

Evidence Table

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Name of Evidence Review:	Uplands Evidence Review
Name of Review Sub-topic (if any):	Tracks
Review Question	Do type of vehicle and usage influence the impact of the track upon either the structural integrity or hydrology of the blanket peat?

Study Details	Population and setting	Methods of allocation to intervention / control	Outcomes and methods of analysis (inc effect size, CIs for each outcome and significance)	Results	Notes
<p>Authors: Arp, C.D. & Simmons, T.</p> <p>Year: 2012</p> <p>Aim of study: Analyzing impacts of off-road vehicles on watershed processes.</p> <p>Study design: Correlation and observational</p> <p>Quality Score 2+</p> <p>External validity:</p>	<p>Source population: mineral and organic soils .</p> <p>The number of ORV movements varied between 45 on the least used track to 155 on the most used.</p> <p>These figures are round trips per year.</p> <p>Setting:</p>	<p>Methods of allocation: Study sites determined by existing use.</p> <p>Intervention description: comparison of present development and use of tracks with historical aerial imagery.</p> <p>Control / comparison description: Nearby site not subject to vehicle use.</p> <p>Sample sizes: 9 tracks with 1 track (2km in length) focused</p>	<p>Primary outcome measures: Headwater expansion of drainage channels. This evidence table focuses upon the observations relating to the tracks on organic soil.</p> <p>Secondary outcome measures: n/a</p> <p>Follow-up periods: none given.</p> <p>Methods of analysis:</p>	<p>1. Damage varied depending upon trail use, soil type and associated vegetation.</p> <p>2. More than half of trails crossing mineral soil had some vegetative cover.</p> <p>3. Sections of trail crossing organic soils often had extensive braiding with an average of 8 semi-parallel tracks covering a width of 17-125</p>	<p>Limitations identified by author:</p> <p>Limitations identified by review team: Could have done more to quantify damage to soil structure and to estimate erosion rates although study was mainly aimed at identifying the processes taking place.</p> <p>Evidence gaps and/or</p>

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<p>2+</p>	<p>national park in Alaska, USA</p>	<p>upon for additional study.</p> <p>Baseline comparisons:</p> <p>Sufficiently powered: no power given. Likely under-powered.</p>	<p>comparison of aerial imagery plus some data collection from track focused upon.</p>	<p>metres.</p> <p>4. About 25% of trail braids on organic soils were un-vegetated, while the rest supported some vegetation on newly formed or infrequently-used trails or had re-vegetated following inactivity. In addition, these areas were characterized by the presence of ponded water in trail depressions resulting from a combination of erosion and thaw-subsidence.</p> <p>5. More severely degraded trails were consistently found along the upslope edge of the trail corridor.</p>	<p>recommendations for further research: Long-term study to determine extent of hydrogeomorphic processes and impacts upon streamflow , water quality and aquatic habitat.</p> <p>Sources of funding: U.S. Geological Survey?</p>
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				6. On organic soils, trails could be divided into locations with major thaw-subsidence and erosion forming pools and areas of denuded vegetation only without standing water.	
<p>Authors: Robinson, L., Corner, R. W. M., & Roberts, F. J.</p> <p>Year: 2006</p> <p>Aim of study: Reporting on damage caused by motorcycles and quad-bikes</p> <p>Study design: Qualitative and observational</p> <p>Quality Score: 3+</p>	<p>Source population: n/a</p> <p>Eligible Population: n/a</p> <p>Inclusion & exclusion criteria: n/a</p> <p>Setting: North Pennines, England.</p>	<p>Methods of allocation: n/a</p> <p>Intervention description: use by motorcycles and quad-bikes on range of upland habitats.</p> <p>Control / comparison description: n/a</p> <p>Sample sizes: n/a</p> <p>Baseline comparisons: n/a</p>	<p>Primary outcome measures: n/a</p> <p>Secondary outcome measures: n/a</p> <p>Follow-up periods: n/a</p> <p>Methods of analysis: n/a</p>	<p>States that:</p> <ol style="list-style-type: none"> 1) Erosion of wettest ground is one of the most damaging features. 2) Quaking bog partially drained by tyre channels running through it. 3) Tyre ruts re-directing small drainage channels. 4) Tyre tracks destroying plants 	<p>Limitations identified by author: None.</p> <p>Limitations identified by review team: None.</p> <p>Evidence gaps and/or recommendations for further research:</p> <ol style="list-style-type: none"> 1) Recovery rates of mire/flush vegetation post damage. 2) Quantification of alteration to drainage systems.

