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# Measuring and managing the environmental impact of festivals: the contribution of the Ecological Footprint

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## ABSTRACT

This paper assesses the contribution of the Ecological Footprint as a method for estimating the environmental impact of festivals. It responds to calls for more rigorous methods to assess the environmental impacts of festivals, and contributes towards providing festival organisers and policy-makers with a more balanced evaluation of their outcomes. This paper focuses on the 2012 Hay Festival of Literature and Arts (Wales, United Kingdom), and describes how the Ecological Footprint was used to calculate the environmental impact of its visitors. It also considers the potential value of the Ecological Footprint as a method for evaluating alternative strategies designed to improve the environmental sustainability of festivals. The paper demonstrates that Ecological Footprint analysis can provide valuable information for festival organisers and policy-makers on factors influencing the scale of a festivals' environmental impact, and the types of strategies needed to reduce the effect of visitor travel.

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## Introduction

Major events and festivals have become a significant growth area within the tourist industry (Getz, 2005; Jackson, Houghton, Russell, & Triandos, 2005; Li & Petrick, 2006). In the United Kingdom, an estimated 3.5 million people attended music festivals in 2014, a 26% increase since 2012 (Statista, 2016). In 2015, the events sector alone contributed £39.1bn direct spending to the UK economy (Tourism Alliance, 2015). Due to their prevalence and popularity, events and festivals have received increasing interest amongst academics (Getz, 2010), with specific calls for research on their management and evaluation (Gration, Arcodia, Raciti, & Stokes, 2011).

Historically, research on events and festivals has predominately focused on evaluating their economic impacts and to a lesser extent their social and cultural impacts. Despite the rhetoric surrounding the need for sustainable development and to address climate change, Getz (2010) and Gibson and Wong (2011) have highlighted the paucity of academic literature on the environmental impact of events and festivals. More recently however, academic studies have broadened their focus to consider socio-cultural and environmental outcomes (Mair & Whitford, 2013). The application of a triple bottom line (TBL) framework for assessing economic, social and environmental impacts has increasingly been used by researchers to provide a more balanced evaluation of events and festivals (e.g. Andersson & Lundberg, 2013; Fredline, Raybould, Jago, & Deery, 2005; Getz, 2009; Hede, 2007; Sherwood, 2007). However, Gration et al. (2011, p. 347) argue that "Considerable progress is yet to be

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made to develop tools to rigorously apply TBL in ways that satisfy the quest for balance across people, planet, and profit perspectives”.

While methods for evaluating the economic outcomes of events and festivals are well established and there is a general consensus on the indicators to be used, methods for assessing the socio-cultural and environmental dimensions of sustainability are less widely agreed (Gration et al., 2011). An increased understanding of evaluation tools that measure the environmental impact of events and festivals is important due to their potential negative environmental impacts, at both local and global scales (see Gibson & Wong, 2011).

The Ecological Footprint (EF) has received a great deal of interest amongst academics, practitioners and policy-makers as an indicator of global environmental impact (Collins & Flynn, 2015). Although the Ecological Footprint has primarily been applied at national level, it has gained increased interest amongst academics as a method for assessing the environmental impact of resource use of tourism and events (see for example Becken, Frampton, & Simmons, 2001; Collins, Flynn, Munday, & Roberts, 2007; Collins, Munday, & Roberts, 2012; Gössling, Borgström, Hansson, Hörstmeier, & Saggel, 2002; Hunter, 2002; Hunter & Shaw, 2007; Patterson, Niccolucci, & Bastianoni, 2008). However, a limited number of studies have so far used the Ecological Footprint to assess the environmental impacts of festivals (see Andersson & Lundberg, 2013; Gibson & Wong, 2011). Studies that have applied the Ecological Footprint to events and tourism have focused their attention on reporting baseline results, and demonstrating its value as a measure of environmental sustainability and as a communication tool. There is however a notable absence of research that explores how festivals and events might begin to reduce any negative environmental impacts arising from their activities (Jackson et al., 2005).

The empirical research presented in this paper responds to calls for more rigorous tools to examine the environmental impact of festivals. This paper applies the Ecological Footprint to assess the environmental impact of visitor consumption activities relating to the 2012 Hay Festival of Literature and Arts in Wales (United Kingdom). It also considers the potential contribution of the Ecological Footprint as an environmental management tool, by evaluating the potential outcome of several scenarios designed to reduce the environmental impacts of visitor travel. In doing so, this paper reflects on the strengths and weaknesses of the Ecological Footprint as a tool for assisting festival organisers and policy-makers in improving the environmental performance of future festivals.

This paper is structured as follows. It begins by providing a review of methods that have so far been used to examine the environmental impact of events and festivals. Following this we explain what an Ecological Footprint is, its potential value as a method for assessing the environmental pressures arising from consumption activities, and also some key criticisms. Section 3 summarises the main Ecological Footprint findings and identifies those visitor activities with the greatest impacts. In Section 4, we provide background on the 2012 Hay Literary Festival, and how data were collected for the Ecological Footprint analysis. Comparisons are made with other major events in Wales. Section 5 then demonstrates how the detailed EF analysis can inspire investigation of scenarios for reducing the environmental impact of visitor travel at future festivals. The concluding section discusses the strengths and limitations of the Ecological Footprint as an approach for assessing festival environmental impacts, and its potential value as an environmental management tool for festival organisers and policy-makers. It also makes suggestions for further research.

## Evaluating the environmental impacts of festivals

Over the last 10 years, there has been an increased interest amongst policy-makers, event organisers, sponsors and academics to understand the environmental impacts of events and festivals (for example see Collins et al., 2007; Collins et al., 2012; Dolles & Soderman, 2010; Gibson & Wong, 2011; Ponsford, 2011). Alongside this, the importance in staging events and festivals that are more sustainable and environmentally responsible has led to several developments in recent years, including the development of an International Standard ISO 20121 for Sustainable Event Management (i.e. financially viable, socially responsible and reducing event environmental footprints), the establishment of organisations such as A Greener Festival and the Sustainable Event Alliance, and the introduction of

software tools including Julie's Bicycle Creative IG (Industry Greening) Tools and other Carbon calculators. However, despite this increasing interest towards improving the sustainability of events and festivals, there is currently a lack of agreement as to what evaluation methods should be used to assist with TBL reporting. Methods of assessment have become increasingly more sophisticated. There are however, a number of challenges in providing a quantitative assessment of the environmental impacts of events due to their complexity and period of time over which they are held (Collins, Jones, & Munday, 2009). Any quantitative evaluation method used to assess the environmental impacts of festivals is likely to be partial in scope, and the Ecological Footprint is not an exception.

