



A reassessment of the interface between conservation and behaviour

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The field of conservation biology was formed to conserve biodiversity in the face of widespread anthropogenic impacts and is inherently a multidisciplinary endeavour, drawing from a variety of fields from the natural and social sciences (Soulé 1985). The disciplines of animal behaviour and behavioural ecology can certainly provide important guidance to conservation biology by contributing valuable theories, approaches, data and scientific expertise to biodiversity conservation efforts. For example, behavioural research involving captive breeding, cultural evolution and learning, communication, foraging, predation, movement and dispersal, spread of invasive species, endocrinology and stress, social behaviour and mating systems all may contribute to a greater understanding of conservation problems. One decade ago a flurry of publications began to highlight these possible linkages between the two disciplines, emphasizing how behavioural research could inform conservation efforts and calling for increased overlap between the two fields. These publications have included a series of essays and review papers (Caro & Durant 1995; Curio 1996; Ulfstrand 1996; Strier 1997; Martin 1998; Sutherland 1998; Caro 1999; Holway & Suarez 1999; Shumway 1999; Fox 2003; Blumstein & Fernández-Juricic 2004; Linklater 2004;

Blumstein 2006) and at least four edited volumes on behaviour and conservation (Clemmons & Buchholz 1997a; Caro 1998a; Gosling & Sutherland 2000; Festa-Bianchet & Apollonio 2003). Recognizing this interest, the Animal Behavior Society (ABS) formed the ABS Conservation Committee in 1997 to promote research at the interface between behaviour and conservation. This committee publishes a regular newsletter, *The Conservation Behaviorist*, and maintains a Web site with resources devoted to the topic (<http://www.animalbehavior.org/Committees/Conservation>).

Although the linkage between behaviour and conservation seems both intuitive and promising, to what extent has the emerging interest in this linkage actually impacted the two fields? A literature review of papers published in 1996 revealed few publications (9 of 97 total) in the journal *Conservation Biology* on the subject of animal behaviour and no publications in the journal *Animal Behaviour* on the subject of conservation (Sutherland 1998). A similar review found that only 7% of papers in the journal *Conservation Biology* mentioned behaviour between 1993 and 1997 (Shumway 1999; see also Dingle et al. 1997 for similar findings between 1993 and 1995). Linklater (2004) conducted a broader review of the literature (including articles, books, reports, newsletters, Web-based resources) between 1965 and 2002. Although he detected an increase (ca. 6–19%) in the proportion of the literature that mentioned both conservation and behaviour, particularly between 1995 and 2002, very little of this work was published in behaviour journals and most of it was descriptive (Linklater 2004). This left us to wonder to what degree the increased interest in behaviour and conservation has actually translated into the primary research published in leading behaviour and conservation journals as well as membership in professional societies.

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We quantified the interface between the disciplines of behaviour and conservation with several approaches: (1) we performed a keyword search in three primary behaviour journals and three primary conservation journals to assess the prevalence of studies that addressed both fields over a 10-year period; (2) we measured the degree to which those primary conservation and behaviour journals cited each other; (3) we used an existing database to determine the degree to which studies published in the highest-ranked conservation journals address behavioural topics and whether that trend changed over a 20-year period; and (4) we compared the North American membership of ABS and the Society for Conservation Biology (SCB) to assess the degree of overlap between two preeminent professional societies in each field. If there was an emerging interest in behaviour and conservation, we would expect to record a trend for increased focus on conservation in the leading behaviour journals, increased focus on behaviour in the leading conservation journals, greater cross citation between those journals, and high levels of cross membership between the two societies.