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External validity: 3+		Study sufficiently powered: n/a		and altering drainage dynamics of flushes.	3) Do altered drainage systems recover naturally? 4) Is there a threshold for use and if so, what is it? Sources of funding: Not given.
Study Details	Population and setting	Methods of allocation to intervention / control	Outcomes and methods of analysis (inc effect size, CIs for each outcome and significance)	Results	Notes
<p>Authors: Nugent, C. Kanali, C., Owende, P. M. O., Nieuwenhuis, M. & Ward, S.</p> <p>Year: 2003</p> <p>Aim of study: To quantify levels of soil compaction and surface rutting due to excessive passes by typical wood harvesting and extraction</p>	<p>Source population: Afforested blanket bog.</p> <p>Eligible Population: n/a</p> <p>Inclusion & exclusion criteria: n/a</p> <p>Setting: Ireland.</p>	<p>Methods of allocation: Forestry plots requiring thinning/felling.</p> <p>Intervention description: 1 pass by harvester and 1 pass by harvester plus 2 passes by forward loader.</p> <p>Control / comparison description: Same site, no passes by either vehicle.</p> <p>Sample sizes: 24 readings on</p>	<p>Primary outcome measures: Quantification of impact upon soil compaction and rutting.</p> <p>Secondary outcome measures: n/a</p> <p>Follow-up periods: n/a</p> <p>Methods of analysis: t - tests</p>	<p>1. Generally, the influence is confined to top 40cm. 2. Initial soil strength significantly influenced rut development. 3. Proportion of rut depth data that exceeded 15% of the overall wheel diameter was about 5%. 4. Average rut depth after harvester</p>	<p>Limitations identified by author: None</p> <p>Limitations identified by review team: Rutting is seen in context of preventing machines from operating so that only rutting beyond a certain depth seen as significant. What is not disputed is that rutting takes place.</p>

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<p>machines and to establish threshold limits for use of machine traffic.</p> <p>Study design: Quantitative experimental.</p> <p>Quality Score: 2++</p> <p>External validity: 2++</p>		<p>each 'rack'.</p> <p>Baseline comparisons:</p> <p>Study sufficiently powered</p>		<p>traffic 10.2×10^{-2} cm/m with a range of 0.7-24.7 $\times 10^{-5}$ cm/m. Corresponding values for harvester and forwarder traffics combined were 11.3×10^{-2} and 0.1×10^{-2} to 29.1 c,/m respectively. 5. The mean tyre contact pressure was 73.9 kPa.</p>	<p>Evidence gaps and/or recommendations for further research: The nature and extent of rutting caused by ATV and 4X4 use.</p> <p>Sources of funding: European Commission</p>
Study Details	Population and setting	Methods of allocation to intervention / control	Outcomes and methods of analysis (inc effect size, CIs for each outcome and significance)	Results	Notes
<p>Authors: Wong, J. Y., Garber, M, Radforth, J. R., & Dowell, J. T.</p> <p>Year: 1979</p> <p>Aim of study: develop model for characterising muskeg properties</p>	<p>Source population: Muskeg peat in Canada</p> <p>Eligible Population: n/a</p> <p>Inclusion & exclusion</p>	<p>Methods of allocation: not reported</p> <p>Intervention description: sheer tests in situ then development of models</p> <p>Control / comparison description: not reported</p>	<p>Primary outcome measures: Identification of issues relating to shear strength of muskeg and application for use by vehicles.</p> <p>Secondary outcome measures: n/a</p>	<p>Key points in relation to this review: 1. The underlying peat deposit had a much lower bearing capacity and shear strength than the surface mat. 2. Rubber tracks or</p>	<p>Limitations identified by author: Mainly to do with fitting curves to graphs rather than design of study.</p> <p>Limitations identified by review team: Study aimed at larger tracked vehicles.</p>

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<p>in relation to vehicle use.</p> <p>Study design: Quantitative experimental.</p> <p>Quality Score: 2+</p> <p>External validity: 2+</p>	<p>criteria: n/a</p> <p>Setting: Canada</p>	<p>Sample sizes: not reported</p> <p>Baseline comparisons: not reported</p> <p>Study sufficiently powered: Possibly</p>	<p>Follow-up periods: not reported</p> <p>Methods of analysis: Not reported - to be reported in separate paper.</p>	<p>tracks with rubber pads could offer a reasonable compromise in regard to traction requirements whilst minimising surface damage.</p>	<p>Evidence gaps and/or recommendations for further research: Quantified impact of tracked vehicles on blanket bog.</p> <p>Sources of funding: Dept National Defence, Canada.</p>
Study Details	Population and setting	Methods of allocation to intervention / control	Outcomes and methods of analysis (inc effect size, CIs for each outcome and significance)	Results	Notes
<p>Authors: Sparrow, S.D. , Wooding, F. J., Whiting, E. H.</p> <p>Year: 1978</p> <p>Aim of study: Assessment of impacts of ORV on soils and vegetation in Alaska</p> <p>Study design: Quantitative</p>	<p>Source population: Some peat habitats within study.</p> <p>Eligible Population:</p> <p>Inclusion & exclusion criteria: Permafrost sites excluded</p>	<p>Methods of allocation: Identified ORV routes in Denali Highway Region.</p> <p>Intervention description: For subset (4 routes) took bulk density measurements and recorded vegetation.</p> <p>Control / comparison description: Not reported</p> <p>Sample sizes: 4 routes selected for detailed analysis</p>	<p>Primary outcome measures: Quantification of ORV damage in Denali Park</p> <p>Secondary outcome measures: n/a</p> <p>Follow-up periods: n/a</p> <p>Methods of analysis: Statistical methods eg t-</p>	<p>1. Soil depth and drainage were most important factors influencing the long-term impact of traffic on soil - gravel or cobbly based soils less susceptible to erosion than deep gravel-free soils.2. Wettest areas were often most disturbed parts of trail especially</p>	<p>Limitations identified by author: Plant nutrient or productivity not measure but this is a minor issue.</p> <p>Limitations identified by review team: None</p> <p>Evidence gaps and/or recommendations for further research: Comparable studies</p>