A range of approaches currently exist for quantifying the environmental consequences of festivals and events, such as environmental impact assessment (EIA), and life cycle analysis (LCA), biophysical methods and carbon emissions, each with their own strengths and limitations. Biophysical assessment methods such as those used in EIA (e.g. air, water and soil sampling or surveying of local ecosystems) cannot quantify impacts that occur beyond a festival site (Gibson & Wong, 2011), for example, transport emissions generated by visitor travel. Furthermore, biophysical assessment methods cannot account for the indirect impacts associated with resource consumption (e.g. energy use). They also require a deal of time and resources to undertake. Fredline et al., (2005) used several indicators to evaluate the environmental impact of an event: energy use (at the venue), transport (to the venue), water consumption and recycling, and waste generated and recycled. However, while these indicators may relate to event activities that are most resource intensive, they use different units of measurement and so present difficulties in identifying which generate the greatest impacts, or where to focus efforts in order to reduce any negative impacts.

More recently, an increasing number of online carbon calculators have become available, which produce assessments of carbon emissions generated by festivals. However as Gibson and Wong (2011) highlight, there is some uncertainty surrounding their accuracy or applicability to different types of festivals. A number of consultancies also offer detailed carbon audits of events and festivals, however as Gibson and Wong (2011) have explained, there is no consistency in the methodology or algorithms used in final calculations, thereby reducing opportunities for comparisons between them.

In comparison, the Ecological Footprint is able to consider the direct and indirect resource use associated with staging a festival, and those environmental consequences that occur beyond a festival site (e.g. visitor travel). This is an important consideration as studies have consistently shown that visitor travel is responsible for a significant proportion of environmental impacts associated with long distance tourism (e.g. Becken, Simmons, & Frampton, 2002; Gössling, 2002;) and major sport events (e.g. Collins et al., 2007; Collins et al., 2012). Furthermore, Gössling et al. (2002) have argued that measurement approaches currently used are unable to identify the contribution of individual forms of transport to the overall environmental impact. The Carbon Footprint, which measures the total amount of greenhouse gas (GHG) emissions that are directly and indirectly generated by an activity (Galli et al., 2012), is also able to account for impacts that occur beyond a festival site. However, the Ecological Footprint is able to provide a more comprehensive assessment of a festival's environmental impacts as it includes an analysis of GHG emissions and also different land use pressures.

Similar to events, environmental strategies developed by festivals have to date predominately focused on addressing the local environmental impacts of their activities and operations, such as increased use of renewable energy on site, waste minimisation and recycling, water conservation, and reducing noise and light pollution. Although a small but increasing number of festivals are introducing strategies to minimise traffic congestion and pollution in their local area (see for example Glastonbury Green Traveller, 2011). Concentrating efforts to reduce the local environmental impacts of festivals is an important consideration, however this only partially addresses the impacts they can generate. Given the increasing importance and need to reduce global resource use and GHG emissions, there is a need to understand the scale of festivals' resource demands, and the environmental impacts being generated beyond the boundary of the festival site and local area. Furthermore, as highlighted by Collins, Jones, et al. (2009), a concentration on local issues and impacts has meant that it is difficult to compare events and assess the effectiveness of various strategies designed to reduce their environmental impacts.

## The Ecological Footprint

The Ecological Footprint is a resource accounting tool that provides a proxy measure of the global environmental pressures related to human resource use. It provides a quantitative assessment of the amount of bioproductive land required to provide the resources used by a defined population, and to assimilate the wastes produced (i.e. CO<sub>2</sub> emissions), using prevailing technologies and resource management practices (Bastianoni et al., 2013). The Ecological Footprint's unit of analysis is the "global hectare" (gha), and represents a hectare with a world-average biological productivity (Galli, 2015), and is usually expressed in gha per capita for a given population.

The Ecological Footprint combines two powerful ideas. First, recognition of environmental limits to the earth's capacity to provide resources for consumption and economic growth, and this is represented in the Ecological Footprint's methodology to calculate the earth's available biocapacity. Second, it considers justice and equal claim to the earth's resources by assessing the extent to which a population is living beyond its means or creating "ecological overshoot" (Collins, Cowell, & Flynn, 2009, p. 1709). Comparing the area of land required to support a certain level of resource use within the earth's available biocapacity is central to understanding sustainability (Bastianoni et al., 2013), and assessing whether or not consumption is ecologically sustainable (Gössling et al., 2002). The World Wildlife Fund (WWF) for Nature has advocated the Ecological Footprint, and since 2000 it has published its biennial Living Planet Report. The 2014 edition reported that in 2010 the earth's available biocapacity was 1.7 gha per capita (WWF, 2014). In comparison the Ecological Footprint was 2.7 gha per capita, and so indicating a situation of ecological "overshoot". Consumption patterns were not sustainable as resources were being used at a faster rate than they could be generated, and waste products were being emitted faster than they could be disposed.

While the Ecological Footprint presents a number of strengths as a measure of resource use and its environmental impact, it has however faced several criticisms. It does not reflect the impacts of human consumption accurately (see Ferng, 2002; Lenzen & Murray, 2001; van den Bergh & Verbruggen, 1999), nor does it allocate the responsibilities of impact correctly (see McGregor, Swales, & Turner, 2004). The Ecological Footprint is also not able to account for the freshwater consumption, soil erosion and impacts due to the release of long-life toxic materials or the depletion of non-renewable resources (Bastianoni et al., 2013). Some academics have argued that the Ecological Footprint is nothing more than an attention grabbing tool (Moffatt, 2000), and does not provide decision-makers with a useful tool for decision-making due to a limited understanding of how different consumer activities relate to impact (see Ayres, 2000; Ferng, 2002; van den Burgh & Verbruggen, 1999). A response to these criticisms has been published by Goldfinger, Wackernagel, Iha, Lazarus, and Lin (2014); Lin, Wackernagel, Galli, and Kelly (2015) and Galli (2015).

Despite these criticisms, the Ecological Footprint has become an increasingly popular indicator of environmental sustainability and has stimulated an enormous amount of academic and policy attention (Collins & Flynn, 2015, p. 1). This is partly due to it having a number of applications ranging from products, organisations, services and different levels of government, but also because policy advocates of the Ecological Footprint were able to promote it to a wide range of policy audiences as a way "to improve the quality of decision making by ensuring that more attention is given to the environmental consequences of policies" (Collins & Flynn, 2015, p. 5).

So far, the Ecological Footprint has primarily been used at a national government level, whereby decision-makers can obtain information on resource use and available biocapacity (Galli, Wackernagel, Iha, & Lazarus, 2014). However, its application has been extended to assess the environmental impacts of tourism and leisure activities (see for example Becken et al., 2001; Gössling et al., 2002; Hunter, 2002; Hunter & Shaw, 2007; Patterson et al., 2008; Peeters & Schouten, 2006). These studies have usefully demonstrated the scale of tourism's environmental impact, in particular the significance of travel. However, the impacts reported were based on "gross" and not "net" Ecological Footprint, which would account for the potential absence of an Ecological Footprint at a tourist's home location while on holiday. As Hunter and Shaw (2007) have highlighted, the calculation of a "net" Ecological Footprint estimate provides a "more appropriate and conservative basis for tourism

ecological footprint accounting" (p. 295), and in line with the tradition of analysis and being cautious in estimating the scale of an activity's impact.