Assessing the Interface between Disciplines

Our first two methods for assessing the interface between behaviour and conservation involved analyses of three leading behaviour journals (*Animal Behaviour*, *Behavioral Ecology*, *Behavioral Ecology and Sociobiology*) and three leading conservation journals (*Conservation Biology*, *Biological Conservation*, *Ecological Applications*). We chose these six publications because they are premier journals with high impact factors (all >2.0; Journal Citation Reports 2006, Institute for Scientific Information, Philadelphia, PA, U.S.A.), publishing some of the most widely read research in their fields. These journals facilitate research contributions through their online submission systems and their lack of (or voluntary) publication charges, both of which help to encourage the publication of a wide array of international research.

We used the Institute for Scientific Information's Web of Science (Thomson Scientific 2006) to search for the term 'conserv*' to find the words 'conservation', 'conserve' and 'conserving' within titles and abstracts of articles published between 1996 and 2005 in the three behaviour journals. We excluded articles that used these words in contexts other than biodiversity or species conservation (e.g. water or phylogenetic conservation). We also conducted this search within two leading journals in the fields of ecology (*Ecology*) and ecological genetics (*Molecular Ecology*) for 2005. These are fields that have made major contributions to conservation (Soulé & Wilcox 1980; Soulé 1985; Meine et al. 2006), and thus can serve as a standard for comparison to measure the contributions of animal behaviour. We similarly searched for the term 'behav*' to find the words 'behavio(u)r(s)', 'behave' and 'behavio(u)ral' within titles and abstracts of articles published between 1996 and 2005 in the three conservation journals. We excluded articles that used these words to refer to the behaviour of models, humans, systems, or ecological processes

(e.g. fire). Note that our metric may be an underestimate by omitting articles that discussed conservation or behaviour implications without using the terms conservation or behaviour in the title or abstract. However, as we use this metric consistently across years, this should not bias our interpretation of possible temporal trends.

To evaluate the degree to which the conservation and behaviour literature cited each other, we tallied the frequency of citations of conservation journals by articles in behaviour journals (same journals as above) and vice versa for the years 1996 and 2005. To do so, we performed a text search for citations within electronic versions of the journals, except for the 1996 volume of *Ecological Applications*, which we searched manually in the hardcopy of the journal because we did not have access to it electronically. We also tallied the frequency of citations of conservation journals by articles in *Ecology* and *Molecular Ecology*. This allowed for comparison to fields that are widely accepted to have made contributions to conservation biology.

We took another, more comprehensive approach to estimate overlap between the behaviour and conservation fields by more closely examining a broader array of conservation papers. We used a database developed by Lawler et al. (2006) designed to track trends in published conservation research over time. From the database, we analysed 676 papers (44 from 1984, 130 from 1994 and 502 from 2004) from top-ranked ecological journals with a conservation focus. Journals were included in the database if (1) they were in the top 60% of ecology journals as ranked by the Journal Citation Reports (1984, 1994, 2003, Institute for Scientific Information) and (2) if 50% of the papers in the journal addressed conservation topics (see Lawler et al. 2006 for details of methods). Papers that investigated processes that produce, sustain or threaten biodiversity in the face of anthropogenic disturbance were classified as addressing conservation topics. These criteria resulted in two journals for 1984, five journals for 1994 and 14 journals for 2004 (Lawler et al. 2006). Forty per cent of all papers in each of these journals for each of the 3 years were sampled. For each of these papers, one of 10 observers determined whether the study being reported could be categorized as a behavioural study and how often that paper had been cited. Citation rates as of November 2005 were determined using the Institute for Scientific Information's Web of Science (Thomson Scientific 2006). Only those papers with a conservation focus were included in the analyses that we conducted in the present study. Using this database, we analysed whether (1) the number of conservation papers addressing behaviour, (2) the proportion of papers addressing behaviour and (3) the relative citation rate of papers with and without a behavioural focus had changed across the 3 years.

Finally, to assess membership overlap between a behaviour and a conservation professional society, we identified identical names within the 2006 membership lists for ABS and SCB. When possible, we checked the institutional affiliation of overlapping members to verify that the same name represented the same person. SCB membership lists from earlier years were not available, preventing us from determining whether there was

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