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<p>experimental.</p> <p>Quality Score: 2++</p> <p>External validity: 2++</p>	<p>but this included as focused upon vegetation and surface damage. Some of the vegetation types are associated with blanket bog in UK.</p> <p>Setting: Alasaka</p>	<p>Baseline comparisons: Not reported</p> <p>Study sufficiently powered: Probably</p>	<p>tests.</p>	<p>when subject to heavy use (>12 vehicles a year). 3. Repeated ORV use destroys surface mat/organic layer. These soils often become saturated and turn into a quagmire. 4. Soil compaction significant in moderate and heavy use trails (6-12 & >12 vehicles per year respectively) but not in light use (1-6 vehicles per year). 5. Heavily used trails were completely denuded, on less frequently used trails tall shrubs were the most injured plants; sedges appeared to be the least susceptible to</p>	<p>on UK peats.</p> <p>Sources of funding: Bureau of Land Management.</p>
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				injury as a result of ORV traffic. 7. Grasses and sedges usually first plants to re-colonise abandoned trails.	
Study Details	Population and setting	Methods of allocation to intervention / control	Outcomes and methods of analysis (inc effect size, CIs for each outcome and significance)	Results	Notes
<p>Authors: Ahlstrand, G. M. & Racine, C. H.</p> <p>Year: 1993</p> <p>Aim of study: Determine response of vegetation to ORV use.</p> <p>Study design: Quantitative experimental</p> <p>Quality Score: 2++</p> <p>External validity:</p>	<p>Source population: peatland</p> <p>Eligible Population: n/a</p> <p>Inclusion & exclusion criteria: This is a study on permafrost which would be excluded except mainly concerned with vegetation and</p>	<p>Methods of allocation: Poorly drained peatland site with few trees.</p> <p>Intervention description: series of vehicle passes with different types of vehicle.</p> <p>Control / comparison description: untracked areas.</p> <p>Sample sizes: 36 treatment lanes, 4 vehicle types, 3 intensity levels and 3 replicates for each.</p> <p>Baseline comparisons: before</p>	<p>Primary outcome measures: assessment of impact types with intensity and type of vehicle.</p> <p>Secondary outcome measures: n/a</p> <p>Follow-up periods: 2 years</p> <p>Methods of analysis: single and paired t-test, ANOVA, Student-Newman_Keuls test.</p>	<p>1. Vehicle track depth increased significantly with increasing passes.</p> <p>2. Vehicles running on rubber tyres created deeper tracks than similar vehicles mounted on continuous rubber tracks.</p> <p>3. Heavier all-terrain vehicles usually produced deeper tracks than lighter vehicles.</p> <p>4. Shrub injury rates were greatest during</p>	<p>Limitations identified by author: Uneven surface made interpretation difficult. The effects of different speeds, loads, turning radius etc not investigated.</p> <p>Limitations identified by review team: n/a</p> <p>Evidence gaps and/or recommendations for further research:</p> <p>Sources of funding:</p>

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2+	surface impacts. Setting: Alaska	and after Study sufficiently powered: Yes.		first few passes by ATV. 5. Dwarf shrubs Empetrum nigrum and Vaccinium vitis-idaea were least affected. 6. The degree of sedge tussock compression and amount of organic soil exposed along the ATV tracks increased in relation to vehicle weight.	n/a
Study Details	Population and setting	Methods of allocation to intervention / control	Outcomes and methods of analysis (inc effect size, CIs for each outcome and significance)	Results	Notes
Authors: Saarilahti, M. Year: 1997 Aim of study: Investigation into rut formation on peat oils as a result of forest	Source population: Range of habitats on peatland Eligible Population: Inclusion &	Methods of allocation: not known Intervention description: Control / comparison description:	Primary outcome measures: not known Secondary outcome measures: Follow-up periods:	THIS PAPER IS IN FINNISH WITH AN ENGLISH SUMMARY. 1. Rut depth is related to the shear strength and/or penetration resistance of the	Limitations identified by author: not known Limitations identified by review team: Evidence gaps and/or recommendations for further research: 1.

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<p>harvesting.</p> <p>Study design: Quantitative experimental.</p> <p>Quality Score: 2+</p> <p>External validity: 2+</p>	<p>exclusion criteria:</p> <p>Setting: Finland</p>	<p>Sample sizes:</p> <p>Baseline comparisons:</p> <p>Study sufficiently powered:</p>	<p>Methods of analysis:</p>	<p>soil and the wheel load combined with wheel dimensions.</p>	<p>Investigation into rut formation by ATVs and 4X4s on peats. 2. The shear strengths of different peat bodies in the UK.</p> <p>Sources of funding: Not known</p>
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