In My Opinion

From Climate to Caribou: How Manufactured Uncertainty Is Affecting Wildlife Management

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ABSTRACT Over the past decade, declines of Canadian populations of boreal caribou (Rangifer tarandus caribou) have received considerable attention from scientists, government agencies, environmental nongovernmental organizations, Indigenous communities, and the forest industry. Boreal caribou (also known as boreal woodland caribou) was listed as a threatened species in Canada when the Species at Risk Act came into force in June 2003. Many boreal caribou populations have been shown to be decreasing, in some cases precipitously, and empirical evidence from adult survival and calf recruitment surveys indicates that the cumulative effect of habitat disturbance, including that which results from industrial development, is a key driver in the decline. Yet, as scientific understanding of the decline has become clearer, and agreement among scientists and governments about habitat management requirements has increased, campaigns of denial have intensified in the public sphere. In this paper, we examine parallels with climate change rhetoric prolific in the 2000s and show that willful ignorance disguised as skepticism has resulted in public uncertainty despite robust scientific evidence. We show how these strategies of manufactured uncertainty used in climate change denial campaigns have seeped into wildlife management debates, with pernicious results. In this case, it has successfully delayed efforts to effectively address the decline of boreal caribou, which is protected under federal, provincial, and territorial legislation, and inhibited meaningful dialogue about socially acceptable conservation solutions. © 2018 The Authors. Wildlife Society Bulletin Published by Wiley Periodicals, Inc.

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Public backlash against anti-environmental protection narratives of recent decades has taught some industrial interests that it is “more efficacious to question the need for environmental regulations by challenging evidence of environmental degradation, rather than the goal of environmental protection” (Dunlap and McCright 2011:146). Industrial interests sometimes deploy substantial human and financial resources to challenge evidence of harm. For example, the Global Climate Coalition was initiated and financed as an international lobby group to represent major producers and users of fossil fuels. Created to challenge climate change science, and oppose action to reduce greenhouse gas emissions, its budget totaled US$1.68 million in 1997, the year the Kyoto Protocol was negotiated (Revkin 2009). More recently, InfluenceMap’s Lobbying and Corporate Influence Project (www.influencemap.org) estimated that the financing of lobbying by fossil fuel interests to avoid new climate policy and regulation has exceeded US $155 million annually, including ExxonMobil (US$27 m), Shell (US$22 m), and the American Petroleum Institute (US $54 m), among others (InfluenceMap, Apr 2016). It estimates that, globally, each year >US$500 million is spent by the corporate sector on obstructing ambitious climate policy and regulations essential to achieving <2°C global warming.

Public perception is particularly vulnerable to such challenges at the interface of science and policy. Policymaking in democracies requires the consideration of an array of rights and interests; and, in policy–making discourse, value statements are legitimate tools of argumentation and persuasion (Majone 1989). Science, on the other hand, is the result of systematic study and hypothesis testing through observation that follows objective and replicable procedures. It does not often inform public policy seamlessly in part because it provides probabilistic statements rather than pronouncements, and as such, results in uncertainties that can be (and are) exploited, particularly by those opposed to regulatory change (Bradshaw and Borchers 2000).
Michaels and Monforton (2005) called this exploitation of scientific uncertainty—specifically, its use to question the validity of the scientific evidence on which regulations are, or will be, based—“manufacturing uncertainty.” Manufactured uncertainty is created via the proliferation of fallacious arguments with an apparent purpose to mislead and confuse the public in order to protect industrial interests by delaying (or avoiding) policy decisions that would lead to additional regulatory restrictions (Pollack 2003, Antilla 2005, Markowitz and Rosner 2013). Manufactured uncertainty has intensified in public discourse (Oreskes and Conway 2010). Many assume that it is a legitimate part of debate under the guise of a fundamentally important feature of democratic decision-making: skepticism. However, while skepticism is based in truth-seeking, manufactured uncertainty is willful ignorance (Specter 2010). By challenging specific conclusions despite definitive evidence supporting those conclusions, opinions based on conjecture are made equivalent with conclusions based on facts. This willful ignorance disguised as skepticism underlies a wide range of environmental and health controversies. Public “debates” on the impacts of lead paint, tobacco, dichlorodiphenyltrichloroethane (DDT), acid rain, chlorofluorocarbons (CFCs), and others have been shown to be deliberate attacks on society’s ability to become aware of, contemplate, and act upon risk (McCright and Dunlap 2010).

Implications of manufactured uncertainty are likely exacerbated by public expectations and perceptions of the role of scientists in policy arenas: whether they are understood to be objective, authoritative sources that provide policy-neutral observations or rather are purveyors of value-laden recommendations based on personal or political motivations (Pielke 2004). Further, most science is funded by government agencies, corporations, or public or private interest groups that are alleged by some to be funding scientific research to justify specific policy outcomes (Sarewitz 2004). Navigating the landscape of scientific skepticism versus manufactured uncertainty can require a high level of scientific literacy.

Climate change denial is one of the most recent and well-documented examples of this exploitation of uncertainty (Hoggan and Littlemore 2009, Antonio and Brulle 2011, Dunlap and McCright 2011, Dunlap and Jacques 2013). The multipronged strategy of denial (deny the problem exists, deny the key causes of the problem, and claim that the cost of resolving the problem is unacceptably high) is often accompanied by vilification of “the messengers” and those who advocate for change to the status quo. This strategy contributed to successful avoidance of significant changes to the regulatory regime for greenhouse gases for decades (Michaels and Monforton 2005). Although tactics of manufacturing uncertainty are becoming well-known in the cases where there are direct impacts on human health (e.g., Michaels and Monforton 2005, Oreskes and Conway 2010), the proliferation of this strategy with respect to declines in wildlife populations, and associated regulatory requirements to address them, has not been as carefully examined.

