provided significantly higher estimates than direct questioning in 30 out of the 48 cases (Holbrook and Krosnick, 2010b).

ICT involves drafting a short list of three to five innocuous items given to half of the respondents. Although the items do not have to be related to the survey topic, doing so can be advantageous as it often makes more sense to research participants (Chaudhuri and Christofides, 2007). Respondents are asked to report only the total number of items that apply to them. Because only a number is reported, the researcher has no way of knowing which specific items applied. The other half of the respondents receives a list with the same set of items, along with an additional item about the sensitive topic, and is again instructed to provide only a total number. The difference in means of the total number of items reported from the two lists provides an estimate of the proportion of respondents engaging in the sensitive behaviour. The assumption underlying this method is that true random sampling gives two study groups that are on average statistically equivalent. Thus, any difference in

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