# ECOLOGICAL IMPACTS OF RECREATIONAL USE OF TRAILS: A LITERATURE REVIEW

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**SUMMARY:** Recreation such as hiking, jogging, horseback riding, and photography can cause negative ecological impacts to ecosystems, plants and wildlife including trampling, soil compaction, erosion, disturbance (due to noise & motion), pollution, nutrient loading, and introduction of non-native invasive plant species. Corridors such as trails and roads also cause habitat fragmentation and edge effects which may impact some plant and animal species. Thirty references are cited.

**SOURCES OF INFORMATION & SUBJECTS:** This document is based on references obtained from online data base searches, journal articles, information from internet searches, and personal communications. I found many articles on the impact of backcountry camping and horse packing in the western US (which I did not pursue or include in this review), quite a few articles on impacts of recreational use on birds, and one review paper on effects recreation on mammals, birds and herps. I found very few references on possible introduction of invasive non-native plants by hikers or horses, and almost nothing on bicycles or ATVs. Although the primary emphasis of this review is on recreational impacts from trail use, I have also included some articles on powerlines and small roads since they may cause habitat fragmentation and edge effects similar to those caused by trails, although on a somewhat larger scale.

## TYPES OF RECREATIONAL TRAIL USE (possible sources of stress/threats)

Horseback riding
Hiking, jogging, bird watching, photography
Bicycling
ATV use (all-terrain vehicles)

## STRESSES (all somewhat inter-related)

Trampling
Habitat disturbance or modification (noise & motion of recreational users, erosion, soil compaction etc.)
Competition (from introduced exotics)
Habitat fragmentation/edge effects (microclimatic change, reduced dispersal/migration, increased predation)
Nutrient loading (horse and hiker manure & urine)
Pollution (food waste, dangerous litter such as fishing line, plastic six-pack tops)

## TARGETS POTENTIALLY AFFECTED

Ecological communities
Plant species
Birds
Amphibians? Others?

**Trampling:** Effect of trampling is fairly limited, extending only about one meter from the trail's edge (Dale & Weaver 1974, Dawson et al. 1974). Trampling causes compaction of leaf litter and soil; compaction by horses is greater than by hikers (Dawson et al. 1974, Whittaker 1978). Some plant species decrease near trails, especially woody plants since they are brittle (like low shrubs or tree seedlings; Tonnesen and Ebersole 1997) but also more delicate herbaceous plants. Grasses and sedges are most tolerant of trampling (Dale & Weaver 1974, Douglas et al. 1975). Horses destroyed eight times as much cover and created an order of magnitude more bare ground than hikers (Nagy & Scotter 1974).

**Habitat disturbance (Trail width and depth):** Width increases linearly with logarithmic increase in number of users (width doubles with 10-fold increase in use). Trails in meadows are a little wider than trails in forests. "Trails with both horse and foot traffic are similar in width or slightly narrower than those receiving foot traffic alone" [NOT what we've observed in T. Roosevelt Co Park on Long Island]. .. Trails used by horses and people are deeper than those used by people alone" [agrees with Long Island observations] (Dale & Weaver 1974).

**Habitat disturbance (noise & motion):** Based on an extensive review of recreation effects on birds, Bennett and Zuelke (1999) concluded that disturbance from recreation clearly has at least temporary effects on behavior and movement of birds. Direct approaches caused greater disturbance than tangential approaches, rapid movement by joggers was more disturbing than slower hikers, children and photographers were especially disturbing to birds, horses did not seem to disturb birds, and passing or stopping vehicles were less disturbing than people on foot. No studies specifically addressing bicycles were found. Road noise has been shown to negatively affect birds (reduced nesting, etc.) at distances of up to 1,000 m (Forman 1998 ESA talk), so noise from trail users might also affect birds but presumably over shorter distances. Boyle and Samson (1985) reviewed 166 articles containing original data and found negative impacts reported in 81% of them.

