

SERDP 2009 Partners in Environmental Technology Symposium and Technical Workshop. 2 December 2009, Washington DC.

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Quantifying plant propagule transport by vehicle type.

Vehicle movement increases the risk of long distance dispersal of invasive plant species between habitats and ecoregions. The rate at which soil, plant propagules and other matter adheres to vehicles will depend on a number of factors including type of road surface (paved or unpaved and also off-road), the surface conditions (wet versus dry), the type of vegetation encountered, and the distance driven through each condition. In addition, the type of vehicle (tracked, tactical or civilian pattern) will affect both the amount of soil that adheres and the distance that it is likely to be transported. In 2007, 2008 and 2009, tracked, tactical and civilian pattern vehicles were evaluated for seed transport resulting from their normal military maneuvers. Vehicles were washed before, during and after exercises, while being driven distances from 10 to 262 miles. The number of plant propagules per vehicle type was analyzed for relationships to ground surface, ground conditions and distance driven with the aim of aiding prioritization of Department of Defense vehicle washing procedures.

Quantifying Plant Propagule Transport by Vehicle Type

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Summary:

Vehicles are known to transport plant parts, but few quantitative studies exist explaining the quantity of propagules (seeds and vegetative parts) transported on different types of vehicles. This study aims to provide such information by collaborating with military personnel and collecting data from their vehicles during training exercises. Three field studies have been completed: results of the first two completed at Limestone Hills, MT in June 2007, and Orchard Training Area, ID in June 2008 are reported here. Three different types of wheeled vehicle, driven predominately on unpaved roads were compared at Site 1 as part of two exercises. There was no significant difference in the number of seeds/vehicle km for vehicle type or exercise, the overall mean was 1.6 seeds/vehicle km. The second study compared two types of tracked and three types of wheeled vehicles again predominately on unpaved roads. Tracked vehicles transported four times as many seeds (1.8 seeds/vehicle km) than wheeled vehicles (0.5 seeds/vehicle km). These studies demonstrate that even under conditions considered non-conducive to seed movement, large numbers of seeds are being transported by vehicles. For example, in the second study each wheeled vehicle driven predominately on gravel roads travelled ~414 km providing a seed load of 186 seeds/vehicle; tracked vehicles drove ~194 km with a seed load of 350 seeds/vehicle. Our results demonstrate that gravel roads and vehicles are important vectors and dispersal agents, respectively, for plant propagule transport.

Introduction:

Invasion by non-indigenous plant species (NIS) is a global-scale problem that threatens the ecological integrity of native plant communities and ecosystems. NIS are introduced to areas by a variety of natural and anthropogenic means. Roads and vehicles are often regarded as dispersal vectors and dispersal agents for NIS respectively. However, the quantity of plant propagules transported by vehicles, and how this varies with vehicle type is poorly understood. More propagules are likely to be collected by vehicles driven off-road than on paved roads, and by tracked or all-terrain vehicles than civilian pattern vehicles, but there are no quantitative data to support these hypotheses.

To address these issues, field studies were conducted at two military training areas during the summers of 2007 (site 1), 2008 (site 2) and 2009 (site3). Tracked, tactical and civilian pattern vehicles were evaluated.

Objectives:

- Assess the potential of tracked, tactical and civilian pattern military vehicles to transport NIS propagules under field conditions.
 - Site 1 & 3: Limestone Hills, Helena, MT.
 - Site 2: Orchard Training Area, Boise, ID.
- Evaluate the effect of road surface (paved, unpaved and off-road) on the amount of propagules transported by different vehicle types.

Field Exercises & Methodology



Seven different vehicle types have been studied during routine training exercises: Humvees, 2.5-5 ton personnel trucks, & six wheel all terrain vehicles (ATVs) at Site 1. Humvees, Hemmet fuelers, palletized loading systems, M1 tanks & Bradleys at Site 2. All vehicles used in the study had GPS units placed on them to record their location at all times during the exercises studied. Vehicles were driven on paved-, unpaved-, & off-road according to requirements of the training exercise.



Vehicles were washed before & at the end of the exercise with a commercially available wash unit. The after exercise waste was retained & placed in a greenhouse for germination trials.

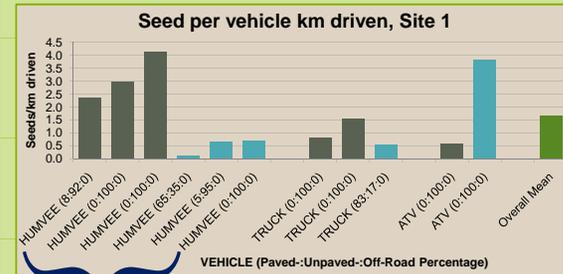
Additional experiments evaluated the "loss" of seed as a result the of passing through the vehicle wash unit & being transported to the greenhouse. Mean seed loss was 55%. Results opposite have been corrected.



Germination & identification of seedlings was recorded over a 1.5 year period for each exercise. Samples were kept at ambient temperature for 1 year then subject to an 8 week cold stratification period to stimulate remaining seed & then returned to ambient conditions to record further seedling germination.

Species richness from the vehicle samples was high: 50 at Site 1 & 77 at Site 2. This richness was higher than recorded in the above ground roadside community.

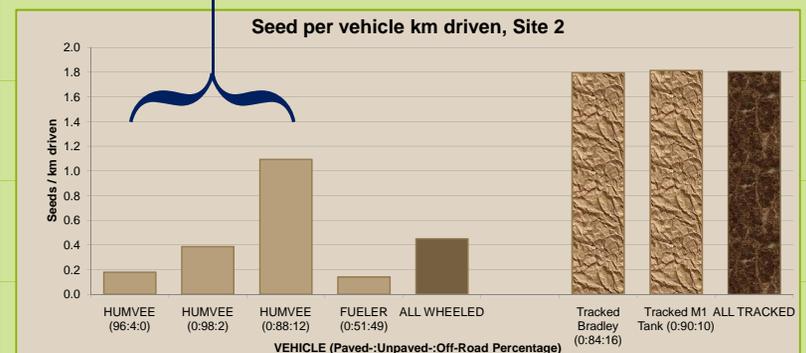
Results



Site 1: There was no difference in seed load for the Humvees, 2.5-5 ton personnel trucks or 6-wheel ATVs, over two different exercises (gray & blue). Overall mean seed load (green) was 1.6 seeds/vehicle km driven, of which 85% was on unpaved roads.

Vehicles were driven on different surfaces. The Humvee data, for which there are most samples, suggest an increase in seed load as the percentage distance driven on paved-, unpaved-, and off-road increases. Site 1 (exercise 1-gray, exercise 2-blue) & Site 2.

Site 2: There was a significant difference in seed load for wheeled versus tracked vehicles (below). There was no difference between the wheeled vehicles. Mean seed load for wheeled & tracked vehicles was 0.5 & 1.8 seeds/km driven respectively.



Acknowledgements:

We would like to thank the personnel at the Fort Harrison National Guard Base in Helena, MT for all of their assistance with the field trials at that site and at Orchard Training Area, Boise ID, and the personnel at OTA for allowing us on site. Lastly, we would like to thank the Little Red Hen LLC staff for their good work and humor throughout all the washing trails. This project is funded by the Strategic Environmental Research and Development Program, Project Number SI-1545