

The Effects of Backcountry Skier-Wildlife Interaction on Wildlife

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▪ Introduction

Outdoor recreation is a growing use of the landscape. Non-motorized recreation is often viewed as benign because of its dispersal over large areas (Stankowich 2008). Yet it is exactly this dispersal that poses a challenge for the wildlife that call these outdoor playgrounds home. The behavior of recreationists, which includes the predictability, frequency, and location of an activity are the factors that influence wildlife disturbance (Stankowich 2008, Knight and Cole 1991).

A growing non-motorized recreational use in the United States is backcountry skiing. There is little research on backcountry skiing, which presents new challenges to wildlife and land managers as they work together to provide access to public lands. Drivers of backcountry skiers are mainly anecdotal and include access to untouched powder, a desire to not support lift-serve ski resorts, to be part of a community, and to explore. Of these drivers, access to untouched powder is affected by the number of skiers who ski in one place on a powder day. The more users there are, the more terrain is needed.

Therefore, as backcountry ski use has risen trail and skiers have spread across the landscape trying to carve out their own stash of powder. Stankowich's literature meta-analysis showed that rapidly or directly approaching humans are more distressing for wildlife than slowly or indirectly approaching humans (2008). It was noted that hikers are particularly surprising to wildlife when they come from above and over a ridge. Backcountry skiers follow a similar pattern to hiking as they ascend mountains on skis and descend at high speeds. Backcountry skiing is therefore less predictable for wildlife than on-trail skiing and results in a large zone of influence on wildlife (Neumann 2010, Taylor and Knight 2003, Miller et al. 2001, Chester 1980).

Recent assessments suggest that recreationists, like predators, affect wildlife individual fitness and in turn population dynamics (Knight and Cole 1991, Creel 2005, Creel et al. 2007, Creel et al. 2008, Boonstra et al. 2008, Neumann et al. 2010). This is important to understand and communicate to the public because non-motorized recreationists tend to believe that their activities are benign due to their dispersal across large areas (Stankowich 2008, Miller et al. 2001). This wide distribution may actually exacerbate user effect on wildlife. Studies have found that recreationists are more likely to support restrictions if they understand how wildlife will benefit (Purdy et al. 1987, Harris et al. 1995). This paper aims to address three effects on wildlife when they perceive a threat (i.e. recreationists). Management suggestions associated with each effect are also included. A combination of evidence-based management and user group self-regulation is integral to the success of managing backcountry skiing.

▪ **Wildlife Behavioral Ecology and Disturbance**

Wildlife has two main response mechanisms to disturbance (Knight and Cole 1991). One is the hardwired genetic response that predisposes them to certain behaviors, such as flight in response to sighting a predator. These responses can be compounded by environmental factors. The second is the learned response, which occurs only after a number of interactions between individuals and stimuli over a lifetime (Knight and Cole 1991). The learned response is why animals that are hunted tend to react more quickly to human presence. These two response mechanisms mean that anthropogenic stressors can trigger both the genetic response if they are perceived as predators as well as the learned response.

The three main actual responses of wildlife to threats are avoidance, habituation, and attraction (Knight and Cole 1991, Whittaker and Knight 1998, Stankowich 2008, Geist 1974). Avoidance occurs when an animal takes flight or in the long-term changes its location. Habituation occurs when the animal becomes accustomed to a disruption, such as elk enduring tourists in Yellowstone National Park. Attraction happens when wildlife seeks out humans, such as when a black bear seeks food at campgrounds (Whittaker and Knight 1998). Avoidance behavior is of particular interest in relation to recreation because of its subtle, long-term effects on individual fitness and population dynamics.

Wildlife react most to spatially unpredictable activities (Taylor and Knight 2003; Miller et al 2001). Backcountry skiing is viewed as an unpredictable activity because it takes places off trail and throughout the landscape. The number of skiers can vary from day to day, which does not foster wildlife habituation. Therefore, backcountry skiing may reinforce avoidance behavior, which triggers risk effects.