A wildlife controversy that has apparently been subject to this strategy of denial is the conflict between industrial logging and the conservation of boreal caribou (Rangifer tarandus caribou, also known as woodland caribou [boreal population], or boreal caribou). The caribou species (R. tarandus)—called reindeer in Europe and Asia—has undergone considerable range retraction over the past several centuries (Morrison et al. 2007). Cardillo et al. (2006) identified parts of the present range of caribou as one of several areas, globally, with a high susceptibility for “latent extinction” due to inherent biological characteristics of resident mammals (e.g., low birth rates) that elevate its risk of future loss as habitat change intensifies. The species is further classified into subspecies (e.g., R. t. caribou) or ecotypes (Festa-Bianchet et al. 2011). Boreal caribou have been the subject of considerable research in Canada, receiving significant attention as a result of vulnerability to effects of human-caused habitat change (e.g., Mallory and Hillis 1998, Schaefer 2003, Environment Canada 2011, Festa-Bianchet et al. 2011, Donovan et al. 2017), and potential to function as an umbrella species in wildlife management (Bichet et al. 2016). A clear link has been established between boreal caribou’s range loss and the intensification of roads and industrial development (Schaefer 2003, Environment Canada 2011). Much scientific evidence supports the hypothesis that human activities can increase habitat for alternate prey (e.g., Boan et al. 2011), thereby supporting greater numbers of caribou predators (e.g., wolves [Canis lupus]) while also increasing predator access and hunting efficiency (via the proliferation of linear corridors; Latham et al. 2011, Lesmerises et al. 2012, Dickie et al. 2017). Boreal caribou has been assessed as “threatened” by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and is protected under federal species-at-risk legislation in Canada (Species at Risk Public Registry 2017). Leading experts in landscape ecology, caribou biology, spatial habitat modeling, and population analysis have published the scientific underpinnings for the identification of critical habitat for boreal caribou (Environment Canada 2011, 2012). Yet, as scientific understanding of the decline of boreal caribou populations has become clearer, and agreement among scientists and governments about habitat management requirements has increased, campaigns of denial have intensified in the public sphere (e.g., Hale 2015).

In this paper, we examine public statements of several forestry corporations, conservative think tanks, industry lobbyists, and their proxies regarding boreal caribou population declines and examine them in the light of peer-reviewed science. We demonstrate that the strategy of exploiting scientific uncertainty in public discourse can be explained by examining 3 tactics: 1) denying there is a problem, 2) denying the sources of the problem, and 3) claiming that the costs of addressing the problem are unacceptably high. This strategy parallels that used during climate change denial campaigns and has seeped into this regulatory debate about the sustainable use of publicly owned forests. In regard to the potential socio-economic costs of regulation, we use northern Ontario, Canada, as a case study.
We examine harvest levels in Forest Management Units that overlap with contiguous boreal caribou range to provide insight into opportunities for habitat conservation and examine the risk of job losses from habitat conservation measures.

**TACTIC 1: DENY THE PROBLEM EXISTS AND VILIFY YOUR CRITICS**

Oreskes (2015) described the use of doubt-mongering to exploit inescapable uncertainties associated with scientific claims as the first strategy in manufacturing uncertainty. Interests that oppose new regulations or policies “insist that the relevant science is too uncertain to provide a good basis for decision-making” (Oreskes 2015:2). This manipulation of information and “diversionary reframing” redirects attention from the actual problem(s) by constructing a debate about something else to downplay potential environmental risk (McCright and Dunlap 2003:351).

Examples of this redirection are common in climate change debates. For example, U.S. Senator Jim Inhofe, considered one of the most vocal Republican senators denying climate change, stated,

> ...without proper knowledge and understanding, alarmists will scare the country into enacting its ultimate goal: making energy suppression, in the form of harmful mandatory restrictions on carbon dioxide and other greenhouse emissions, the official policy of the United States (Inhofe 2003: para. 29), and,

> ...there is substantial scientific evidence that increases in atmospheric carbon dioxide produce many beneficial effects upon the natural plant and animal environments of the earth (Inhofe 2003: para. 245).

Similarly, Marc Morano, a climate analyst with the Heartland Institute, an American conservative public policy think tank, declared that,

> ...now going on almost two decades of no global warming, sea ice recovering, sea level rise actually decelerating, on every metric from polar bears on down, the global warming narrative has weakened (Morano 2014: para. 1).

Stuart Varney, an economic journalist who worked for the conservative Fox News Channel likewise claimed,

> ...it looks to me like we are looking at global cooling... forget this global warming (Welsh 2014: 0:24-0:29) after a Russian research ship was stuck in Antarctic Ice.

Scientific explanations framed to appeal to an audience’s worldviews and values can be legitimate and effective tools for communicating science if they “avoid using framing to denigrate, stereotype, or attack a particular social group” (Nisbet 2009:53). Instead, advocates of the caribou decline denial campaign have sought to undermine the scientific basis of environmental policy by conflating scientific findings with the viewpoints of environmental nongovernmental organizations (ENGOs). Reminiscent of climate change denial, examples of denigration and stereotyping are found
throughout media coverage on caribou decline denial, particularly in media published in forestry-dependent communities. To illustrate:

...while [caribou] policy seems to be influenced by this type of eco-terrorism, who is protecting us, the people who suffer the outcomes of policy? (Cochrane Times Post 2015: para. 13);

...threatening policy that seemed to be driven by environmental extremism, like Caribou Conservation Policy, that suggests 65% of environmentally sustainable forest harvest needs to be set aside to promote the “recovery” of Caribou in areas where they currently don’t live… (Town of Cochrane 2015: para. 3); and,

...the research … brings into question the multiple classification tactic being used by groups like Greenpeace that simply keep dividing the population until “ecotypes” are reduced to the point of creating an illusion of endangerment. The science (including the $11 million just spent by Ontario) has yet to prove that there exists a genetic difference between ‘Eco Type, Forest Dwelling Woodland Caribou and other Tundra Dwelling Caribou’… (Cochrane Times Post 2015: para. 6).

DOES THE PROBLEM EXIST?