**Competition (from introduced exotics):** Few references are available on introduction of exotics by hikers and horses, and is an area in need of more research (Williams & Conway-Durver 1998). Dale & Weaver (1974) studied hiking and horse trails in the Northern Rocky Mountains, and reported that some plant species appeared only at trail sides (invaders) and several of these were non-native. He speculated that these species may be favored by microclimatic edge effects and nutrient enrichment from horse urine and manure. Benninger (1989) reported that horse manure contained viable seeds of at least eight exotic species, and she presumed that horse scat may be a dispersal mechanism for some exotic species. In her study of forested areas in Rocky Mountain National Park she found significantly less plant cover, and more exotic plant species near trail edges; exotic species tended to be more abundant on more heavily used trails; and total species richness (but not exotic richness) was significantly negatively correlated with distance from trailheads (Benninger-Truax et al. 1992). They inferred that trail corridors were serving as conduits for movement of species (Benninger-Truax et al. 1992). Exotic species richness in Montana grasslands was highest near road edges and steadily declined out to 100 m, the most distant sampling position (Tyser and Worley 1992). However, the gradient for three back-country trails

was much less pronounced due to high numbers of exotic species at 100 m distant. They believed the widespread distribution of exotic grasses was due to past pasturing of concession horses. The two most abundant exotic species near both roads and trails were timothy (*Phleum pratense*) and bluegrass (*Poa pratensis*), species that had been included in past roadside seeding (and are common in pastures and hay).

Timothy is an aggressive exotic at Yellowstone (Meyers-Rice pers. comm.). Other grasses common in pastures and hay that can be weedy are Lolium multiflorum and Lolium perenne (rye grass); common wildland weeds closely related to cultivated oats are Avena fatua and A. barbata (Meyers-Rice pers. comm.). In addition to spreading weeds in their manure, horses may collect and spread weed seeds via their tails (Meyers-Rice pers. comm.).

In T Roosevelt Co Park, Montauk LI, NY, several exotic grasses appear more abundant along the sides of horse trails including velvet grass (Holcus lanatus), bluegrass, fescue, orchard grass and timothy (Jordan, unpub. obs.). These grasses are common in pastures and hay, and probably have been introduced by the horseback riding concession. Bentgrass (Agrostis alba/tenuis), is found throughout the park and in essentially all grasslands on Long Island. Bentgrass likely was an early introduction by European settlers.

Lespedeza cuneata (Chinese lespedeza) occurs along a trailside in pine barrens forest in the Peconic River Headwaters, LI, NY near but outside of a DEC "food plot" where this invasive exotic had been planted (cover for released pen-reared game birds)(M. Jordan unpub. obs). The vector for seed movement is unknown.

It is not possible to tell from reports of weeds along trail sides if the weedy species were actually out-competing native species, or if they were just "filling in" ecological space opened up by reduction of native species due to unfavorable environmental change (due to trampling, microclimate change, etc.). Some of both probably may occur, depending on circumstances. It is also not possible to tell how the weeds got there, although hikers could conceivably carry weed seeds on their clothes and shoes and move them to new areas (potential research study - stop hikers at trail heads and scrape their boots! Measure weed abundance relative to distance from trailheads). A correlation analysis of literature from 184 studies from around the world found that the number of exotic species in nature reserves increased with the number of visitors, but no conclusions could be drawn about roles of dispersal and disturbance since other variables were involved (Lonsdale 1999).

**Habitat fragmentation/edge effects:** Microclimatic changes (increased sunlight, increased rainfall due to reduced canopy interception, increased wind, decreased humidity, altered temperature regime, etc.) have been documented within the edges of forests adjacent to clearings (Chen et al. 1999, Saunders et al 1991, Wildove et al. 1986) and similar effects probably could occur along a forest trail wide enough to open up the canopy (Cole, N. 1978, Dale and Weaver 1974). These microclimatic alterations could result in plant species changes and might also affect wildlife. Several references document negative impacts on breeding bids of recreational trails as narrow as 1-3m wide in forest and grasslands (Miller et al. 1998, Hickman 1990), as well as by dirt

roads and powerlines (Kroodsma 1982, Askins 1994). The negative impacts included decreased nesting near trails, altered bird species composition near trails, and increased nests predation by cowbirds, skunks, racoons and foxes using the clearings as corridors. These effects are possible even if the forest canopy is not opened by the trail (Hickman 1990).

Trails also might impede movement and dispersal of some animals that are reluctant to cross openings, especially those with exposed bare soil.

**Nutrient enrichment:** Nutrient enrichment from horse manure and urine is a likely factor that could favor invasion of weedy species along horse trails. Research has shown that experimentally fertilized grasslands undergo a dramatic species change resulting in increased abundance of non-native grasses, decline of native grasses and decreased diversity (Wedin & Tilman 1996).

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