▪ **Risk Effects Experienced by Wildlife After Disturbance**

Avoidance behavior causes risk effects in wildlife with flight being the most obvious, but not the most harmful one (Creel et al 2008, Thiel et al 2008, Blumstein et al 2003). According to Creel, risk effects are the product of hundreds or thousands of small actions, with individually small effects on fitness that eventually add up and lower overall fitness (2005). This is true for both small and large animals (Ruxton 1997). There is some evidence that risk effects influence trophic cascades as shown in Figure 1 (Schmitz et al. 1997). This paper will focus on three effects: flight, change in habitat use and forage change, and increased vigilance (Creel et al. 2008, Knight and Cole 1991, Creel et al. 2005, Taylor and Knight 2003, McArthur 1989).

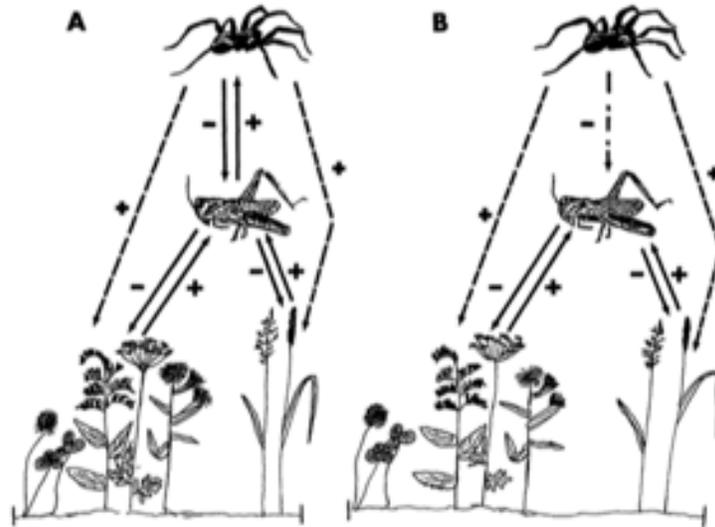


Figure 1. Hypothesized mechanisms driving trophic cascades in the experimental old-field system composed of spiders, grasshopper nymphs, and herbaceous vegetation (forbs and grasses). Solid lines represent direct consumer-resource interactions (+/-). Dashed lines represent indirect interactions. The dash-dotted line represents a nonlethal effect or behavioral modification. In (A), trophic cascades are brought about by the direct lethal effects of spiders on grasshopper nymphs. In (B), trophic cascades are induced indirectly by spiders causing shifts in grasshopper foraging behavior and increasing starvation risk. (Schmitz et al. 1997)

◆ Flight

Flight is the most commonly identified human wildlife interaction. It has generally been studied in relation to large mammals. Large mammals exhibit the greatest response when human activity is spatially unpredictable (Miller et al 2001). Whether or not an animal flushes depends on a number of factors including location, frequency, and predictability of disturbance (Knight & Cole 1991).

Flight is traditionally assessed using a flight initiation distance, which looks at how far away a threat is from an individual before they flee. Influencing factors of flight initiation distance are angle of approach, time of year, time of day, reproductive state, distance to refuge, whether or not the population is hunted, type of disturbance, etc. (Blumstein et al 2003). However, flight initiation distance may not be the most accurate indicator if there is not another site for the animal to move to. An animal living in an area with no alternative site may not flee when disturbed. People often assume incorrectly that no movement means that the animal is habituated and thus not affected by the disturbance (Stankowich 2008).

Various studies have shown that a lack of flight does not equal a lack of effect. A study of wood grouse (*Capercaillie Tetrao urogallus*) shows that there is a negative physiological effect that occurs without an observable behavioral response (Thiel et al 2008). These individuals are experiencing risk effects even when not in flight. In a study of Snowshoe hares, Boonstra links stress to lowered individual fitness, which can affect reproduction and in turn may affect population dynamics (1998). This is supported by

Creel's work that indicates that without consideration of the indirect effects of predation, decreased reproduction would be mistaken for bottom-up limitation by resources (2007). These studies show that a lack of flight can be just as harmful as flight and likely compounds any stress induced by the flight itself.

Another quirk of flight relates to individual fitness. Malnourished individuals are less likely to flush and will flush shorter distances than individuals in good nutritional condition (Knight & Cole 1991). This could be particularly important for animals already under stress, such as northeastern moose that have experienced a recent population decline related to heavy tick loads.