Rationale for Identifying and Protecting Ecotypes

The evolutionary importance of a collection of individuals at a level below the taxonomic designation of species (e.g., ecotypes) is well-established in the field of conservation biology (Mace 2004). Virtual all current scientific literature on caribou populations in Canada acknowledges such diversity under the species level (e.g., Courtois et al. 2003a, Sorensen et al. 2008, Festa-Bianchet et al. 2011, Pinard et al. 2012, Hervieux et al. 2013). Recent scientific research in Ontario has further strengthened the distinction of ecotypes based on both behavior during calving and overall movements. Unlike tundra ecotypes, which aggregate on calving grounds, boreal caribou use a dispersed calving strategy in which females are generally solitary, particularly in the spring to late summer when they “space away” from other caribou to reduce predation risk. Boreal caribou are the only caribou found exclusively in the boreal ecoregion throughout the year, with annual range overlap with other caribou ecotypes occurring only during winter (Pond et al. 2016).

In Canada, 4 caribou subspecies were recognized by Banfield (1961): 2 migratory or tundra caribou [R. t. groenlandicus and R. t. granti], a woodland subspecies [R. t. caribou], and the high-arctic Peary caribou [R. t. pearyi]. However, because of an explosion of interest in caribou phylogeography and population genetics in the past decade, the COSEWIC recognized that the prevailing taxonomy did not fully capture the variability of caribou across their range (COSEWIC 2011, Festa-Bianchet et al. 2011). The COSEWIC used an alternative approach to categorize diversity within the species, focusing on evolutionarily significant units of adaptive diversity through a delineation of discrete populations known as Designatable Units (DUs; COSEWIC 2011). Designatable Units are conceptually similar to Designated Population Segments identified under the U.S. Endangered Species Act of 1973 (as amended). Designatable Units are considered irreplaceable components of Canada’s biodiversity and analogous to fundamental units for conservation that are widely used internationally (Irvine et al. 2005, Vélez-Espino and Koops 2009). The Committee’s DU decisions were based on multiple lines of evidence, including distinct subspecies, ecotypes, or natural population groupings; available evidence on phylogenetics, genetic diversity and structure, morphology, movements, behavior and life history strategies; discreteness from neighboring units; and significant differences according to a set of evolutionary criteria. This analysis identified 12 DUs for caribou, including boreal caribou, which are currently designated as “threatened” under both federal and some provincial laws (COSEWIC 2014).

Ecotypic classification is a well-established approach used by the scientific community. References by organizations like the OFIA to the estimated number of caribou in Canada or globally as evidence that a problem does not exist appears to be a tactic to manufacture uncertainty.

Evidence of Population Decline

A substantial body of scientific literature has shown that many populations of boreal caribou are declining (e.g., see Environment Canada 2008, 2011, 2012) and some face extirpation (see Festa-Bianchet et al. 2011). In summarizing available data, COSEWIC (2014) noted that 81% of boreal caribou populations were in decline. However, all ecotypes of woodland caribou (boreal, mountain, and migratory) are declining across Canada. In Ontario, the southern limit of caribou distribution has receded northward to approximately 50% of the historic range, in concert with northward settlement and expansion of industrial development (Schaefer 2003). Habitat loss and population declines have been observed elsewhere across Canada (McLoughlin et al. 2003, Environment Canada 2008), including 60% range loss in Alberta and 40% in British Columbia (Hummel and Ray 2008). In western Quebec, caribou have been virtually absent south of the 50th parallel for ≥50 years (Courtois et al. 2003b). Newfoundland populations have declined by 60% (Government of Newfoundland and Labrador 2009), and 6 of 13 herds in the southern Rockies have <50 individuals, and hence are thought to be unlikely to persist over even the short term (Festa-Bianchet et al. 2011).

Scientific Understanding of How Caribou Use the Landscape

At present, there is sufficient scientific understanding of how boreal caribou herds use the landscape to inform science-based policy. It is accepted by the scientific community that boreal caribou have evolved the ability to digest lichen, a type of forage largely unused by other ungulates, and to minimize
predation by selecting habitats with low densities of other prey species (Seip 1992, Hillis et al. 1998, Rettie and Messier 2000, Gustine et al. 2006, Wittmer et al. 2007). As such, boreal caribou primarily use large tracts of mature conifer forests and peatlands with abundant terrestrial and arboreal lichens (Schaefer and Pruitt 1991, Courtois et al. 2004, Ferguson and Ellkie 2004, Wittmer et al. 2007). Habitat fragmentation associated with roads and other linear features, such as power lines, has been shown to be an important factor in how boreal caribou use these forest types; for example, functional habitat loss, or avoidance, has been shown to occur within 750–1,250 m of logging roads and other linear features (Leblond et al. 2011). The decline in boreal caribou survival rates has been strongly linked to the amount of disturbance within their ranges, including the amount of young forest associated with early succession forest growth after logging or fires and the proliferation of linear features (Dyer et al. 2001, Wittmer et al. 2007, Sorensen et al. 2008). Evidence of this relationship provides a strong scientific basis for policy development, as noted by Environment Canada:

while improved data would enhance our understanding and address outstanding uncertainties, [our] report concludes that sufficient information exists to support a scientific basis to inform the identification of critical habitat for boreal populations across Canada (Environment Canada 2011:i).

Climate change deniers exploited the complexities of human-caused global warming to deliver an organized “disinformation” campaign (Dunlap 2013). We suggest that the complexities of boreal caribou ecology are likewise being used to deny that a problem exists. There is abundant scientific research that supports 1) the distinction of caribou ecotypes, 2) the fact that boreal caribou are declining across Canada, and, 3) a robust understanding about the manner in which boreal caribou use the landscape and their vulnerability.

**TACTIC 2: DENY THE SOURCE OF THE PROBLEM**

It is a general ethical principle that those who contributed to the creation of a problem should take some commensurate responsibility for solving the problem (Rawls 2009). As such, once the relevant expert community achieves consensus that an environmental problem is occurring, the focus shifts to the issue of responsibility (Frumhoff et al. 2015). Unaddressed responsibility can affect industrial users in several ways: shareholder’s divestment, consumer boycotts, protests, and potential legal action by governments, civil society and individuals. These consequences can impel changes in regulations (Gunningham et al. 2004).