The Ecological Footprint's application to festivals has so far been limited. One example is Wong (2005, cited in Gibson & Wong, 2011), who tailored the Ecological Footprint method to a music festival "Splendor in the Grass" in Australia. Using survey data, on-site energy and water readings and existing consumption models, the festivals' Ecological Footprint was estimated to range between 1.53 gha/capita (lowest) to 1.96 gha/capita (highest). The study concluded that attendees' overall resource use at the festival was less than the national average. However, the energy and resources needed to support their travel was significantly higher than the national average. This was due to distances travelled by attendees to the festival, and some 69% having travelled by car.

### **Hay Festival of Literature and Arts (2012)**

Hay Festival is an annual literature and arts festival held at the end of May/early June, in the rural town of Hay-on-Wye in Wales. Hay-on-Wye is world renowned for its books and bookshops, and is the National Booktown of Wales. The town has a resident population of approximately 1900 and is located on the edge of the Brecon Beacons National Park (one of three designated National Parks in Wales), and adjacent to the English border.

Hay Festival was initially founded as a poetry festival in 1988 with a relatively small audience of 1000 visitors. Since then the festival has grown quite dramatically in terms of its scale and scope, and has become one of the largest literature festivals in the world. Initially held over a couple of days, the festival is now held over 11 days and the number of events has grown from 20 to more than 800. The festival also has a number of sponsorships including a Title Sponsor (The Telegraph newspaper) and a Broadcast Sponsor (Sky Arts). Alongside this, the festival's organisation has grown to a core team of 20 staff, which increases to several hundred volunteers and other paid staff during the festival period. The festival site contains a number of exhibitors, food and drink outlets, a festival merchandise shop and a bookshop. The growing popularity of the festival, its high profile speakers and sponsors has enabled Hay Festival to develop into a "brand", and its organisers have been invited to stage festivals in ten other countries across the world including Columbia, Ireland, Maldives, Mexico, Peru and Spain.

Hay Festival is an interesting case as its organisers have explicitly incorporated sustainability practices and management into the organisation and staging of its festival. In 2006, the festival appointed a Sustainability Director and launched its "Greenprint" programme with three specific aims: first, to audit, assess and introduce changes to reduce the direct environmental impacts of the festival (i.e. energy use, procurement, waste and energy); second, to enable visitors to make more sustainable choices, such as travelling to the festival by public transport rather than by car; and finally, to include a programme of festival events on a range of sustainability issues, with the aim of engaging, educating and inspiring individuals to make changes when they leave the festival.

In terms of addressing the festival's direct environmental impacts, its organisers have focused on waste, procurement and venues. Achievements to date have included reduced use of resources (including printed material) by 35%; reduced use of diesel by 20%; reduced use of electricity by 15%; 100% renewable energy onsite; recycling 75% of waste produced on site; composting 4.8 tonnes of food waste from on-site catering outlets; and trialling of a solar water heating system (Hay Festival Wales, 2013). The festival is considered an example of good practice in Wales, and has worked with Visit Wales (the Tourism Division of the Welsh Government) to produce a Hay-on-Earth "Toolkit" as a guide to help other event organisers in Wales address the impacts of their events and make them more sustainable (see Hay Festival Wales, 2012). The festival's organisers are also working towards achieving certification for the British Standard (BS) 8901 on "Specification for a sustainability management system for events" and the "Green Dragon Environmental Standard".

The festival's organisers have collaborated with other organisations to reduce the indirect environmental impacts generated by visitors, in particular visitor travel. For example, with financial support from Visit Wales, provision of an enhanced public bus service from the nearest train station in Hereford (34 kilometres away) to Hay-on-Wye during the festival period. A shuttle bus service was

developed with its Broadcast Sponsor “Sky Arts”, to transport visitors to and from the festival site and their overnight accommodation in six neighbouring towns and villages. The festival has teamed up with three car share schemes to promote car sharing through its website, and a bike hire and maintenance service is also available at the festival site (Hay Festival Wales, 2013). In 2015, the organisers introduced a “Park and Ride” bus service in a nearby village, thereby helping to reduce traffic congestion in Hay-on-Wye during the festival period.

The empirical research presented in this paper relates to a single festival, and so the results will be of direct relevance to Hay Festival given its unique characteristics and rural setting. However, the level of analysis provided through this single case can enhance our wider understanding of visitor resource demands in relation to festivals, and the types of transport strategies that may be needed to reduce their environmental impacts in the future.

## Calculating Hay Festival’s Ecological Footprint

The Ecological Footprint of the 2012 Hay Festival focused on assessing the environmental impact of visitors’ consumption activities. An estimated 100,000 visitors attended the festival that year, and this figure was based on information provided by its organisers and included the number of session tickets sold, number of ticket sales and a percentage for free non-ticketed events.

As visitors at Hay Festival will have a unique set of consumption patterns that differ to other festivals and events, their Ecological Footprint was calculated using a bottom-up approach and involved the use of actual visitor consumption data. A survey was used to collect the following data from visitors attending the festival: their purpose of visit, travel modes (to/from and during the festival), duration of stay, choice of overnight accommodation, food and drink consumption at the festival, other activities undertaken while attending the festival and expenditure on a range of items, including travel, food and drink, leisure and tourist activities, festival merchandise and retail shopping.

Visitor surveys were conducted at the festival site on four of the 11 festival days (two weekdays and two weekend days). Results were used to inform estimates of visitor consumption and expenditure patterns for the remaining seven non-surveyed days. The visitor survey was undertaken by five trained surveyors, and involved 200 hours of surveying over the four-day period. A summary of how visitor consumption was calculated is provided in Table 1, together with assumptions and a summary of data sources. As the Ecological Footprint analysis presented in this study relied on data from a visitor survey in 2012, the age of these baseline consumption data could be considered a limitation and reduce the usefulness of the Footprint and scenario results. However, as the number of visitors attending the festival annually is fairly consistent and 69% of visitors surveyed regarded themselves as “regular” attendees, it is probable the majority will have similar consumption patterns year on year and so the festivals’ Footprint results will remain fairly constant.

The festival site is free to access by the public. Some events at the festival require visitors to purchase tickets although others are free non-ticketed events, and so the profile of the visiting population was unknown (for example, the proportion of United Kingdom and international visitors). Therefore, the survey sampling approach was random rather than purposeful. Key locations at the festival site were used as sampling points for conducting the survey (i.e. festival entrance/exit and outdoor seating areas). Based on the estimated number of visitors (i.e. 100,000), 0.7% of visitors (701 visitors) were surveyed, of which 93.3% (654) were used for the Ecological Footprint calculations. Responses received for 6.7% (47) “casual” visitors were not included in the Ecological Footprint analysis as their main purpose for being in Hay-on-Wye was for other reasons (i.e. other tourist activities, retail shopping or visiting friends and family in the locality).