There is also evidence that flight initiation is species-specific. Different animals have different flight initiation distances based on both their genetic and learned response mechanisms. For example, large mammals that are hunted may flee when the perceived threat is at a further distance than non-game animals. Large mammals are generally more likely to flee a longer distance than small mammals (Blumstein et al. 2003).

Management Implications. Flight initiation distances have been used to estimate areas of influence around existing trails (Taylor and Knight 2003). An area of influence is the area that parallels a trail or line of human movement within which wildlife will flush from a particular activity with a certain probability (Miller et al. 2001). Using areas of influence, managers can estimate the most appropriate trail density for a given recreational activity and particular area. If trails already exist at high density, then managers may choose to designate management zones for a particular recreation activity. A management zone allows for human use while keeping parts of the landscape free of trails (Papouchis et al 2001, Miller et al. 2001). Since backcountry skiing is inherently an off-trail activity, a management zone approach is likely the best approach for managers. Management zones can be established using existing data on wildlife and recreation use and will help foster self-regulation in the community by identifying a boundary of acceptable use.

◆ **Change in Habitat and Forage Use**

Regular disturbance in an area can lead individuals or groups to change their habitat and forage use to less desirable, but safer habitat. A change in habitat can alter feeding ecology (Knight and Cole 1991, Papouchis et al. 2001, Miller et al. 2001). Backcountry skiing causes a disturbance and in certain popular areas, may fall under the category of regular disturbance.

Black bears are vulnerable to habitat change when faced with human disruption. A study in the Sierra Nevada Mountains looked at overwintering den abandonment after human disturbance. The work focused on disturbance near ski resorts, specifically Lake Tahoe. A major problem was the similarities between den sites selected by black bears and those selected by ski resorts for ski runs. Both bears and skiers prefer slopes with northeast aspects because of high snow accumulation, decreased sunlight, and prevailing winds.

These qualities ensure that these locations will hold snow for the longest (Goodrich and Berger 1994).

A high overlap between bear denning sites and potential winter recreation areas indicated a high potential for den abandonment due to human disturbance. This affect is magnified when applied to female bears that will abandon her den and her cubs, which may have longer-term affects on the population. Bears tended to remain active after the abandonment. This disturbance adversely affects individual fitness and reduces physical condition (Goodrich and Berger 1994).

In another black bear study in the Rocky Mountains of Colorado, a shift in home range use by black bears was examined. McCutchen showed that the black bears changed their home ranges in relation to human activity (1989). They transitioned to using poorer quality habitat to avoid humans. This movement of home range due to a perceived threat links to Scott Creel's work on elk herds displaced by wolves in Yellowstone National Park (2005).

Wolves constrain habitat selection by elk in Yellowstone National Park simply by their presence. Elk move from preferred, high quality grassland foraging to wooded areas for protection. The wooded areas provide lower quality forage. Long-term lower quality foraging can affect the fitness of a group of elk versus the loss of one animal lost to predation. Therefore, wolves may have a greater effect on elk dynamics than would be predicted by direct predation alone. Many prey species alter their use of habitats in response to predation risk, trading a reduction in forage quality or quantity for increased security (Creel 2008). A strong shift in habitat selection is likely to alter diets or energy budgets (Creel 2005). Although recreationists are not predators, wildlife respond to human recreationists as if they were predators, therefore recreationists may be affecting population dynamics.

In a study done on chamois reaction to joggers, hikers, and mountain bikers in Switzerland, it was found that fewer chamois stayed in the pastures of the study area after the experiment than before (Gander and Ingold 1997). This study is important because it shows that there is a sustained behavior change after disturbance (Figure 3).

