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Viewpoint

Marine mammals and ocean noise: Future directions and information needs with respect to science, policy and law in Canada

Rob Williams [a,b,*], Erin Ashe [a,b], Louise Blight [c,d], Michael Jasny [e], Linda Nowlan [c]

[a] Sea Mammal Research Unit, Scottish Oceans Institute, University of St Andrews, St Andrews, KY16 8LB Scotland, UK
[b] Oceans Initiative, Pearse Island, BC V0N 1A0, Canada
[c] WWF-Canada, Suite 1588, 409 Granville Street, Vancouver, BC V6C 1T2, Canada
[d] Procellaria Research & Consulting, 944 Dunsmuir Road, Victoria, BC V9A 5C3, Canada
[e] Natural Resources Defense Council, 4479 W. 5th Avenue, Vancouver, BC V6R1S4, Canada

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ABSTRACT

Marine mammals are ecologically and culturally important species, and various countries have specific legislation to protect the welfare of individual marine mammals and the conservation of their populations. Anthropogenic noise represents a particular challenge for conservation and management. There is a large and growing body of research to support the conclusion that anthropogenic noise can affect marine mammal behavior, energetics, and physiology. The legal, policy, and management issues surrounding marine mammals and noise are similarly complex. Our objective is twofold. First, we discuss how policy and legal frameworks in Canada have some important differences from other jurisdictions covered in previous reviews, and provide a useful general case study. Secondly, we highlight some priority research areas that will improve marine mammal conservation and management. Our examples focus on the research needed to meet stated conservation objectives for marine mammal species in waters under Canadian jurisdiction.

1. Introduction

Marine mammals are ecologically and culturally important species, and various countries have specific legislation to protect the welfare of individual marine mammals and the conservation of their populations (Bowen, 1997; Reynolds et al., 2009). Historically, the central focus of marine mammal conservation has been on lethal threats, namely whaling or bycatch in fisheries. Today, one of the most pressing challenges for marine mammal conservation science is to quantify and mitigate sublethal effects of human activities (Reynolds III, 2005; Schipper et al., 2008).

Anthropogenic noise represents a particular challenge for conservation and management. Much of the early, and perhaps most contentious, research on marine mammals and noise focused on high-energy, impulsive sounds (e.g., military sonar) (Jepson et al., 2003). These are the types of noise sources that are thought to have led to cetacean mortalities, as they have coincided with mass strandings of beaked whales (Fernandez et al., 2005). In recent years, researchers and managers have begun to tackle the ubiquitous, chronic sources of anthropogenic ocean noise from activities like shipping (Clark et al., 2009; Moore et al., 2012). Chronic sources of pollutants, including noise, are notoriously difficult to manage or regulate, but safe criteria need to be set in order to protect human and environmental health.

There is a large and growing body of research to support the conclusion that anthropogenic noise can affect marine mammal behavior, energetics, and physiology (see reviews in (Nowacek et al., 2007; Richardson et al., 1995; Southall et al., 2007; Weilgart, 2007)). The legal, policy, and management issues surrounding marine mammals and noise are similarly complex (Hatch and Fristrup, 2009; Horowitz and Jasny, 2007; Van der Graaf et al., 2012; Weilgart, 2007). We do not recap that body of literature here. Instead, our objective is twofold.

First, we note that the key reviews have focused on policy and legislation in Europe and the United States of America (USA). While the scientific underpinnings and overarching objectives are similar in Canada, the policy and legal frameworks have some important differences. Canada provides an interesting case study, because of recent developments with species at risk litigation and species recovery planning from which other jurisdictions may learn. As in the USA, Canada will need to develop frameworks

* Corresponding author at: Sea Mammal Research Unit, Scottish Oceans Institute, University of St Andrews, St Andrews, KY16 8LB Scotland, UK. Tel.: +1 2509748048.
E-mail address: rmcw@st-andrews.ac.uk (R. Williams).

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for marine mammals and noise that must apply to three oceans – the Pacific, Atlantic, and Arctic. Secondly, in the years since the seminal reviews on this topic, there has been increased recognition that anthropogenic noise can cause chronic, habitat-level alterations to ocean ambient noise (Clark et al., 2009; Williams et al., 2014a), and mitigation of chronic noise will require different management tools than those used to mitigate effects of intense, high-amplitude sounds (Hatch et al., 2012). Similarly, recent directions suggest that Canada is beginning to assess impacts from multiple stressors simultaneously, which creates additional challenges for scientists and managers. As a result, we believe it is timely to outline some priority research areas to improve marine mammal conservation and management in this regard. Setting criteria for noise exposure, including noise exposure thresholds, is one of the main challenges. Regulators are asking for help from the science community to establish these criteria, which can be then applied in a number of settings, and through a variety of legal and policy instruments, to minimize impacts on marine mammals. The recent developments with species at risk recovery planning in Canada serve as an example. As a result of *David Suzuki Foundation v. Minister of Fisheries and Oceans*, a 2010 Federal Court decision upheld on appeal (Federal Court, 2010), the federal government is obliged to protect the acoustic components of critical habitat in action plans for some marine mammals. Legal and policy instruments designed to protect marine mammals from harmful levels of ocean noise can be thought of as a framework for the delivery of an ever-improving body of scientific advice to conservation policy. Science, law, and policy are meant to form a three-way dialogue. Although research on marine mammals and noise may be universally applicable, our case studies focus on the research needed to meet stated conservation objectives for marine mammal species at risk in waters under Canadian jurisdiction.