Visitors’ Ecological Footprint was measured using Footprint Reporter™, a Carbon and Ecological Footprint software analysis programme developed by Best Foot Forward Limited, a UK Footprint Consultancy (part of Anthesis Consulting Group PLC). The software enables the user to measure the Ecological Footprint for a range of consumption categories for any geographical area in the United



**Table 1.** Estimating visitor consumption for Hay Festival.

Visitor consumption category	Data sources	Estimated using
Travel	<p>Visitor survey at festival (0.65% sample)</p> <p>Hay Festival visitor estimates</p>	<p>Visitor travel to the festival</p> <p>Return distances travelled to Hay-on-Wye.</p> <p>Where multiple methods of transport were used, calculations included mode used to travel the furthest distance.</p> <p>Return distances travelled by bus from Hereford to Hay-on-Wye also included.</p> <p>UK visitors</p> <p>Visitor home location based on postcode. Distances travelled to festival calculated using AA Route Planner (<a href="http://www.theaa.com/driving/mileage-calculator.jsp">http://www.theaa.com/driving/mileage-calculator.jsp</a>).</p> <p>Assumed distances travelled by road were the same as for other modes (excluding air travel).</p> <p>Average car occupancy estimated from survey data (2.6 persons/vehicle).</p> <p>International visitors</p> <p>Home location based on main airport of departure.</p> <p>Distances travelled based on distance from airport of departure to airport of arrival. Distances calculated using Webflyer Mileage Calculator (<a href="http://www.webflyer.com/travel/mileage_calculator/">www.webflyer.com/travel/mileage_calculator/</a>).</p> <p>Assumed distances travelled by air were the same for other modes (e.g. ferry, Channel Tunnel).</p> <p>Return distance from UK airport of arrival and Hay-on-Wye. Average car occupancy estimated from survey data.</p> <p>Visitor travel during festival</p> <p>Distance travelled by visitors each way from festival site to overnight accommodation, estimated using following locations; Hay-on-Wye (2.4 km), Brecon (20 km), rest of Wales and England (12 km).</p> <p>Return distances travelled by Shuttle bus from festival site to Hay-on-Wye.</p> <p>Average car occupancy estimated from survey data.</p>
Food and drink	<p>Visitors survey at festival site (0.65% sample)</p> <p>Survey of food and drink operators (at festival site: 100% sample) and food businesses (Hay-on-Wye: 15% sample)</p>	<p>Type and quantity of food and drink items purchased by visitors at festival, outlets in Hay-on-Wye and overnight accommodation.</p> <p>Estimated spending on food and drink during stay.</p> <p>Average cost of food and drink items by outlets at festival and Hay-on-Wye.</p> <p>Composition of food items estimated using UK government guidance on food portion sizes (FSA [Food Standards Agency], 2008).</p>
Energy use (overnight accommodation)	<p>Visitor survey at festival site (0.65% sample)</p>	<p>Number of visitor bednights spent in overnight accommodation, and type of accommodation.</p> <p>Energy use per bednight based on:</p> <p>friends and family (Collins &amp; Flynn, 2005),</p> <p>Guesthouse, hotel, hostel and self-catering (Gössling et al., 2002).</p> <p>Assumed energy use per bednight for:</p> <ul style="list-style-type: none"> <li>• camping/caravanning and “couch surfing” was 1/3rd of that for a hostel.</li> <li>• a second home was the same as for self-catering accommodation.</li> </ul> <p>Assumed all hotels were 3 star rated.</p>

Kingdom (Best Foot Forward, 2011). It uses a component-based approach to calculate Ecological Footprint's by disaggregating resource use into five consumption categories (direct energy use, materials and waste, food and drink, personal transport, water use and built land). Ecological Footprints are calculated using consumption data for each of these categories, and applies conversion factors contained within Global Footprint Network's National Footprint Accounts (the global organisation which provides scientific data, including conversion factors for calculating Ecological Footprints), supplemented with LCA data. For a more detailed description of the Ecological Footprint methodology, see Chambers et al. (2005). The methodology used within this software has been used to calculate the Ecological and Carbon Footprints of several major events including the Wimbledon

Championships, Olympic Games (London 2012), America's Cup in San Francisco (2013), and 2014 FIFA World Cup Brazil, and therefore has attained significant international credibility.

## Hay Festival – Ecological Footprint results

A summary of the Ecological Footprint results for visitors attending the 2012 Hay Festival is shown in Table 2. These are expressed as gha for all visitors (i.e. 100,000) and per average visitor per day. Based on the analysis of visitors' physical consumption activities at the festival (i.e. travel to/from and during the festival, food and drink consumption, and energy used in overnight accommodation), the total Ecological Footprint was estimated to be 3300 gha. On a per visitor day basis, the Ecological Footprint was estimated to be 0.011 gha.

For comparative purposes it is useful to consider the Ecological Footprint of visitors "at home". This was calculated based on what visitors would have consumed, for each of the consumption categories over the same period of time (i.e. three days, the average length of stay), had they not attended the festival and gone about their everyday activities. This was estimated using Ecological Footprint results for a resident living in Cardiff (Wales' capital city) (see Collins, Flynn, Wiedmann, & Barrett, 2006), and so the calculations assumed that all festival visitors (United Kingdom and international) had similar consumption patterns as a Cardiff resident. Cardiff data on household consumption were used as it was at a sufficient level of detail to enable comparisons to be made across all categories. As shown in Table 2, the "total" Ecological Footprint for an average visitor was an estimated 1.8 times greater than if they had stayed at home. The main reason for visitors' larger Ecological Footprint was that by attending the festival, they were engaged in different patterns of consumption, which in turn generated a larger Footprint. The "additional" Ecological Footprint generated by visitors attending the festival was 1500 global hectares, or 0.005 gha per visitor day. This was calculated by subtracting visitors' Ecological Footprint "at home" from the "total Ecological Footprint" for each of the footprint components.

Overall, visitor travel had the most significant impact, accounting for 61% of visitors Ecological Footprint (2000 gha or 0.007 gha per visitor day). Visitor travel was found to be eight times greater than their travel Footprint at home for the same period (300,000 visitor days). As shown in Table 3, visitors travelled an estimated 71 million passenger kilometres (or 710 km per average visitor). Of this total distance, 59% was by car and 35% by air (the majority being international air travel). While the festivals' organisers have taken some action towards encouraging visitors to make more sustainable travel choices; travel by rail, coach, bus and bicycle accounted for only 7.5% of the total distances travelled by visitors. Closer examination of the results also reveals that 65% of the total travel Footprint was attributable to UK visitors and 35% to international visitors. The largest contributors were car and international air travel (i.e. 63% and 32% of the total travel Footprint). Travel by car accounted for 91% of the total distance travelled by UK visitors, and 91% of their travel Footprint.

Table 2. Summary of Ecological Footprint results for the 2012 Hay Festival.

Consumption category	Visitor "Total EF" [gha] (gha/visitor/day)	Visitor "Additional EF" [gha] (gha/visitor/day)	Visitor EF "at home" location [gha] (gha/visitor/day)
Food and drink	260 (0.001)	−340* (−0.001)	600 (0.002)
Energy use in overnight accommodation	1100 (0.004)	190 (0.001)	920 (0.003)
Travel	2000 (0.007)	1700 (0.006)	250 (0.001)
Total	3300 (0.011)	1500 (0.005)	1770 (0.006)

Note that all Ecological Footprint figures have been rounded up to two significant figures.

