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RESPONSE

Seals, salmon and stakeholders: integrating knowledge to reduce biodiversity conflict

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Biodiversity conflict (*sensu* Young *et al*., 2010) is one of the fastest-growing areas in conservation biology (Dickman, 2010). Much of the work on biodiversity conflicts has focussed on terrestrial systems (e.g. Woodroffe, Thirgood & Rabinowitz, 2005) but Linnell (2011) highlights similarities across biodiversity conflicts linked to individual species whether in terrestrial or marine environments (e.g. seals and wolves). Thus, while biodiversity conflicts are characterized by their complexity and history, making each conflict unique (Young *et al*., 2010), there is likely to be a degree of commonality across management strategies particularly when considering the social factors (Dickman, 2010; Linnell, 2011).

The Moray Firth Seal Management Plan (MFSMP) is an example of a conflict management scheme that incorporates the use of lethal predator control as a management strategy (Treves & Naughton-Treves, 2005). Lethal control has served as a mitigation tool for both the ecological and social aspects of the conflict. The reduction in shooting associated with the plan has benefited the conservation of harbour seals (Thompson *et al*., 2007). The impact of lethal control of seals on salmon populations, however, is difficult to measure directly, although modelling has been used to estimate the potential effects (Butler *et al*., 2006). While the data collected in our study will allow the production of more accurate models of the impact of seals in rivers, it is unlikely to alter earlier conclusions that the impact of removing seals from larger rivers on salmon stocks and fisheries is probably small. Due, in part, to difficulties in measuring salmon populations, direct experimentation is challenging and is unlikely to be achievable in the short term. Maintaining some level of lethal control also helped to engender support for the plan with fisheries interests, whereas a ban on lethal control is likely to have alienated stakeholders and exacerbated the conflict as in some terrestrial systems (Young *et al*., 2005; Thirgood & Redpath, 2008).

In his paper, Butler (2011) contends that fishery stakeholder perceptions are a significant obstacle to moving the MFSMP forward (Butler *et al*., 2011). Subsequent research on the social outcomes (i.e. decision quality, relationships and capacity-building) of participation in the MFSMP suggests that there has been some progress in this regard (Young, 2010). Young (2010) found that the novel approach of a fisheries-led process combined with a 'local champion' enabled the integration of knowledge from all relevant stakeholders, including local fishermen and scientists, on an equal footing, which helped dispel certain deeply held beliefs, and created a better understanding of scientific research. This was evidenced by the fact that stakeholders from the fisheries industry collectively gave the highest score to the technical quality of decisions (Young, 2010). The plan was also successful in reducing the conflict between seal conservation and fisheries, which was one of its explicit objectives (Young, 2010). This does not mean that the MFSMP has been wholly successful in changing stakeholder perceptions, and we agree with Butler's (2011) emphasis on the need to continue to engage stakeholders. Indeed, Young *et al*. (2012) highlight the risk associated with the lack of continued feedback to stakeholders of scientific research and stress the need for local coordination groups capable of providing a link between researchers and local stakeholders.

While Butler (2011) suggests including stakeholders as co-researchers in future research on seal and salmon interactions, this may not be the sole means of integrating local and scientific knowledge. Our research programme has shown that, with sufficient buy-in from stakeholders, they can become actively and directly involved in the research. The collection of diet samples and the capture of seals in rivers, for example, would not have been possible without the local knowledge and assistance of fisheries interests. Such an involvement gives those stakeholders involved a feeling of ownership of the project, aiding in both the