For those that manufacture uncertainty, denying responsibility is an essential part of delaying or avoiding new regulation. For example, climate change denial intensified throughout the 1990s as leading fossil fuel corporations, including ExxonMobil, Shell, and British Petroleum, provided financial backing for the Global Climate Coalition (GCC). A key purpose of the GCC was to oppose greenhouse-gas emission-reduction policies through an aggressive lobbying and advertising campaign that challenged the integrity of the scientific evidence that supported the idea that climate change was, in large part, due to fossil fuel use (Frumhoff et al. 2015). Climate change deniers argued that the burning of fossil fuels was not a significant contributor to climate change. For example,

...the science indicates that human activity is not the cause of all this global warming. And that in fact, nature is the cause, with solar flares, etc. (Grandia 2009: para. 5);

I do not believe that human activity is causing these dramatic changes to our climate the way these scientists are portraying it...I do not believe that the laws that they propose we pass will do anything about it, except it will destroy our economy (Bennet 2014: para. 2–3); and,

The ‘pause’ reveals that it is scientifically obvious that carbon dioxide is not the overriding driver of the climate. The global warming movement has morphed into a coalition of ‘climate cause deniers’. They deny the hundreds of causes and variables of climate change and pretend CO2 is the ‘control knob’ overriding all the others (Idso et al. 2014: para. 19).

In a similar manner, several industrial interests have argued that there is a lack of evidence linking industrial logging and associated road building with the decline of boreal caribou:

...we need the government to place a moratorium on all caribou policy until a scientific study can validate the relationship between disturbance and [boreal caribou] population growth (The Empire Club of Canada 2015: 46:15–46:25); and,

...statistical analysis shows the relationship between levels of disturbance and [boreal caribou] population growth is very weak (Kennard 2015: para. 12).

They have also claimed that boreal caribou populations are “healthier” in logged areas. For example,

...an increasing body of information shows that in areas where the forest has been harvested, the caribou do just as well if not better than in areas that haven’t been harvested (Brown 2015:A5);

...areas subject to forest management have healthier caribou populations than areas that have been entirely left to nature...This suggests that woodland caribou are not threatened due to a lack of habitat...it is due to variables within their habitat that MNRF [Ministry of
Natural Resources and Forestry] either is unable to control or incapable of measuring (OFIA 2015: para. 11–12); and,

...more woodland caribou are being born and surviving from year to year in areas ... which are managed by forestry companies ... compared (to areas) which have little to no disturbance and are not managed by the forest sector ... (Clutchey 2015:A1).

Similarly, the Montreal Economic Institute, a conservative think tank based in Montreal, Quebec, stated that,

From the 1999 survey to the 2012 survey, the [caribou] population doubled from 115 to 247 individuals. This occurred while nearly 70% of the overall land area in the region was disrupted by forestry operations (Guénette and Desrochers 2014:3) and therefore, [critics who point the finger specifically at the forestry industry are therefore jumping to conclusions that are not justified by the available data (Guénette and Desrochers 2014:4).

An additional strategy to avoid accountability has been to suggest that industrial users are a victim being unfairly scapegoated by critics. For example,

For years now, some environmental activist groups have been pointing the finger at Resolute and the forest products industry as the main reason why woodland caribou populations are under stress in the Canadian boreal forest (Resolute Forest Products 2015: para. 1); and,

So what is the real reason for caribou decline, if in fact there is a decline? It is impossible to pin it on a forest industry that is a shadow of what it once was... (Hoffman 2015:A5).

IS THE SOURCE OF THE PROBLEM KNOWN?

Cumulative Disturbance and Boreal Caribou Decline
The negative effect of human-induced habitat alteration on caribou populations has been demonstrated in many peer-reviewed publications (e.g., Bradshaw et al. 1997, Dyer et al. 2002, McLoughlin et al. 2003, Sorensen et al. 2008, Vistnes and Nellemann 2008). For example, boreal caribou strongly avoid road networks, resulting in displacement from selected habitats, known as functional or indirect habitat loss (Bowman et al. 2010).

Scientific research has established a strong relationship between boreal caribou decline and amount of cumulative disturbance, including that which results from industrial logging and associated road development (Environment Canada 2011, 2012). In 2009, Environment Canada reviewed information from radiocollared boreal caribou from 25 populations across Canada to inform the identification of critical habitat. The results of this meta-analysis demonstrated a highly significant relationship between calf recruitment and levels of disturbance (e.g., harvesting, fires, and blowdowns) within caribou ranges. Based on these results, Environment Canada (2012) created a management threshold of habitat alteration to support the persistence of boreal caribou. Environment Canada (2012) stated,

Unavailable, inadequate or degraded habitat affects the reproductive success of females as well as the survival of calves, and can result in population decline (p. 10);

...disturbance primarily associated with the following human land-use activities... [has]...a negative effect on boreal woodland caribou local populations across Canada: forestry; oil and gas exploration and development; mining and mineral exploration and development; hydro-electric development... (p. 15); and,

Across most of the distribution of boreal caribou, human-induced habitat alterations have caused an imbalance in predator–prey relationships resulting in unnaturally high predation rates (p. 15).

Boreal Caribou Decline in Areas Where Industrial Logging Is Not Permitted
In its 2014 State of the Woodland Caribou Resource Report (OMNRF 2014a), Ontario’s Ministry of Natural Resources and Forestry (OMNRF) found that calf recruitment for boreal caribou was low in most ranges north of areas managed for industrial forestry, even though disturbance levels were shown to be low in their analysis (see white triangles in Fig. 1). However, the ministry stated that most of the evidence from their surveys supported the scientific explanations of other population declines in Canada, specifically 1) forests managed for timber harvesting attract and support high densities of moose (Alces alces) and white-tailed deer (Odocoileus virginianus), which results in increased densities of predators, including wolves and black bears (Ursus americanus), and thus greater caribou mortality; 2) roads built and maintained in forests managed for timber harvesting are used by predators, leading to increased hunting efficiency and greater caribou mortality associated with predation; and 3) cumulative effects of disturbances are a central contributor to population declines (OMNRF 2014a).

