Polar Biol (2008) 31:399–407
DOI 10.1007/s00300-007-0377-9

REVIEW

The matter of spatial and temporal scales: a review of reindeer and caribou response to human activity

Ingunn Vistnes · Christian Nellemann

Received: 21 November 2006 / Revised: 3 October 2007 / Accepted: 3 October 2007 / Published online: 30 October 2007

Abstract Research on impacts of human activity and infrastructure development on reindeer and caribou (*Rangifer tarandus*) is reviewed in the context of spatial (m to many km) and temporal (min to decades) scales. Before the 1980s, most disturbance studies were behavioral studies of individual animals at local scales, reporting few and short-term (min to h) impacts within 0–2 km from human activity. Around the mid 1980s, focus shifted to regional-scale landscape studies, reporting that *Rangifer* reduced the use of areas within 5 km from infrastructure and human activity by 50–95% for weeks, months or even years and increased use of remaining undisturbed habitat far beyond those distances. The extent could vary with type of disturbance, sex, terrain, season, and sensitivity of herds. Of 85 studies reviewed, 83% of the regional studies concluded that the impacts of human activity were significant, while only 13% of the local studies did the same. Accurate assessment of impacts from human activity requires regional-scale studies, a pattern confirmed in a few long-term (decades) pre- and post-development studies. Such long-term studies are needed to improve understanding of both temporal and spatial patterns.

Keywords Caribou · Disturbance · Oil · Pipelines · Reindeer · Roads · Scale

I. Vistnes (✉)
Norut NIBR Finnmark, Follumsvei 33, 9510 Alta, Norway
e-mail: ingunn.vistnes@finnmark.norut.no

C. Nellemann
Norwegian Institute for Nature Research,
Fakkelgården, Storhove, 2624 Lillehammer, Norway

Introduction

Over the last century, humans have dramatically altered the face of the planet and triggered the highest extinction rate of flora and fauna in recent history (Chapin et al. 2000; Clark et al. 2001; Loreau et al. 2001). Roads, railway lines, power lines, airports, harbors, and dams form the skeleton of the modern world (UNEP 2001), which are necessary for accessing, developing, and transporting people, goods, and services (Leinbach 1995). Infrastructure development, however, has many environmental costs and has been shown to disrupt the physical environment, alter the chemical environment, impact species relationships, accelerate introduction of invasive species, modify animal behavior, and induce changes in land use in areas proximate to developed roads (Andrews 1990; Forman and Alexander 1998; Lawton et al. 1998; Trombulak and Frissell 2000). Growth in infrastructure and subsequent habitat fragmentation has also been shown to negatively impact the ability of wildlife to cope with climate change (Thomas et al. 2004; Tyler et al. 2006).

In the Arctic, natural resources exploitation and anthropogenic activity is more recent, and has expanded rapidly during the last 30 years (UNEP 2001), driven largely by the region's large reserves of hydrocarbons and minerals (UNEP 2004; Kryukov and Moe 2005). Today oil and gas development is the keystone to many northern economies, with plans underway to extend infrastructure and development networks to new regions (UNEP 2004; Cizek 2005). Examples of this expansion are found in the Yamal Peninsula of Russia, in the National Petroleum Reserve and Arctic National Wildlife Refuge of Alaska, and in the Barents Sea region.

Following the large industrial development projects of petroleum exploration and hydroelectric power in Canada