\*Visitors food and drink EF is almost 50% less at the festival than at home. There are several possible reasons for this. First, the EF calculations only included food and drink purchased at the festival and in Hay-on-Wye town, and excluded items consumed at home, or brought to the festival (i.e. picnics). Second, visitors may have underestimated how much they would purchase at the festival.

**Table 3.** Distances travelled by visitors and the corresponding Ecological Footprint.

Mode of travel	UK visitors		International visitors		All visitors	
	Distance travelled (pkm)	EF (gha)	Distance travelled (pkm)	EF (gha)	Distance travelled (pkm)	EF (gha)
Air	0.1%	0.2%	95.0%	94.0%	35.0%	32.0%
Bus	2.0%	2.9%	0.1%	0.1%	1.3%	1.3%
Campervan	0.9%	1.4%	0.0%	0.0%	0.6%	0.9%
Car	91.0%	91%	3.7%	5.3%	59.0%	63.0%
Coach	0.4%	0.1%	0.0%	0.0%	0.2%	0.1%
Ferry	0.0%	0.0%	0.5%	0.2%	0.2%	0.1%
Rail	5.1%	2.6%	0.9%	0.5%	3.6%	1.9%
Walk/cycle	0.008%	0.0%	0.0%	0.0%	0.005%	0.0%
Other	0.1%	0.3%	0.0%	0.0%	0.1%	0.2%
Total	45 million	1300	26 million	670	71 million	2000

### Comparing Hay Festival with other major events

To enhance our understanding of the scale of visitors’ resource use and environmental impact, it is useful to compare the festival’s Ecological Footprint results with other events. Here we draw comparisons with two major events held at Cardiff’s Millennium Stadium; the 2004 FA Cup Final (Collins et al., 2006) and a 2007 Rugby 6 Nations fixture (Collins & Roberts, 2008). The Ecological Footprint for both of these events was also calculated using the same methodology. Although they are sport events, of different durations and held in an urban setting, they do enable us to draw comparisons and understand further the environmental impacts that can be generated by different types of events.

Comparisons between the two events and Hay Festival are made considering the Ecological Footprint results per visitor and per visitor day (see Table 4). The Ecological Footprint results highlight that the environmental impact of events is linked to the number of visitors. It also suggests that the location and capacity of the host area (i.e. appropriate public transport infrastructure) may also be linked to their Ecological Footprint. Cardiff being the capital city of Wales has relatively good public transport infrastructure, and is well connected to other areas of the United Kingdom. Therefore, the travel Footprint per visitor is lower for events in Cardiff, as more visitors choose to travel by public transport rather than by car. Similarly, the Ecological Footprint results for energy use in overnight accommodation and food and drink are larger for Cardiff events. This is due to greater availability of hotel accommodation and more opportunities to eat out.

**Table 4.** Comparison of Ecological Footprint results for major events and festivals in Wales.

Consumption activity	Event/festival		
	Hay Festival (2012)	FA Cup Final (2004)	Rugby Six Nations (2006)
Travel	2000 (0.002 gha/visitor) (0.007 gha/visitor day)	679 (0.0093 gha/visitor) (0.0093/visitor day)	493 (0.0058 gha/visitor) (0.004 gha/visitor day)
Energy use in visitor accommodation	1100 (0.011 gha/visitor) (0.004 gha/visitor day)	Not calculated	405 (0.0047 gha/visitor) (0.008 gha/visitor day)
Food and drink	260 (0.0026 gha/visitor) (0.001 gha/visitor day)	202 (0.0028 gha/visitor) (0.003 gha/visitor day)	231 (0.0027 gha/visitor) (0.002 gha/visitor day)
Waste	Not calculated	33 (0.005 gha/visitor) (0.005 gha/visitor day)	Not calculated
Event duration	11 days	1 day	3 days*
Average length of visit per visitor	3 days	1 day	3 days
Total visitors	100,000	73,000	85,499
Location	Hay-on-Wye	Cardiff	Cardiff

\*In the case of the 2006 RBS Rugby Six Nations, although the match is played on a single day the duration was taken as three days as a significant proportion of visitors were in Cardiff the day before or following the event, and so will have had expenditure and consumed on these days.

## Beyond impact: scenarios to reduce visitors' travel Footprint

This paper so far has reported on the Ecological Footprint results for visitors attending the Hay Festival, and highlighted the significant contribution made by visitor travel. While the Ecological Footprint does not advise on how to reduce the environmental impact of a festival, the component-based approach to calculating visitors' Ecological Footprint can indicate where the largest impacts occur (i.e. those factors that have contributed towards the scale of the Ecological Footprint), and so may present itself as a valuable tool from which to assess the impact reductions that could be achieved by alternative transport strategies. In the case of Hay Festival, visitor travel accounted for 61 per cent of the total Ecological Footprint. The festival's rural location, combined with total distances travelled by visitors, a preference to travel by car and air, and Hay-on-Wye town having poor public transport infrastructure are factors that contributed to the scale of visitors' travel Footprint.

In assessing travel scenarios for Hay Festival, 2012 was taken as the baseline year from which to calculate the potential decrease in the travel Footprint. We have used an approximate approach similar to that espoused by MacKay (2008); and therefore the Ecological Footprint scenario results are estimates, and should be interpreted as an upper bound on the Ecological Footprint reductions. Changes to distances travelled by visitors using alternative forms of transport were calculated using the freely available spatial network analysis software sDNA (Chiaradia, Cooper, & Webster, 2012).

As a significant proportion of visitors' travel Footprint was attributable to car and international air travel (63% and 32% respectively), a number of alternative scenarios focusing on more sustainable modes of transport were developed to examine the extent to which they could reduce visitors' travel Footprint (see Table 5). These scenarios were developed around suggestions provided by visitors as part the visitors' survey and also the festival's organisers. In this paper, we present the results of five scenarios, which can assist in demonstrating some of key strengths and limitations associated with the Ecological Footprint as a potential environmental management tool for festival organisers.

Scenario 1 focuses on reducing air travel by international visitors, and could reduce visitors' travel Footprint by 34%. It would however mean 2% fewer international visitors attending the festival, and could have a negative impact on the local economy due to reduced spending by these visitors. When assessing the potential Ecological Footprint reduction of this scenario, there are a number of

Table 5. Selection of alternative travel scenarios.

Scenario	Scenario description	Travel EF decrease/increase	
		(gha)	(%)
1	Reduce international air travel Zero international visitors attend the festival.	-671	-34%
2	Visitors travel to festival by public transport (festival coach and bus service) Day visitors travel from main towns to festival by bus. Overnight visitors travel from main towns to festival by coach. Journeys between festival site and accommodation made by bus.	-694 (100% occupancy) +46 (average occupancy)*	-35% (100% occupancy) +2% (average occupancy)
3	Visitors travel to festival by public transport (festival coach and minibus service) Day visitors travel from main towns to festival by minibus. Overnight visitors travel from main towns to festival by coach. Journeys between festival site and accommodation made by minibus.	-910 (100% occupancy) -464 (average occupancy)	-46% (100% occupancy) -24% (average occupancy)
4	Car-sharing Visitors that currently travel to festival car-share (minimum car occupancy of 4).	-466	-24%
5	Festival relocated to rail hub All visitors (day and overnight) travel to festival by rail. Journeys to overnight accommodation made by bus (100% occupancy at festival bus stop).	-300	-15%

\*Average occupancy refers to national average levels of vehicle occupancy (26%: bus, 28%: coach). Scenario footprint calculations make use of Ordnance Survey data © Crown copyright and database right 2012, Royal Mail data © Royal Mail copyright and database right 2014 and National Statistics data © Crown copyright and database right 2014.

assumptions within the calculations that need to be acknowledged. First, international visitors are not replaced with additional UK visitors; second, international visitors that would have attended the festival do not replace their visit with another foreign holiday. The potential knock-on effect of this scenario is an important consideration for festival organisers; however, it would be outside the scope of any environmental impact assessment method, including the Ecological Footprint.