Further, in a separate report (OMNRF 2014b), the ministry noted that the anomalous results were uncertain from several perspectives: 1) they resulted from a new survey technique in which large numbers of caribou were assigned to unknown age and sex classes; 2) disturbances in these northerly landscapes might be systematically underestimated relative to more southerly locations because of slower rates of
forest growth, crown closure, and natural thinning; and 3) a lack of fire history data in some of these northern areas may have resulted in an underestimate of fire-related disturbance. Additionally, local extirpation in national parks (e.g., Pukaswka National Park in Ontario), does not refute the disturbance–recruitment relationship. Rather, scientific research has demonstrated the significant challenge of maintaining small, isolated caribou populations (Bergerud et al. 2014).

Furthermore, the recent reductions in timber harvest levels in Ontario do not refute the relationship between cumulative disturbance and population decline. Scientists have shown that the population and distributional responses of boreal caribou to habitat change exhibit time lags: effects are not instantaneous. Tilman et al. (1994) characterized the time-lag between habitat change and local disappearance as an “extinction debt,” and peer-reviewed scientific studies have shown that such a lag exists for boreal caribou (Rettie and Messier 2000, Vors et al. 2007).

Nonetheless, scientific understanding is continually evolving, and there are legitimate areas of uncertainty (i.e., not “manufactured uncertainty”) for which further inquiry will support greater success in habitat management and recovery. At present, these include 2 key factors: 1) how climate change might affect future forests and boreal caribou habitat; and 2) variability in regional and local population responses to cumulative disturbance and other stressors.

With respect to climate change, recent projections suggest that the boreal forest will undergo greater warming than other forest biomes (Price et al. 2013). This could result in relevant environmental changes, potentially including increased forest productivity, greater frequency and severity of forest fires, and increases in tree-destroying insect pests, among others (Price et al. 2013). These changes could have significant effects on boreal caribou range distribution (e.g., warming in combination with increases in natural disturbances could support the northward progression of other ungulates, such as white-tailed deer, thereby increasing boreal caribou predation as well as transmission of disease and pathogens (e.g., brainworm [Paralaphostrongylus tenuis], which is carried by white-tailed deer). Climate change could very well exacerbate effects of industrial development and human activity (Vors and Boyce 2009, Masood et al. 2017).

In addition, recent research has shown that the probability of boreal caribou survival may vary in response to disturbance at local levels (Rudolph et al. 2017), the spatial configuration of harvest (Cyr et al. 2017), latitudinal gradients (Gagné et al. 2016), and forest productivity (Fortin et al. 2017). However, we found no peer-reviewed research that refuted the scientific foundation of the Federal Recovery Strategy. While the strategy recommends that 65% of boreal caribou habitat be maintained in an undisturbed condition (which provides a measurable probability of 60% for a local population to be self-sustaining), it recognizes that management responses may legitimately vary across the country if based on strong evidence:

...habitat disturbance within a range needs to be managed by the responsible jurisdiction at a level that will allow for a local population to be self-sustaining.

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Figure 1. Relationship between mean caribou calf recruitment and total disturbance (anthropogenic and natural) of selected caribou ranges across Canada (gray circles [n = 24]; Environment Canada 2011) compared with estimates for Ontario (OMNRF 2014 b–h; black squares depict ranges that overlap with areas licensed for industrial logging [n = 6]; white triangles depict ranges north of the area licensed for industrial logging [n = 7]). Dashed lines depict 90% prediction band for best univariate regression model based on the gray circles.
As there is variation in habitat and population conditions between boreal caribou local populations across their distribution, for some ranges it may be necessary to manage the range above the 65% undisturbed habitat threshold, while for others it may be possible to manage the range below the 65% undisturbed habitat threshold. However, there must be strong evidence, validated by Environment Canada, from population data collected over an extended period of time to support the management decision to establish a lower range-specific threshold (i.e., the lag effects of disturbance on a local population have been considered and accounted for). (Environment Canada 2012:34).

**TACTIC 3: CLAIM THE PROBLEM IS TOO COSTLY TO RESOLVE**

The threat of economic decline and associated job loss has long been a key feature of campaigns against regulation. As such, a third strategy to undermine environmental regulation is to claim that the cost of addressing the issue is too high. This has been a common strategy, for example, of climate change deniers:

This [Kyoto] treaty is a loser for American households. ... [it] would cost American families billions of dollars and millions of jobs (GCC 1998);

To get to the [Kyoto] target, we would have to stop all driving in the U.S. or close all electric power plants or shut down every industry... (Exxon 1998);

...[e]nergy suppression ... means higher prices for food, medical care, and electricity, as well as massive job losses and drastic reductions in gross domestic product, all while providing virtually no environmental benefit (Inhofs 2003: para. 30); and,

... I do not believe that the laws that they propose we pass will do anything about it. Except it will destroy our economy (Kliegman 2014: para. 2).

This strategy is often deployed with respect to boreal caribou. For example, the OFIA has claimed the following:

...in order for the north to get its share of the $20 billion [estimated economic expansion in Canada by 2020], we need government to hit the pause button on all policy that would impact the wood supply in this province until clear and transparent economic impact analysis has been conducted, [and] we need the government to place a moratorium on all caribou policy until a scientific study can validate the relationship between disturbance and population growth... It’s really simple—less wood, less jobs. (The Empire Club of Canada 2015: 45:53–47:28).

Some mayors in northern Ontario have echoed this perspective:

While there is a lot of uncertainty regarding reasons for the decline of woodland caribou, there is no uncertainty regarding the impact of measures to limit wood supply. Curtailing harvesting means mill shutdowns, business closures and job losses. (Kennard 2015: para. 12); and,

...the implementation of the Caribou Conservation Plan will be) like dropping a bomb right in the middle of Northern Ontario. The aftermath will be entire communities dying. (Kapuskasing Times 2015: para. 12).

**CAN WE AFFORD TO RECOVER CARIBOU?**

**An Ontario Case Study**

Employment in the forest products sector has decreased, and all aggregate measures of sector size such as value of shipments, value of exports, employment, gross domestic product, asset value, and capital expenditures trended down over the 2000s (Bogdanski 2014, de Avillez 2014). By 2012, the Canadian forest–products sector had only one-quarter of the employment levels that it had 50 years ago (de Avillez 2014).

