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Willingness to pay of trail runners for sustainable country park use in Hong Kong

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ABSTRACT

Trail running has evolved from a fringe to mainstream activity but is associated with a rise in adverse environmental impacts including trail degradation, littering and disturbance of wildlife. This study explores the preferences of trail running race participants for sustainable use of country parks in Hong Kong. We use a face-to-face survey and discrete choice experiment methodology to measure the willingness to pay of race participants for the provision of drinking water fountains, biodiversity conservation, trail maintenance and green auditing of race events. The results suggest that there is a latent desire among trail runners to contribute to the preservation of natural areas through a surcharge on top of race entry fees. Mean willingness to pay for the provision of drinking water, conservation of biodiversity and trail maintenance is estimated in 2018 to be USD 12, USD 19 and USD 24 respectively. Furthermore, from stakeholder interviews it is concluded that the proposed fund-raising mechanism of a surcharge on top of the race entry fee would be readily accepted by trail runners, race organisers, NGOs and the government. This paper presents a practical and acceptable model that tackles environmental degradation caused by trail running whilst instigating a more democratic management approach between the government and other park stakeholders.

Management Implications

This article explores the willingness to pay (WTP) of protected area recreational users for specific management interventions and the practical means by which such payments can be realized. The study findings give protected area managers and event organisers useful insights into the preferences of recreational users for conservation measures. We find that trail race participants are willing to pay significant amounts for drinking water fountains, conservation of biodiversity and trail maintenance through a surcharge on the race registration fee.

1. Introduction

Trail running can be defined as the sport of running off-road, often on hilly or mountainous terrain. Other terms used for this pastime include mountain running, which refers to running at elevation; fell running, the sport of running on hills, mountains or fells; and ultrarunning, not exclusively but often run off-road and always over distances greater than a marathon (Chase & Hobbs, 2010). These terms overlap and are used interchangeably but for the purpose of this research the term trail running will be used to denote long-distance running on predominantly natural surfaces. Whilst trail running races can be considered a form of adventure racing, which is characterized as a type of event involving teams of participants and typically carried out over long distances (Newsome et al., 2011), they can also be run individually and over a wide range of distances from a few kilometers to 100 km or more.

Records of trail running date back as far as antiquity, such as Herodotus' account of the messenger Pheidippides' run from Athens to Sparta and back (Grogan, 1981). As a modern sport, trail running initially existed as a niche activity, primarily in Europe and North America, with the first trail running associations being founded in the 1970's and 1980's (e.g. The Fell Runners Association in 1970 and the World Mountain Running Association in 1984). In the first decade of the 21st century, with the confluence of the growth of interest in natural areas and adventure sports, the popularity of trail running started to grow, developing from a fringe activity into one much more widely practiced. In the US alone, the sport had 4.9 m participants in 2009 (Montrail and Outdoor Foundation 2010).

With the growth of adventure sports there is a growing concern of the deleterious impacts such activities have on the natural environment

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(Burgin & Hardiman, 2012; Newsome, 2014; Pickering et al., 2010). These include waste in the form of litter, which apart from being an eyesore can adversely affect wildlife; human excrement, which can cause the spread of pathogens (Newsome, 2014); damage to vegetation; compaction of trails; disturbance of wildlife; creation of informal trails; exacerbation of runoff that increases water turbidity; and the spread of weeds (Beeton, 2006; Newsome et al., 2011).

Whilst the practice of adventure sports in natural areas may result in negative environmental impacts, there is evidence to suggest that trail runners are concerned about the adverse effects of their sport on the environment and wish to ameliorate them. Farago (2013) noted that at the first annual Estes Trail Ascent – Trail Running Conference in the US one of the major themes was the sustainability of trail running. In Hong Kong, Cheung (2016) found that trail runners are particularly environmentally aware and willing to adopt environmentally friendly behaviour. In many contexts, however, there is an absence of practical models for financing the amelioration of environmental degradation caused by recreational activities (Schägner et al., 2016; Zaradic et al., 2009). This is likely to be the case in Hong Kong, where the charging of entrance fees to country parks would be publicly and politically unacceptable.

The aim of this paper is to quantitatively measure trail runners' preferences for environmental protection and estimate their WTP for specific conservation measures using a choice modelling method. Internationally, choice modelling has been widely used to measure public preferences for environmental characteristics including the recreational use of natural areas (Bullock & Lawson, 2008; De Valck 2017; Landauer et al., 2012). To our knowledge, the present study is among the first applications of choice modelling to measure environmental preferences in Hong Kong.[1] We further aim to assess the acceptability to relevant stakeholder groups of an innovative payment vehicle that raises funds for conservation. The results can potentially assist park management and race directors in the formulation of a policy for the sustainable management of trail running races and more generally for organized events in country parks. In a broader context, the study aims to examine the applicability of the principle of stakeholder participation for more sustainable management of a common pool resource.