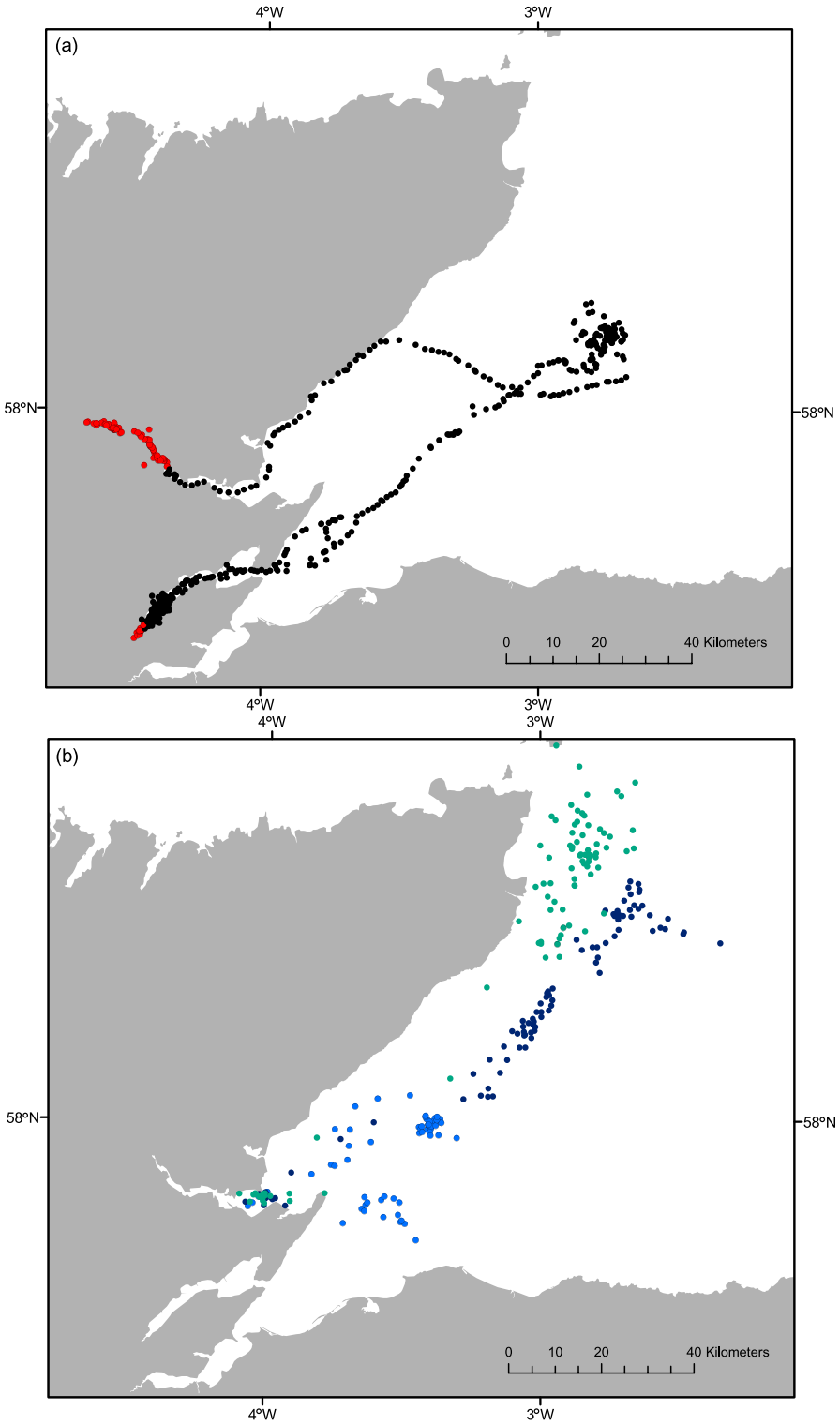

Figure 1 (a) Recorded locations 4 February–1 March 2007 of one female harbour seal (Pv.009) captured in the River Conon. Locations in red indicate in-river locations. Locations were recorded using a Global Positioning System Fastloc/Global System for Mobile Communications tag for which 95% of locations are accurate to ± 55 m (Bryant, 2007). (b) Recorded locations in February 2005 of one female and two male harbour seals captured in the Dornoch Firth. Locations were recorded using Argos Satellite Relay Data Loggers (SMRU, Scottish Oceans Institute, University of St Andrews, UK). Locations shown are of location quality (LQ) = – 1, 1, 2 or 3 (Vincent *et al.*, 2002). Colours indicate locations belonging to different individuals.

acceptance of the research findings and, more broadly, buy-in to the overall management process (Young, 2010).

Management decisions often need to be taken without a full understanding of ecological systems and must therefore be based upon the best available understanding. From a population perspective, seals entering rivers and eating salmon is a rare occurrence and, consequently, sample sizes are small (Graham *et al*., 2011). However, taken together, the multiple lines of evidence provide managers with greater certainty over the existence of problem seals. In his paper, Linnell (2011) indicates that comparative telemetry data from rogue and non-rogue seals would be particularly useful. While this was one of our original objectives, our attempts to obtain such information were frustrated by a number of factors, primarily the very small number of individual seals that used rivers and tag failure. Two seals that had previously been identified using photo-identification (Graham *et al*., 2011) were captured in the River Conon and fitted with Global Positioning System Fastloc/Global System for Mobile Communications tags (SMRU, Scottish Oceans Institute, University of St Andrews, UK). Unfortunately, both tags failed to transmit their data. However, one of the seals, an adult female harbour seal (Pv.009) was subsequently recaptured in the Kyle of Sutherland, and the tag and data, recorded between 4 February and 1 March 2007, were recovered. Pv.009 had been photographed in the River Conon in multiple years, but her recapture in the Kyle of Sutherland and her tracking data provided the first evidence of a known individual using more than one river (Fig. 1a).

Here, we contrast the data from this river-tagged seal with tracking data obtained from three seals caught in the Dornoch Firth (Sharples, Matthiopoulos & Hammond, 2008; Fig. 1). The telemetry data highlights the fact that Pv.009 repeatedly visited rivers although she also used offshore foraging areas that are typical of those used by other non-rogue seals in the Moray Firth (Fig. 1a,b) indicating that Pv.009 did not forage exclusively in rivers. From 4 February to 1 March, Pv.009 was detected in rivers during 46% of days (Fig. 1a). In marked contrast, no other seals caught and tagged in the Moray Firth have been detected in rivers (Thompson *et al*., 1996; Sharples *et al*., 2008; Cordes *et al*., 2011). These data are extremely limited and inconclusive; nevertheless, they do support the case presented in Graham *et al*. (2011).

While our studies have been successful in addressing a number of aspects relating to the conflict between seal conservation and salmon fisheries, there are many challenges facing those managing seal and salmon populations. As such, our results need to feed into a wider legal and management framework. For example, the drive to introduce marine renewables in the Moray Firth, and Scotland as a whole, may potentially impact on both seals and salmon. Management of these species is sufficiently complicated that there may be no ultimate solution to the myriad of potential conflicts associated with seal conservation (Linnell, 2011). However, such conflict situations are likely to benefit from the approach adopted in the MFSMP, advocated by Linnell (2011) and Butler (2011), of seeking wide stakeholder engagement while tackling specific tractable research questions to inform management decision making.

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