In Ontario, the most recent decline in the forest products sector began around 2003 and hit its lowest levels in 2008; in 2013, employment in the forest products sector was 41.2% below its level in 2000 (Capeluck and Thomas 2015). However, in the many recent studies that have reviewed factors that most critically influence job loss in the forest products sector across Canada, reductions in potential wood supply associated with regulations to increase sustainability were not identified as a cause. Instead, deep structural changes in the demand for forest products, high labor and energy costs, and decline of real net investment in the sector were identified as key drivers (e.g., Bogdanski 2014, de Avillez 2014, Capeluck and Thomas 2015). More recent factors have included a strong Canadian dollar, the slump in the U.S. housing market, a global recession, and now potentially, revised trade arrangements with the United States (Johnston and Parajuli 2017).

Going back even further in time, gross domestic product, employment and investment in the forest products sector had been declining well before the most recent economic downturn. For example, the importance of employment in the forest products sector as a proportion of total employment in Ontario declined significantly over the past 2 decades: from 1.4% in 1997 to 0.6% in 2013 (Capeluck and Thomas 2015). The Senate Standing Committee on Agriculture and Forestry stated the “decline [in demand] is more structural than cyclical...” (2009:10). For example, with the advent of social media and the proliferation of electronic media, daily newspaper circulation in the
United States decreased from 55.8 million newspapers in 2000 to 44.4 million newspapers in 2011 (Capeluck and Thomas 2015). The newsprint market is projected to continue its decline, although the rate of decline will be slower. In Japan, North America, and Western Europe, demand for paper is projected to decrease by around 0.8%/year to 2030, whereas the demand for tissue paper, containerboards, and carton boards will grow (Pulp and Paper Canada 2015). Although the lumber market is more likely to recover, it may not reach historic highs because competition from low-cost producers in Russia and Brazil (and potentially the United States) will present significant competition for the Canadian sector (Couture and Macdonald 2013).

Further, Capeluck and Thomas (2015) found little evidence that the postdownturn (i.e., after 2008) increased productivity in Ontario was a supply-side phenomenon: it was not driven by more favorable natural resource development conditions. Indeed, the recent crisis in the forestry sector can itself negatively reinforce impacts on the sector, in the form of longer term timber supply shortages. The Canadian Council of Forest Ministers (2008) reported that the bankruptcies associated with the most recent economic downturn resulted in declines in reforestation investment, and many new tenure holders are now managing forests that experienced a period of low silvicultural (i.e., forest regeneration) investment.

Across Ontario, full allowable cuts are not harvested (e.g., see Ter-Mikaelian et al. 2013 [Fig. 2], OMNRF 2012). To examine this in more detail, we compared conifer wood volumes available for harvest with those actually harvested for 2 time periods: prior to and after the downturn (prior to 2005 and after 2008, respectively). In terms of currently available wood supply, harvest levels approved in Forest Management Plans include volumes for mills that are idled or permanently closed. As such, the use of the annual allowable cut as a metric to assess the importance of regulations can exaggerate the effects of potential wood supply reductions on jobs. If available wood volume exceeds the amount harvested, then it is reasonable to argue that restrictions on volumes harvested will have little, if any, impact on current employment levels.

In our analysis, we focused on forest management units (FMUs) that overlapped the North American Boreal Zone (NRCan 2016), including those both north and south of the contiguous caribou range. From 2004 to 2008 annual harvesting levels in Ontario dropped by 10 million m$^3$ (43%) in association with the sector-wide downturn; hence, to estimate pre-downturn harvesting levels, we calculated planned and actual harvest volumes in Annual Reports (AR-8) for the most recent 5-year term ending prior to 2005. If these figures were not available, we used pre-downturn harvest levels reported in their independent forest audits. For post-downturn estimates, we used information from Annual Reports (2011–2015), which provided information for each FMU on average for 3.8 years. We used a 5-year time period because harvests can vary considerably from 1 year to the next. Further, there were several FMU amalgamations between the 2 time periods, in which cases we calculated available and harvested volumes for the 2 time periods for the amalgamated units ($n = 24$).

Prior to the downturn, conifer wood utilization (i.e., actual harvested volume compared with that available) did not vary with percent overlap with caribou range ($P = 0.59$; Fig. 3A). Yet, the actual conifer harvest averaged 82% (lowest harvest averaged 42%) of the available volume for this time period; the mean for FMUs with $\geq 50\%$ caribou range overlap was only slightly lower than those with $<50\%$ overlap (80% vs. 82%, respectively [$n = 9$ and 15]). After the downturn, the difference was significant ($P = 0.02$; Fig. 3B). In this time period, the mean for units with considerable overlap ($\geq 50\%$) with the caribou range was much lower than that for more southerly units (32% vs. 49%, respectively), suggesting there are factors that make these units less economically favorable for harvesting within boreal caribou range, such as proximity to mills. We conducted a subsequent review of the most recent published annual harvesting reports (2015–2016) and found that change in harvesting levels in FMUs with $\geq 50\%$ caribou range overlap ranged from $-84.6\%$ to $179.3\%$ that year, with an average change of 1.2% (2 FMUs had a higher harvest level, 4 had lower, 2 unchanged and 1 not reported).

For the majority of FMUs in Ontario, the processing facilities for the wood are not located within the boundaries of the management unit itself; instead, the wood must travel to a variety of mills that range in sizes and specialties for processing. Factors such as hauling costs, including costs associated with road building, are of key importance in determining the economic importance of fiber sources. In fact, between 2005 and 2015, the Ontario Government provided CANS$605 million in industry subsidies to construct and maintain forest access roads, suggesting that road costs are a critical component of economic viability (OMNRF 2015). Yet, even with these subsidies, it is evident that not all wood supply is of equal value to the industry. Forestry operations are harvesting substantially less wood from units that overlap with caribou range, and well below allowable cuts.
The discussion of real economic tradeoffs may be more germane to areas outside Ontario—for example, when considering the cumulative disturbance effects on boreal caribou habitat in parts of western Canada under which sits the world's second largest oil reserve. At a national scale, Alberta's boreal caribou herds are among the most imperiled (Environment Canada 2011, 2017); scientists have estimated that extirpation will occur within decades for most of these herds if population trends do not change (Schneider et al. 2010). Both development associated with petroleum extraction and industrial logging are contributing to cumulative disturbance (Hebblewhite 2017); therefore, the proliferation of seismic lines associated with the oil and gas industry is extensive. This is not a factor in our Ontario case study.