Scenarios 2 and 3 consider the effect of replacing car journeys with alternative public transport modes. Scenario 2 involves replacing all car journeys with a festival coach and bus service. If 100% occupancy was achieved for both modes, this could reduce the travel Footprint by as much as 35% (a similar reduction as Scenario 1). However, if both services were not operated efficiently and occupancy levels were similar to the national average for bus and coach (26% and 28% respectively), the travel Footprint could increase by 2%. If occupancy levels on both modes were below the national average, the travel Footprint could increase further. The sensitivity surrounding vehicle occupancy levels in this scenario highlights an important contribution of the Ecological Footprint as an environmental management tool, as it directs the user (i.e. the festival organiser), to consider alternative ways to reduce the risk of low occupancy levels as well as any potential financial losses.

Scenario 3 is one possible way of minimising the risk of low occupancy levels (and increasing the travel Footprint), and involves replacing car journeys with coaches and minibuses (instead of normal-sized buses). Minibuses are currently used to transport visitors from the festival site to overnight accommodation in neighbouring villages, and so this scenario would expand their current use. Of the two public transport scenarios presented here, Scenario 3 may be more effective in reducing the environmental impact of visitor travel as the Ecological Footprint could be reduced by some 24%–46%, depending on occupancy levels.

The calculation of Scenarios 2 and 3 do involve a number of assumptions (i.e. occupancy levels), and this limitation is not unique to the Ecological Footprint. Furthermore, the Footprint software used here did not enable the authors to consider the effect of different vehicle occupancy levels and so had to be supplemented with DEFRA data on GHG emissions (DEFRA, 2012). The Ecological Footprint is not designed to nor is it able to indicate which location(s) any future festival transport services should operate from. Estimating visitor demand for transport services from different geographical locations would require a survey to be conducted alongside online purchasing of tickets, or a spatial gravity model (Fotheringham & O'Kelly, 1989) to extrapolate from the 2012 Festival survey results.

Scenario 4 considers the effect of increased car sharing by visitors that currently travel to the festival by car. This scenario was developed around visitors' preference to travel to the festival by car. As shown in Table 5, increased car sharing by visitors that currently travel by car (with a minimum of four occupants) could reduce the travel Footprint by as much as 24%. While this reduction in the travel Footprint is lower than what could potentially be achieved by Scenario 2 (i.e. increasing visitor travel by coach and bus), from a festival organisers perspective there is less risk involved, as low uptake rates will not lead to an increase in visitors' travel Footprint.

Scenario 5 focuses on the extent to which visitor's travel Footprint would increase or decrease if the festival was held in a location with good public transport infrastructure. For this scenario, Cardiff was selected as the alternative location and it was assumed all visitors travelled to the festival by rail, and used the local bus service to travel to overnight accommodation. For both modes, it was assumed occupancy levels were similar to national average levels. Although it is unlikely that the festival would relocate to Cardiff or indeed any other location due to its historical roots and branding closely associated with Hay-on-Wye as a Booktown, this scenario could reduce visitors' travel Footprint by 13%, which is modest compared to Scenarios 2 and 3. Although rail travel has a lower Ecological Footprint per passenger km than car, the main reason for the lower Footprint reduction compared to switching to coach, bus and minibus, is the different occupancy levels envisaged in the scenarios.

## Conclusions

The purpose of this paper was to assess the contribution of the Ecological Footprint as a method for examining the resource demands of festivals, and identifying which consumption activities have the

most significant impacts. It also aimed to assess the potential contribution of the Ecological Footprint as a tool for policy-makers and festival organisers in evaluating the effect of alternative transport scenarios. While the results are of immediate significance for Hay Festival and festivals held in similar locations, they still have relevance for other festival organisers, particularly given the increased popularity and growth in festival attendance.

The analysis shows that festivals do have significant resource demands and environmental impacts, in particular visitor travel. These impacts are comparable with major sporting events. The Ecological Footprint offers a number of potential advantages to policy-makers and festival organisers in terms of understanding and managing the environmental impact of festivals in the future. First, the Ecological Footprint is a valuable communication and awareness-raising tool as it personalises sustainability by assessing the impact of consumption from a consumer perspective. The Ecological Footprint results could be communicated to festival visitors to enable them to appreciate the link between their consumption activities and global environmental impacts. Festival organisers could also use the results to advocate pro-environmental behaviours amongst visitors, such as using public transport. Second, the component-based approach used to calculate the Ecological Footprint results provides a detailed insight into the resource uses of festival visitors. The use of the global hectare to assess the resource demands of visitors enables comparison of different visitor activities, and can identify those with the most significant impacts. Furthermore, the detailed level of analysis provided by the Ecological Footprint provides an interesting insight into the contribution of different forms of travel to the festivals overall impact – in the case of Hay Festival, car travel and international air travel.

The ability of the Ecological Footprint approach to evaluate alternative transport scenarios has assisted in enhancing our understanding of the types of strategies that may be required to reduce the impact of visitor travel at festivals, particularly those in rural locations with poor public transport services. However, it is acknowledged that there is uncertainty surrounding how visitors will respond to these strategies, and so results need to be considered as estimates of impact rather than actual.

The festival's current approaches to encouraging visitors to use more sustainable forms of transport (awareness raising via its website and modest enhancement to the local bus service) have had limited success, as only 7.5% of distances travelled by visitors were rail, coach, bus and bike. There is a need for a more radical change in how visitors travel to the festival if the travel Footprint is to be reduced significantly. The scenarios presented in this paper have highlighted the importance of increasing occupancy above the national average levels. As Scenarios 2 and 3 indicate, the provision of public transport services could lead to an increase in the travel Footprint if occupancy levels are too low (at or below national levels). To secure the required occupancy levels, organisers need to consider carefully where to locate services and how to incentivise visitors to switch mode in order to reduce any such risk. The latter will require a more sophisticated understanding of factors that influence visitor travel choices and barriers to influencing behaviour change. Further research is also needed on factors influencing the travel choices of different types of attendees by age, gender, occupation, group size and composition. It would also be worthwhile undertaking research to identify what incentives would be most effective for different audiences, or a willingness of visitors to pay for travel by public transport versus the car.