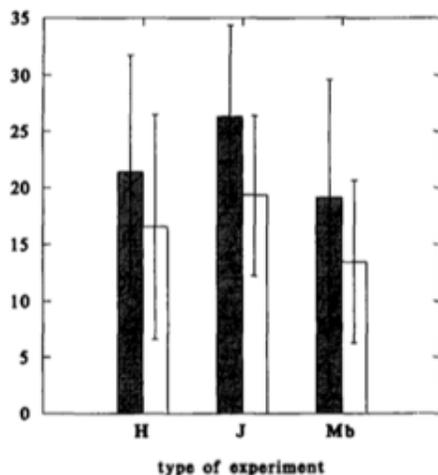


Figure 2. Mean (\pm SE) number of chamois staying in all the pastures of the study area before (hatched bars) and after experiment (blank bars). H: hiking experiments ($n=11$, $p=0.005$), J: jogging experiments ($n=9$, $p=0.011$), Mb: mountain biking experiments ($n=9$, $p=0.021$; two-tailed Wilcoxon signed ranks test, respectively). (Gander and Ingold, 1997)

Off-trail recreationists have the potential to cause changes in habitat and forage use of wildlife populations. Combining what is known about local wildlife population distributions and habitat distribution in an area will help inform land managers on where to encourage and discourage use. Otherwise, the loss of suitable habitat might reduce the carrying capacity on public lands (Taylor and Knight 2005).

Management Implications. Since recreation alters forage and habitat use by wildlife some management steps need to be taken. For the general disturbance of wildlife, the management zone technique mentioned under flight, is a good option. A specific concern surrounding backcountry skiing is black bear den disturbance. Various studies suggest protecting black bear denning areas from human disturbance during winter (Goodrich and Berger 1994, Papouchis et al 2001). The Vermont Department of Fish and Wildlife has had success with closing cliffs for nesting peregrine falcons every summer, which includes closing trails leading to the cliffs. The program is publicly well known and effective. This provides a framework for closing bear denning areas in winter. Furthermore, in places where trails are currently being proposed or built, managers can restrict the number and spatial arrangement of trails so that sensitive areas or habitats are avoided (Miller et al 2001).

◆ **Vigilance**

Vigilance refers to an animal's alertness in relation to predator threats. As noted before, recreationists are perceived as predators. A study of skier/moose interaction in Sweden showed that moose moved significantly faster during the first hour following a disturbance, which doubled their energetic usage per kg of body weight. On top of this their movement rates increased for the three hours following disturbances with no evidence of habituation found (Neumann et al. 2010). A lack of habituation increases the risks to wildlife because when they resist habituation there are more severe consequences on an individual's energy budget when the animals' risk perception is high (Neumann et al. 2010). This could provide particularly important insight when planning management for backcountry skiing because of the irregularity of users and the frequency of the disturbance.

Management Implications. Again, management zones for backcountry skiing would likely help this by ensuring a refuge for wildlife outside of the designated use area. Since vigilance is hard to see, developing educational materials for users that promotes the understanding of human disturbance on wildlife. Through education, land managers can inform recreationists of how their activities affect wildlife and how they can modify their behavior to minimize impacts (Miller et al 2001). Effective education can also aid in users developing a conservation ethic, which is crucial for self-regulation to be effective.

▪ **Conclusion**

Backcountry skiers trigger avoidance behaviors (Taylor and Knight 2003) and the risk effects associated with them. Understanding where wildlife and recreationists uses overlap is important. It is also important to look at all winter recreation uses, to understand the full extent of possible wildlife interaction because recreational activities should not be viewed in isolation (Knight and Cole 1991). There may be synergisms or connections when more than one recreational activity is occurring simultaneously (Knight and Cole 1991). For instance, there are backcountry ski trails off the backsides of most ski resorts in Vermont, which results in the tallest mountains in Vermont being full of recreationists in winter. These could have compounding affects on each other (Bell and Austin 1985).

Creating robust, adaptable recreation management strategies depends on including people on the landscape. Good planning relies on transitioning away from anecdotal approaches, to systematic evidence-based ones (Sutherland et al 2004). Long-term this will create stronger conservation outcomes throughout landscapes that recognize nature as dynamic and resilient, in our midst rather than far away, and integral in sustaining human communities (Marvier et al 2012).

All of this is important when thinking about recreation and wildlife as trails continue to spider across our conserved landscape. Backcountry skiing is all off trail and thus, creates clusters of lines through the woods that may increase the area of influence of a backcountry skier in a particular area.

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