**DISCUSSION**

Manufactured uncertainty is not a new strategy. Economic and ideological interests have used campaigns of denial since the early 21st century to maintain their activities and avoid potential legal responsibility. Most prominently, the lead (Markowitz and Rosner 2002), asbestos (Castleman 2002), vinyl chloride (Markowitz and Rosner 2002), and tobacco industries (Kluger 1996) have been shown to have misled the public to avoid and delay regulation. Climate change denial
campaigns have employed the same strategy, and may well have nearly perfected it. Scientific complexities and intrinsic uncertainties are now regularly exploited in policy-making debates (Dunlap 2013).

The negative and pervasive impacts are considerable. Successful use of this strategy has weakened environmental protection, undermined public debate on policy solutions, enabled harmful activities to continue long after their danger was scientifically established, and even legitimized campaigns for industrial expansion (e.g., Michaels 2008, Jacques et al. 2008). With respect to boreal caribou in Ontario, it has been integral to forestry sector lobbying through trade associations and proxies. Such lobbying has allowed the industry to evade recovery requirements of the province’s Endangered Species Act, 2007 (Ontario ESA) for greater than 10 years, including through a 5-year regulatory exemption approved in 2013. Denial that boreal caribou are in decline, and industrial logging and associated roads have contributed to this decline in significant ways, are used to substantiate the claim that the implementation of stricter habitat management is unnecessary red tape. Despite strong scientific evidence of “the decline, extirpation, and perhaps extinction of several evolutionarily significant units of woodland caribou” across Canada (Johnson et al. 2015:176), little is being done on the ground to stop anthropogenic sources of caribou decline (Festa-Bianchet et al. 2011). Instead, in many ranges, cumulative disturbance continues to increase (Environment Canada 2017).

Manufactured uncertainty also negatively affects forestry-dependent communities by deflecting attention from the real and ubiquitous issues facing the future of Canada’s forest products sector, including the actual causes behind local mill closures and job loss, which are not primarily supply-side driven. Even though the quality and the size of the natural resource base in Canada have not played a significant role, either positively or negatively, in terms of productivity (de Avillez 2014), environmental organizations seeking to protect habitat for boreal caribou and other species are blamed for economic hardship. Our analysis indicates that such job loss rhetoric is exaggerated: in Ontario, for example, current harvesting levels are well below the allowable cut for FMUs that have considerable overlap with continuous caribou range, indicating that not all wood is of equal economic value to the sector (e.g., hauling distances reduce its economic viability). Current harvesting levels could be accommodated with a lower allowable cut; for example, actual harvest levels for FMUs with ≥50% overlap with caribou range during 2011–2015 were only 36% of the allowable on average, and prior to 2005 they were 80%. This gap provides opportunities for alternative and modified land-management activities, including measures focused on the protection of critical caribou habitat.

More broadly, when lobbyists use rhetorical arguments to give “the appearance of legitimate debate where there is none” (Diethelm and McKee 2009:2), it perpetuates “an erroneous view of science” (Oreskes and Conway 2010:268). Although “hearing both sides” of an issue is justifiable when debating values, it is problematic when applied to science (Oreskes and Conway 2010:268). All scientific knowledge is incomplete, whether it be observational or experimental, and open for modification as knowledge advances (Oreskes and Conway 2010). However, legitimate scientific skepticism must comply with the expectations of science, including publication in peer-reviewed scientific journals where methods and findings can be scrutinized. Presenting untested, speculative claims as noncontroversial scientific conclusions, which is a hallmark of climate change denial as well as the denial of caribou decline, confuses the public’s understanding of both the issues and science itself.

CONCLUSIONS

Several forestry corporations, conservative think tanks, industry lobbyists, and their proxies have seeded doubt about the need for boreal caribou habitat conservation, particularly among residents of forestry-dependent communities. As is the case with most biological systems, factors affecting the decline of boreal caribou are complex. Nonetheless, decades of scientific research have yielded transparent and consistent results to inform public policy. Using peer-reviewed scientific literature, we have shown that, in contrast to the current public campaign of denial, boreal caribou is in decline, the distinction of the boreal caribou ecotype is supported by science, and the robust scientific understanding about the way boreal caribou herds use the landscape is sufficient to advance the implementation of critical habitat protection. The relationship between increasing levels of disturbance (i.e., habitat loss and fragmentation) and boreal caribou population decline is well-established, with industrial forestry and associated roads shown as a key driver. Our understanding of how climate change may support or impede boreal caribou recovery is evolving, and there is uncertainty in predicting a future outcome for any specific local population; however, there is sufficient science to support habitat management that limits increases in cumulative disturbance and/or requires restoration. We also find little evidence in Ontario that recent mill closures and job losses are associated with supply problems; instead, the current gap between available harvest levels and actual harvest levels suggests that there is space for alternative management strategies to accommodate caribou recovery efforts.

We have also shown parallels between this campaign and climate change denial campaigns, where economic and ideological interests have used a 3-part strategy to redirect public opinion: first, by questioning the seriousness of problem and portraying environmental groups as untrustworthy “radicals” who falsify or exaggerate evidence (see Buell 2003, Dunlap and McCright 2011); second, by denying responsibility for the problem and the need for new or improved regulation (see Herrick and Jamieson 2001); and third, by claiming that the costs of addressing the problem are unacceptably high. With respect to boreal caribou specifically, we have shown that such lines of argument have served to 1) simplify complex scientific concepts regarding boreal caribou population decline and call into question the scientific rationale for deeming boreal caribou to be at-risk;
2) vilify those who have called attention to caribou decline; 3) dispute scientific consensus that human activities, particularly those that contribute to the increasing fragmentation of habitat, are significant drivers of the decline of boreal caribou; and 4) rationalize claims that caribou conservation will result in catastrophic job loss associated with any reductions in wood supply. Insofar as these arguments blatantly contradict that which is accepted as “established knowledge by the relevant expert community” (Oreskes 2015:3), they comprise a strategy to manufacture uncertainty, with pernicious results.