2. Marine mammals and noise in a Canadian context

From a strictly scientific perspective, researchers in all countries struggle with the same technical and logistical constraints of understanding the effects of sound on highly mobile, highly migratory species in a costly-to-study ocean environment. Canadian policies on this topic have been articulated in much the same way as in many other developed nations, in that they address two broad objectives: promoting the welfare of individual animals; and ensuring that human activities do not cause irreversible depletion of species or the critical habitats on which they depend. It could be argued that the importance of commercial hunts of Atlantic seal populations – managed under the *Fisheries Act* – has caused Canada to focus on sustainable, consumptive use of marine mammal populations to a greater extent than those countries whose primary research or management needs relate to accidental forms of anthropogenic mortality or non-consumptive use of marine mammals (Johnston et al., 2000). Much of Canadian environmental law offers considerable discretion to responsible ministers (Boyd, 2003; Revel, 1981; VanderZwaag et al., 2012; Wood et al., 2010), but Canada's *Species At Risk Act* (SARA) contains mandatory requirements for identification of (and management of threats to) critical habitat of endangered species (Taylor and Pinkus, 2013), which is defined in SARA as the habitat needed for a species' survival and recovery. With respect to marine mammals and noise, we argue that Canada has taken a progressive stance by listing underwater noise as a threat to critical habitats of at least two endangered whale species: Pacific humpback whales (Fisheries and Oceans Canada, 2013) and northern and southern resident killer whales (Fisheries and Oceans Canada, 2011). In contrast, the U.S. declined to include acoustics as a primary constituent element of southern resident killer whale critical habitat under the *Endangered Species Act* (National Marine Fisheries Service, 2008). The U.S. has included underwater noise levels as primary constituent elements of critical habitat for Cook Inlet beluga, but has been criticized for basing those levels exclusively on habitat abandonment, rather than inclusively on various mechanisms, such as foraging loss, that can degrade habitat without driving range-limited cetaceans away[1].

It may be instructive to note that, in the few months while this paper was in review, the federal government downlisted Pacific humpback whales from the Threatened category under SARA to Special Concern, a lesser category. The practical outcome of this downlisting is that there are no longer any legal requirements to identify and protect critical habitat for this species, and consequently, no prohibition on the destruction of that habitat. Interestingly, this rapid change of status – and related changes to protection requirements – underscores the fragmented and potentially fragile nature of habitat protection for vulnerable species in Canada and other jurisdictions: "noise disturbance" is still listed as one of the primary threats to Pacific humpback whales, yet without the species retaining a listing of Threatened or Endangered, Canadian law may not be adequately positioned to address concerns around noise pollution or habitat destruction. We describe some of these inadequacies below. Nonetheless, the identification of acoustic attributes as part of critical habitat for endangered species stands as an example for other jurisdictions. In our view, Canada's next steps in turning qualitative conservation objectives into concrete management actions for killer whales (and, presumably, other species in the future) will be of interest to policy-makers, managers and scientists in other regions who are grappling with similar issues.

There are a number of industrial developments proposed or underway (e.g., port expansion, increases to tanker traffic) in Canadian marine waters that may dramatically alter the acoustic environment there (Gavrilchuk and Lesage, 2014). Several policies and laws are designed to protect marine mammals from harmful levels of anthropogenic noise, but (a) very large science gaps remain in our ability to assess and ultimately mitigate impacts of noise on marine mammals (see below), and (b) there is no comprehensive legal framework for the marine environment comparable to the European Union's *Marine Strategy Framework Directive*, or for marine mammals, comparable to the U.S. *Marine Mammal Protection Act*. Major science gaps, and the piecemeal nature of Canadian policy and legislation, act in concert to contribute to the difficulty in managing underwater noise in waters under Canadian jurisdiction. In this paper, we provide a brief overview of marine mammals and ocean noise issues at the science-policy interface from a Canadian perspective, and based on those issues, spell out the research projects that strike us as ones most urgently required to initiate over the next 3–5 years to meet Canada's stated objectives of protecting marine mammals from harmful effects of ocean noise. Undertaking these projects will give regulators much needed information to develop action plans for the recovery of species at risk. The research results will also be useful for related regulatory procedures such as project environmental assessments, management plans for marine protected areas, and zoning to give effect to marine spatial plans.

We are not employees of the Government of Canada, and our independent perspective is important to note. This paper includes authors from various points of view, including those of biologists, an acoustician, environmental lawyers, academics and representatives from the marine conservation community. Canada's environmental legislation explicitly calls for participation

[1] 50 C.F.R. § 226.220; 76 Fed. Reg. 20180 (April 11, 2011).