Journal of Outdoor Recreation and Tourism ∎ (∎∎∎∎) ∎∎∎–∎∎∎

Contents lists available at ScienceDirect

Journal of Outdoor Recreation and Tourism

journal homepage: www.elsevier.com/locate/jort

Experimental assessment of weed seed attaching to a mountain bike and horse under dry conditions

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ARTICLE INFO

Article history:
Received 5 January 2016
Received in revised form
19 July 2016
Accepted 19 July 2016

Keywords:
Alien plants
Biological invasions
Tourism impacts
Recreation ecology
Epizoochory
Human mediated seed dispersal

ABSTRACT

Mountain biking is popular in many natural areas, but remains controversial, at least in part, due to divergent views about its environmental impacts. In contrast to research assessing the risk of activities such as horse riding and hiking spreading weed seed, similar data for mountain bikes does not appear to be available in the academic literature. To start to address this gap, we present the results of a preliminary experiment comparing seed attachment to a horse and a mountain bike in dry conditions along 20 1 m by 50 m transects through areas where weeds are seeding. In total, seed from more than 12 species were found on the horse and more than 10 species on the bike. Per transect, a greater diversity of seed attached to the horse (6 vs 4 morphtaxa) than the bike, but they had similar numbers of seed (Average=22). When seed composition per transect was compared using ordinations, there were clear differences with more seed from non-native grasses such as *Chloris virgate* and *Chloris gayana,* the native grass *Dicantheum scericeum*, and the non-native herb *Vicia sativa* on the bike, while on the horse there tended to be more seed from the grass *Poa queenslandica* (native) and the *Axonopus fissifolius* (non-native). This pilot study demonstrates how mountain bikes can carry seed from a diversity of weeds in Australia. More extensive testing will better quantify the types and amount of seed that could be dispersed, as well as test the effect of factors such as weather conditions, timing and location of rides on seed dispersal by bikes. In the interim, recommendations for bikes to be regularly cleaned, including between rides in areas of high conservation value are likely to help reduce the risk of mountain biking spreading weed seed.

MANAGEMENT IMPLICATIONS

- Mountain bikes, like horses, cars and clothing, can collect weed seed, but the number and type of seed differ.
- Implementing cleaning protocols for mountain bikes (e.g., wash down/brush down prior to use and after use) will help reduce the risk of weed dispersal.
- This preliminary study emphasizes the importance of research assessing different recreational activities as weed seed vectors.

1. Introduction

Mountain biking is an increasingly popular activity, including in natural areas of high conservation value (Hardiman & Burgin, 2013; Newsome & Davies, 2009; Pickering, Hill & Newsome, 2010). Debate around the appropriateness of this recreational activity often focuses around the environmental impacts of mountain biking, including comparing impacts with other activities such as horse riding and hiking (Newsome & Davies, 2009; Pickering, Hill & Newsome, 2010; Pickering, Rossi & Barros, 2011). Despite the importance of assessing and minimising the impact of bike riding, there remains limited research on its environmental impact in general, and even fewer studies comparing its impacts with other recreational activities (Pickering, Hill & Newsome, 2010; Pickering, Rossi & Barros, 2011). For instance, there are recent published reviews of over 45 research papers on the role of vehicles (Ansong & Pickering, 2013a; Pickering & Mount, 2010, 13 papers), horses

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http://dx.doi.org/10.1016/j.jort.2016.07.005
2213-0780/

(Ansong & Pickering, 2013b; Pickering & Mount, 2010, 14 papers) and hikers (Ansong & Pickering, 2014; Pickering & Mount, 2010, 21 studies), as weed seed dispersal vectors, but there appears to be no equivalent review, or even original papers for mountain biking.

Weeds as a term is often used to refer to plants growing in sites were they are not wanted, and include plants that have negative economic and/or environmental impacts (Richardson et al., 2000; Weber, 2003). Here we will focus on plants that are not native to a region (alien to Australia) and that can invade natural ecosystems beyond their native range (Weber, 2003; Williams & West, 2000). The introduction of weed seed by recreational activities in areas of high conservation value is an important issue (Chown et al., 2012; Mack & Lonsdale, 2001; Ware, Bergstrom, Müller & Alsos, 2012), as weeds are a major threat to biodiversity globally. Weeds can out compete native species, disrupt important ecosystem process, and are expensive and difficult to control (Groves, Lonsdale & Boden, 2005; Levine et al., 2003; Weber, 2003). As recreation is one of the few activities allowed in many areas of high conservation value such as protected areas, any seed dispersed by these activities is important, with dispersal a critical step in biological invasions (Foxcroft, Pyšek, Richardson & Genovesi, 2013). Recreation activities can also transport seed over long distance, well away from roads and into otherwise remote areas (Pickering, Hill & Newsome, 2010; Pickering & Mount, 2010).