RESOLVING THE POLITICAL IMPASSE

Conflicts over environmental policy are increasing and need to be managed to minimize negative effects on biodiversity, human livelihoods, and human well-being. Scientists, government agencies, media, and stakeholders can improve engagement in these types of public debate. Scientists should recognize that much scientific work is not reaching the public (e.g., it has been suggested that the average readership of a zoological paper is fewer than 6 people; Parsons 2013). As such, there is a significant opportunity, and perhaps responsibility, to engage in civic science whereby scientists reach out to the public, communicate scientific results, and contribute to scientific literacy. As part of civic science, scientists should also publicly refute false and inaccurate claims, and effectively communicate risks to public audiences. In addition, some surveys suggest that the public no longer trusts bureaucracies to make decisions on technical matters, and prefers that scientists move beyond simply reporting results to being actively involved in interpreting and integrating scientific results into policy decisions (e.g., Lach et al. 2003). Scientists can and should promote better understanding and use of scientific information by policy advocates and policy makers (Doremus and Tarlock 2005). Scientists can remain objective while expressing risk and outcomes in the development of alternative policy trade-offs, and thereby suggest alternatives for meeting specific policy goals (Noss 2007). Further, scientific uncertainty is best incorporated into policymaking frameworks as knowledge. As with all science, new findings will emerge. However, all new science must be considered within the context of what is already known.

Governments are responsible for the public interest, and most governments in Canada have committed to science-based policy. When the OMNRF published its Integrated Range Assessments for boreal caribou in 2014, it communicated these results largely through segregated information sessions with different interest groups and First Nations. The result was that the publicly funded research perpetuated silos of (mis)understanding and did not serve to foster trust or convergence among perspectives. Governments should engage in more transparent, risk-based communications when conveying policy options to the public. In this way, governments can help limit the ability of groups with a vested interest in scientific, judicial, or regulatory outcomes to use manufactured uncertainty as a tool to obstructing judicial and regulatory decisions (Rohr and McCoy 2010).

The media also have an important responsibility: how evidence is presented by journalists can heighten readers’ uncertainty perceptions around scientific conclusions (Dixon and Clarke 2013). For most people, “the news media are the most important sources of information about environmental issues” (Herrick and Jamieson 2001:11). Therefore, press releases on controversial issues should not be published as news. Many news sources must better distinguish between journalism and opinion editorials. Journalism requires adhering to principles of accuracy, independence, and impartiality. In the case of media outlets in northern Ontario, providing an opportunity for caribou scientists to support or refute statements made by interest groups, within the same coverage, is critically important for increasing public understanding of science.

The forest industry and ENGOs are 2 key stakeholders embroiled in this debate. The resolution of these conflicts requires these parties to recognize problems as shared, including approaches that establish clear goals, with a transparent evidence base, and an awareness of quantified trade-offs. As such, to achieve sustainability in the forestry sector, the debate should now focus on goal-setting and implementation of caribou conservation strategies, including range plans and protection of critical habitat, which have the highest likelihood of achieving long-term caribou persistence while minimizing effects to jobs in the sector. Acknowledging that boreal caribou are in decline and industrial logging and associated road building are central factors in that decline would open the current dialogue to larger management questions, such as the sustainability of current harvest levels, the expectation of industrial expansion, and the long-held position by some in industry that no additional government regulation is required to protect species at risk. There are forestry companies (e.g., Tembec [now Rayonier], Alberta-Pacific Forest Industries) that have acknowledged the best available scientific evidence and focused on developing solutions within their sphere of responsibility rather than publicly exploiting campaigns of denial. Additionally, Forest Stewardship Council (FSC) Canada (which certifies >54 million ha of forests in Canada) has affirmed that forest management that supports the recovery of boreal caribou is an important sustainability metric in Canada. In 2010, FSC Canada convened a science panel to carry out a review of the adequacy of its voluntary National Boreal Standard in addressing boreal caribou conservation issues. The panel’s report (Dzus et al. 2010) made a number of recommendations for strengthening its standard and provided a framework for integrating risk associated with cumulative disturbance. In addition to stakeholders, there are First Nations who have developed caribou recovery plans that are consistent with scientific guidance of the Federal Recovery Strategy. For example, Fort Nelson First Nation (FNFN), in northeastern British Columbia, developed and released the Medzh (boreal caribou) Action Plan to address the habitat loss that has led to the rapid decline of boreal caribou, which once occurred in large numbers in FNFN’s territory (Fort Nelson First Nation 2017). For future direction, Jamieson and Hardy (2012) present a succinct
rule of argument that, if all stakeholders adopted, would benefit public discourse on controversial issues: 1) assertions should be backed by relevant evidence, 2) the fairness and accuracy of evidence should be subject to scrutiny, 3) evidence must be presented within its context, 4) relevant evidence must be disclosed not suppressed, and 5) like items should be compared to like. Many boreal caribou populations are declining, in some cases, precipitously. Cumulative disturbance, including industrial logging and associated roads, is a key driver of that decline. Addressing the population decline need not result in catastrophic job loss because there is sufficient wood supply available (at least in ON, Canada) to maintain jobs in the forest product sector and increase caribou habitat protection, if this is undertaken now. The opportunities for recovery will diminish if vested interests continue to challenge the evidence of population declines and undermine the need for increased caribou habitat protection. **ACKNOWLEDGMENTS** The authors wish to thank 2 anonymous peer-reviewers and the Wildlife Society Bulletin Associate Editor, who provided useful insights that improved the quality of our paper. We also thank Dr. J. Ray (Wildlife Conservation Society Canada) for her review and advice on our original manuscript, and Dr. A. Bell (Ontario Nature) for her editorial comments and suggestions. **LITERATURE CITED** Anderson, K. 2015. Mayor “disappointed” by caribou response. Kapuskasing Times. http://www.kapuskasingtimes.com/2015/08/17/mayor-disappointed-by-caribou-response. Accessed 17 Aug 2015. Antilla, L. 2005. Climate of skepticism: US newspaper coverage of the science of climate change. Global Environmental Change 15:338–352. Antonio, R. J., and R. J. Brulle. 2011. 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