The scenario function of the Ecological Footprint method could be further used by policy-makers to assess the effectiveness of festival transport strategies, and inform decisions on whether to provide support for certain festivals or transport initiatives. Footprint reduction targets could be set, and progress monitored in achieving them. Moreover, improved information on the types of strategies that have been effective in certain contexts could be shared with other festival organisers.

Although beyond the scope of this paper, the economic cost of alternative transport strategies will be an important consideration for festival organisers as they will need to ensure any financial losses are minimal. As the Ecological Footprint provides a quantified assessment of the environmental cost of resource use (i.e. the global hectare), the environmental savings associated with alternative transport strategies could be considered alongside the financial costs.

While the Ecological Footprint does present a number of strengths to festival organisers and policy-makers, it does have its limitations. While the Ecological Footprint can be relatively straight forward to

calculate using Footprint software, the accuracy of such calculations will depend on assumptions contained within the software, which may not always be appropriate to specific cases to which it is applied. The purchasing of Footprint software may also be expensive, particularly for smaller festivals that may not have the necessary resources. Both of these issues could be mitigated if there was greater transparency in the conversion factors and assumptions used within Footprint calculators. However, keeping this information proprietary does enable software providers to fund continual development of the Ecological Footprint methodology and future software. It can also assist in maintaining some consistency in the methodology, and so enabling comparisons between festivals and events.

Our analysis involved calculating visitors' "additional" Ecological Footprint as well as their "total" Ecological Footprint, and in doing so provided a more appropriate and conservative estimate of visitors' environmental impact. However, the accuracy of any "additional" Footprint result is dependent on the availability of up-to-date data on visitor consumption "at home". Ecological Footprint studies have not been completed for every location in the United Kingdom, and so National or Ecological Footprint for a neighbouring city will need to be relied on, and so the accuracy of the estimated results will be a consideration. While "additional" footprints can be used to compare the scale of impact for different events, they cannot be interpreted as a potential Ecological Footprint saving that would occur in the scenario of complete festival cancellation, as in this case it is unlikely that visitors would remain "at home" and would be likely to engage in alternative leisure activities.

This study did not account for the activities of sponsors, speakers, festival staff and volunteers or other activities at the festival site such as energy use. These wider activities could be included in the Ecological Footprint analysis if the appropriate data were available. This research has considered a single rural festival held over multiple days. Further research is needed on the impacts of different festivals (e.g. music, food), and in different locations (e.g. rural, urban and semi-rural) and different durations (e.g. multiple versus one day festivals).

While the Ecological Footprint may assist in addressing some of the issues relating to other environmental assessment methods, the authors do acknowledge that it does not provide a complete sustainability assessment as it only considers environmental impacts of resource use, and would need to form part of a broad sustainability assessment that include social and economic outcomes. The Ecological Footprint does however offer organisers a useful method for assessing the environmental dimension of sustainability, and so could contribute towards providing a more rigorous measure of environmental impact within a wider TBL framework. Despite its limitations, the Ecological Footprint can be a valuable tool for festival organisers and policy-makers, as it does address some of the difficulties associated with other methods. A final word of caution is that all such tools are only useful if organisers respond appropriately to the findings and report on the effectiveness of their efforts: while we can and should measure the Ecological Footprint in detail, the desired gains in sustainability can only come from active management of environmental impacts.

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No potential conflict of interest was reported by the authors.

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## References

- Andersson, T.D., & Lundberg, E. (2013). Commensurability and sustainability: Triple impact assessments of a tourism event. *Tourism Management*, 37, 99–109.
- Ayres, R. (2000). On the utility of the Ecological Footprint concept. *Ecological Economics*, 32(3), 347–349.
- Bastianoni, S., Niccolucci, V., Neri, E., Cranston, G., Galli, A., & Wackernagel, M. (2013). Sustainable development: Ecological Footprinting in accounting. In S-E Joergensen (Ed.), *Encyclopedia of Environmental Management*, 2467–2481.
- Becken, S., Frampton, C., & Simmons, D. (2001). Energy consumption patterns in the accommodation sector – The New Zealand case. *Ecological Economics*, 39, 371–386.
- Becken, S., Simmons, D.G., & Frampton, G. (2002). Energy use associated with different travel choices. *Tourism Management*, 23(4), 343–354.
- Best Foot Forward (part of Anthesis Group Plc.). (2011). *Footprint Reporter™ User Guide*. Oxford: Best Foot Forward.
- Chambers, N., Child, R., Jenkin, N., Lewis, K., Vergoulas, G., & Whiteley, M. (2005). *Stepping forward*. A resource flow and ecological footprint analysis of the South West of England technical Report. Oxford: Best Foot Forward Limited. Retrieved 14 October 2013 from <http://www.steppingforward.org.uk/downloads/technical.pdf>
- Chiaradia, A., Cooper, C., & Webster, C. (2012). *sDNA a software for spatial design network analysis*. Retrieved 9 March 2015 from <http://www.cardiff.ac.uk/sdna/>
- Collins, A., Cowell, R., & Flynn, A. (2009). Evaluation and environmental governance: The institutionalisation of Ecological Footprinting. *Environment and Planning A*, 41(7), 1707–1725.
- Collins, A., & Flynn, A. (2005). A new perspective on the ecological impacts of planning: A case study of Cardiff's international sports village. *Journal of Environmental Policy and Planning*, 7(4), 277–302.
- Collins, A., & Flynn, A. (2015). *The ecological footprint: New developments in policy and practice*. Cheltenham: Edward Elgar Publishing.
- Collins, A., Flynn, A., Munday, M., & Roberts, A. (2007). Assessing the environmental consequences of major sporting events: The 2003/04 FA. *Urban Studies*, 44(3), 1–20.
- Collins, A., Flynn, A., Wiedmann, T., & Barrett, J. (2006). The environmental impacts of consumption at a subnational level: The ecological footprint of Cardiff. *Journal of Industrial Ecology*, 10(3), 1–16.
- Collins, A., Jones, C. & Munday, M. (2009). Assessing the environmental impacts of mega sporting events: Two options?. *Tourism Management*, 30, 828–837.
- Collins, A., Munday, M., & Roberts, A. (2012). Tourism consumption at major events and environmental consequences: An analysis of the UK stages of the 2007 Tour de France. *Journal of Travel Research*, 5(5), 577–590.
- Collins, A., & Roberts, A. (2008). *Assessing the impact of UK events*. Paper presented at ESRC Seminar Series on 'Sustainable Consumption and Production', Cardiff: BRASS Research Centre.
- DEFRA. (2012). *2012 guidelines to Defra/DECC's GHG conversion factors for company reporting: Methodology paper for emission factors*. PB 13792, July 2012. Retrieved 16 February 2015 from [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/69568/pb13792-emission-factor-methodology-paper-120706.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69568/pb13792-emission-factor-methodology-paper-120706.pdf)
- Dolles, H., & Soderman, S. (2010). Addressing ecology and sustainability in mega-sporting events: The 2006 Football World Cup in Germany. *Journal of Management & Organization*, 16(4), 587–600.
- Ferng, J.J. (2002). Toward a scenario analysis framework for energy footprints. *Ecological Economics*, 40, 53–69.
- Food Standards Agency (FSA). (2008). *Food portion sizes* (3rd ed). London: TSO.
- Fotheringham, A.S., & O'Kelly, M.E. (1989). *Spatial interaction models: Formulations and applications*. Dordrecht: Kluwer Academic Publishers.
- Fredline, L., Raybould, M., Jago, L., & Deery, M. (2005). Triple bottom line event evaluation: A proposed framework for holistic event evaluation. In *Proceedings of International Event Research Conference* (pp. 2–15). Lindfield: Australia Centre for Event Management. Retrieved 2 March 2016 from <http://vuir.vu.edu.au/2218/>
- Galli, A. (2015). On the rational and policy of ecological footprint accounting: The case of Morocco. *Environmental Science and Policy*, 48, 210–224.
- Galli, A., Wackernagel, M., Iha, K., & Lazarus, E. (2014). Ecological Footprint: Implications for biodiversity. *Biological Conservation*, 173, 121–132.