We already know that cars are a major vector for weed seed, with a recent review of 13 studies of seed on cars finding that seed from 626 species from 75 families has been recorded on cars (Ansong & Pickering, 2013a). This includes many species of weeds, with 599 of the species found on cars listed as weeds in some part of the world. More than 100 of these species are classified as internationally important environmental weeds. For hiking, seed from 449 species has been found on clothing based on results from 21 studies (Ansong & Pickering, 2014). Again, nearly all are listed as weeds in one or more countries, with 58 classified as internationally-recognised environmental weeds. For horse riding there is data on 249 species from five studies on seed germination from horse dung (Ansong & Pickering, 2013b). In contrast to the results of these reviews, there appears to be no equivalent studies of seed dispersal via mountain bikes in the academic literature. There are also few academic papers assessing seed attached to the fur of horses (Gower, 2008; Couvreur, Christiaen, Verheyen & Hermy, 2004; Couvreur, Verheyen & Hermy, 2005), in contrast to studies assessing seed germinating from horse dung (see papers in Ansong & Pickering, 2013b; Pickering & Mount, 2010).

With tens of thousands of people going mountain biking riding and tens of thousands of kilometres of mountain bike trails including in areas of high conservation (Hardiman & Burgin, 2013; Newsome & Davies, 2009; Schaefers, 2006; Webber, 2007), it is important to start assessing the risks of mountain bikes as vectors for weed seed. This paper presents the results of a 'proof of concept' experiment comparing the potential of horses and mountain bikes as seed vectors under dry conditions using a modified protocol previously used to assess the risk of weed seed attaching to hikers clothing (Mount & Pickering, 2009). Specifically, it assessed: (1) which weeds have seed that can attach to horses and to mountain bikes, and (2) which vector collects the most seed and/or diversity of seed. Although the results are from a single small experiment under dry conditions, they highlight a protocol that could be used more widely, while also providing what appears to be the first study published in the academic literature documenting seed attachment on mountain bikes.

2. Methods

2.1. Experiment

To assess the potential of horses and mountain bikes to act as seed dispersal vectors, seed attachment was assessed using an experimental protocol. As a wide range of factors are likely to affect seed attachment to bikes, using a standardized methodology helps minimise the effect of factors other than those that are the specific focus of the study. For example, the number and type of seed attaching to vectors such as cars and clothing has been found to vary among sites, season, weather conditions as well as with the behaviour of the vector (Ansong & Pickering, 2014; Cousens, Dytham & Law, 2008; Mount & Pickering, 2009; Taylor, Brummer, Taper, Wing & Rew, 2012; von der Lippe, Bullock, Kowarik, Knopp & Wichmann, 2013). Therefore, this experiment was undertaken in the same location, on the same day, with the horse and bike subjected to similar densities and types of weed seed.

The experiment was conducted on a dry day in early September (spring), in the subtropical zone in south-eastern Queensland, Australia (27°56′55.68″S, 153°07′09.41″E), at a site previously used for grazing animals where weeds were present and seeding. There were at least 30 species seeding, most of which were not native to Australia, and many of which are considered weeds by the State and Australian Government, with mature seed that were capable of attaching to the horse or bike at the time of the experiment. As seed attachment is likely to be greater under wet conditions, the experiment can be viewed as providing a conservative baseline for seed attachment. Replication of the experiment in wetter conditions would be likely to result in higher numbers of seed attaching including in mud.

2.2. Sample design

A total of 20 1 m by 50 m transects were marked out in the field and then randomly assigned to one of two treatments: either horse or mountain bike (e.g. 10 replicate transects for each treatment). Each replicate consisted of a person leading the bike or horse 50 m on one side of the transect, then turning around and returning parallel to the path just covered so the bike or horse moved through previously untrampled vegetation for 100 m. To control the bike and horse so they stayed within transects, they were not ridden, but lead through transects, with the person guiding the bike/horse walking just outside the transects, but at the same distance from the bike/horse. The horse was a 20-year-old thoroughbred mare, approximately 15.5 hands at the shoulder, while the mountain bike was a recently serviced 21 in. Trek 800 mountain bike with nobly tyres and a water bottle cage on the vertical tube.

Before starting each transect the bike or horse was brushed down to remove any seed already attached. At the end of the horse transects, the horse was led onto a clean sheet pegged into the ground and carefully brushed down for 5 minutes or until there was no more visible seed on the coat. As weather conditions were dry, and there was complete vegetation cover at the site (e.g. no exposed soil or mud) it was assumed unlikely that seed would adhere to the underside of the hoof, therefore, the horse's hooves were not cleaned. At the end of each bike transect, the mountain bike was wheeled onto a clean sheet and all visible seed removed from the entire bike using a brush and tweezers including cleaning the wheel spokes, chain, gears and drink bottle holder. The seed collected from each replicate was collected and carefully stored for later analysis in a laboratory, where the seed was sorted under a dissecting microscope, counted and identified. Seed were identified to species where possible using a reference collection of seed and plants collected at the site at the time of the experiment, but not in the areas

Please cite this article as: Pickering, C., et al. Experimental assessment of weed seed attaching to a mountain bike and horse under dry conditions. *Journal of Outdoor Recreation and Tourism* (2016), http://dx.doi.org/10.1016/j.jort.2016.07.005