- Galli, A., Wiedmann, T., Ercin, E., Knoblauch, D., Ewing, B., & Giljum, S. (2012). Integrating ecological, carbon and water footprint into a "Footprint Family" of indicators: Definition and role in tracking human pressure on the planet. *Ecological Indicators*, 16, 100–112.
- Getz, D. (2005). *Event management and event tourism* (2nd ed.) New York: Cognizant.
- Getz, D. (2009). Policy for sustainable and responsible festivals and events: Institutionalization of a new paradigm, *Journal of Policy Research in Tourism, Leisure and Events*, 1(1), 61–78.
- Getz, D. (2010). The nature and scope of festival studies. *International Journal of Event Management Research*, 5(1), 1–47.
- Gibson, C.R., & Wong, C. (2011). Greening rural festivals: Ecology, sustainability and human-nature relations. In C.R. Gibson & J. Connell (Eds.), *Festival places – Revitalising rural Australia* (pp. 92–105). Bristol: Channel View Publications.
- Glastonbury Green Traveller. (2011). *Become a green traveller and enjoy the benefits*. Retrieved on 2 March 2016 from <http://www.glastonburyfestivals.co.uk/become-a-green-traveller-and-enjoy-the-benefits/>
- Gössling, S. (2002). Global environmental consequences of tourism. *Global Environmental Change*, 12(4), 283–302.
- Gössling, S., Borgström Hansson, C., Hörstmeier, O., & Saggel, O. (2002). Ecological Footprint analysis as a tool to assess tourism sustainability. *Ecological Economics*, 43, 199–211.
- Goldfinger, S., Wackernagel, M., Iha, K., Lazarus, E., & Lin, D. (2014). Footprint facts and fallacies: A response to Giampietro and Saltelli (2014) "Footprints to Nowhere". *Ecological Indicators*, 46, 622–632.
- Gratton, D., Arcodia, C., Raciti, M., & Stokes, R. (2011). The blended festival scape and its sustainability at nonurban festivals. *Event Management*, 15, 343–359.
- Hay Festival Wales. (2012). *Hay-on-Earth Toolkit* [Online]. Retrieved 14 October 2015 from <https://www.hayfestival.com/greenprint/#>
- Hay Festival Wales. (2013). *Hay on Earth Festival Report*. Hay on Wye: Authors. Retrieved 19 December 2015 from <http://www.hayfestival.com/greenprint/documents/HayonEarth2013Report.pdf>
- Hede, A.-M. (2007). Managing special events in the new era of the triple bottom line. *Event Management*, 11, 13–22.
- Hunter, C. (2002). Sustainable tourism and the touristic ecological footprint. *Environment, Development and Sustainability*, 4, 7–20.
- Hunter, C., & Shaw, J. (2007). The ecological footprint as a key indicator of sustainable tourism. *Tourism Management*, 28, 46–57.
- Jackson, J., Houghton, M., Russell, R., & Triandos, P. (2005). Innovations in measuring economic impacts of regional festivals: A do-it-yourself kit. *Journal of Travel Research*, 43, 360–367.
- Lenzen, M., & Murray, S.A. (2001). A modified ecological footprint method and its application to Australia. *Ecological Economics*, 37, 229–255.
- Li, X., & Petrick, J.F. (2006). A review of festival and event motivation studies. *Event Management*, 9, 239–245.
- Lin, D., Wackernagel, M., Galli, A., & Kelly, R. (2015). Ecological Footprint: Informative and evolving – A response to van den Bergh and Grazi (2014). *Ecological Indicators*, 58, 464–468.
- MacKay, D. (2008). *Sustainable energy – Without the hot air*. Cambridge: UIT.
- Mair, J., & Whitford, M. (2013). An exploration of events research: Event topics, themes and emerging trends, *International Journal of Events and Festival Management*, 4(1), 6–30.
- McGregor, P.G., Swales, J.K., & Turner, K.R. (2004). The impact of Scottish consumption on the local environment: An alternative to the Ecological Footprint?, *Quarterly Economic Commentary*, 29(1), 29–34.
- Moffatt, I. (2000). Ecological Footprints and sustainable development. *Ecological Economics*, 32, 359–362.
- Patterson, T.M., Niccolucci, V., & Bastianoni, S. (2008). Adaptive environmental management of tourism in the Province of Siena, Italy using the Ecological Footprint. *Journal of Environmental Management*, 86, 407–418.
- Peeters, P., & Schouten, F. (2006). Reducing the Ecological Footprint of inbound tourism and transport to Amsterdam. *Journal of Sustainable Tourism*, 14(2), 157–171.
- Ponsford, I.F. (2001). Actualizing environmental sustainability at Vancouver 2010 venues. *International Journal of Event and Festival Management*, 2(2), 184–196.
- Sherwood, P. (2007). *A triple bottom line evaluation of the impact of special events: The development of indicators* (Unpublished doctoral dissertation). Melbourne: Victoria University. Retrieved 2 March 2016 from <http://vuir.vu.edu.au/1440/>
- Statista. (2016). Music concert and festival attendance in the United Kingdom (UK) in 2012 and 2014 (in 1,000s). Retrieved on 10 March 2016 from <http://www.statista.com/statistics/282032/music-concert-and-festival-attendance-in-the-uk-by-attendee-type/>
- Tourism Alliance. (2015). *UK Tourism Statistics 2015*. Retrieved 12 February 2016 from [http://www.tourismalliance.com/downloads/TA\\_369\\_395.pdf](http://www.tourismalliance.com/downloads/TA_369_395.pdf)
- van den Bergh, J.C.J.M., & Verbruggen, H. (1999). Spatial sustainability, trade and indicators: An evaluation of the 'ecological footprint'. *Ecological Economics*, 29, 61–72.
- Wong, C. (2005). *The environmental impacts of a festival: Exploring the application of the ecological footprint as a measuring tool* (Honours thesis). Sydney: University of New South Wales.
- World Wildlife Fund (WWF). (2014). *Living Planet Report 2014*. Gland: Author. Retrieved 15 March 2015 from [http://wwf.panda.org/about\\_our\\_earth/all\\_publications/living\\_planet\\_report/](http://wwf.panda.org/about_our_earth/all_publications/living_planet_report/)