2. Study site description: trail running in Hong Kong country parks

2.1. Hong Kong country parks

Hong Kong is blessed with a stunning and varied landscape, much of which has been preserved for posterity through the creation of the country park system (broadly equivalent to national parks). There are currently 24 country parks covering 443 km^2 (AFCD, 2016), or about 40% of Hong Kong's total land area, with a 25th park under planning (Planning Department, 2010), as well as 11 special areas (see Fig. 1). The parks, for which access is free, are hugely popular, and in line with international trends, are coming under increasing pressure from recreational use (Manning & More, 2002). In 2017 there were 13 million visitors to country parks in Hong Kong (AFCD, 2017) engaging in a wide range of recreational activities including camping, photography, hiking, picnicking, barbequing and increasingly, sporting activities including mountain biking and trail running (Cheung, 2013; 2016).

The Conservation and Countryside Branch of the Agriculture, Fisheries and Conservation Department (AFCD) of the Hong Kong Government is responsible for the management of the Country Parks (Jim & Wong, 1996) with the Country and Marine Parks Board (Hong Kong Government, 2005). A three-zone framework is used to control visitors to country parks in Hong Kong (Jim, 2010). This zoning system (the details of which are not publicly available) is, with the exception of a small number of areas, not actively enforced and is intended to limit anthropogenic environmental degradation by concentrating visitors in easily accessible high intensity zones (Cheung, 2013) whilst discouraging visits to areas of higher conservation importance by making them more difficult to reach. However, in common with the global trend of increasing interest in nature-based active recreation (Buckley, 2006, 2009; Burgin & Hardiman, 2012; Newsome et al., 2012), preferences in Hong Kong have changed with a marked increase in interest in adventure sports, especially trail running (Cheung, 2016; Lee, AFCD, personal communication) for which participants actively seek more remote and often ecologically sensitive country park areas (Cheung 2013, 2016).

In response to these changing recreational preferences and an overall increase in the number of park visitors there have been calls for alternative management strategies. Lau (2011) advocated an adaptive management approach, characterized by the acceptance of uncertainty, inclusion of stakeholders in decision making, objective and experimental driven management with monitoring of results and the use of feedback to facilitate learning and adaptation (Newsome 2012). Stakeholder engagement in particular is a critical element of adaptive management, and arguably for the sustainable use of common pool resources (Burger & Gochfeld, 1998; Frey, 1994; Ostrom, 2000, 2002, 2010), but the AFCD has yet to adopt a more inclusive approach. The environmental non-governmental organization Civic Exchange (2002) noted that although the AFCD has increased public engagement through consultations, these processes rarely impact on the government's position. Thus, the government's country park management approach continues to be predominantly one of command and control.

2.2. Trail running in Hong Kong

Trail running in Hong Kong has only recently become a mainstream sporting activity. The first trail running series in Hong Kong was established in 1984 (Jacqueline, 2016) after which, in 1986, the largest trail running event in Hong Kong was initiated, the 100 km Oxfam Trailwalker (Oxfam Trailwalker, 2017). It was not until the end of the 1990's, however, that the number of races started to increase significantly. According to the Agricultural, Fisheries and Conservation Department (AFCD) of the Hong Kong Government, the number increased from just ten races in 2008 to over 150 in 2017 (Lee, AFCD, personal communication). Furthermore, the number of participants per race is increasing, with races reaching their quota within hours of being open to applicants. The Oxfam Trailwalker attracted 4900 participants in 2017 and had a waiting list of many more wishing to join (Tam, Oxfam, personal communication).

Pröbstl et al. (2010) identify three types of conflict that can occur with recreational use of natural areas - between conservation and recreational functions, between different types of recreational use, and between practitioners of a specific recreational activity. The limit placed on the number of races and number participants per race has so far been successful in avoiding conflict between trail running race participants. Nevertheless, trail running in country parks in Hong Kong is observed to have a significant adverse environmental impact. In a unique empirical study of the impacts of a trail running event in Hong Kong on trails, Ng et al. (2018) measured the conditions of a section of trail before and one day, one month and seven months after the race took place. The study concluded that the impacts of trail running racing were similar to those caused by hiking but much more intense and at a higher rate than for the latter. The observed negative effects included trail widening and

[1] The contingent valuation (CV) method has been applied by Chen and Jim (2012) to assess willingness to pay for ecotourism development in country parks using a hypothetical Ecotourism Development Tax as a payment vehicle, and by Cheung & Jim, 2014 to investigate willingness to pay for a hypothetical ecotour to protected areas. To the authors' knowledge, the only applications of the choice experiment method in the environmental field in Hong Kong are Auger et al. (2003), which surveyed students from the University of Hong Kong to investigate the willingness to pay (WTP) of consumers for ethical product features, and Chau et al. (2010), which assessed the WTP for environmentally friendly building attributes.

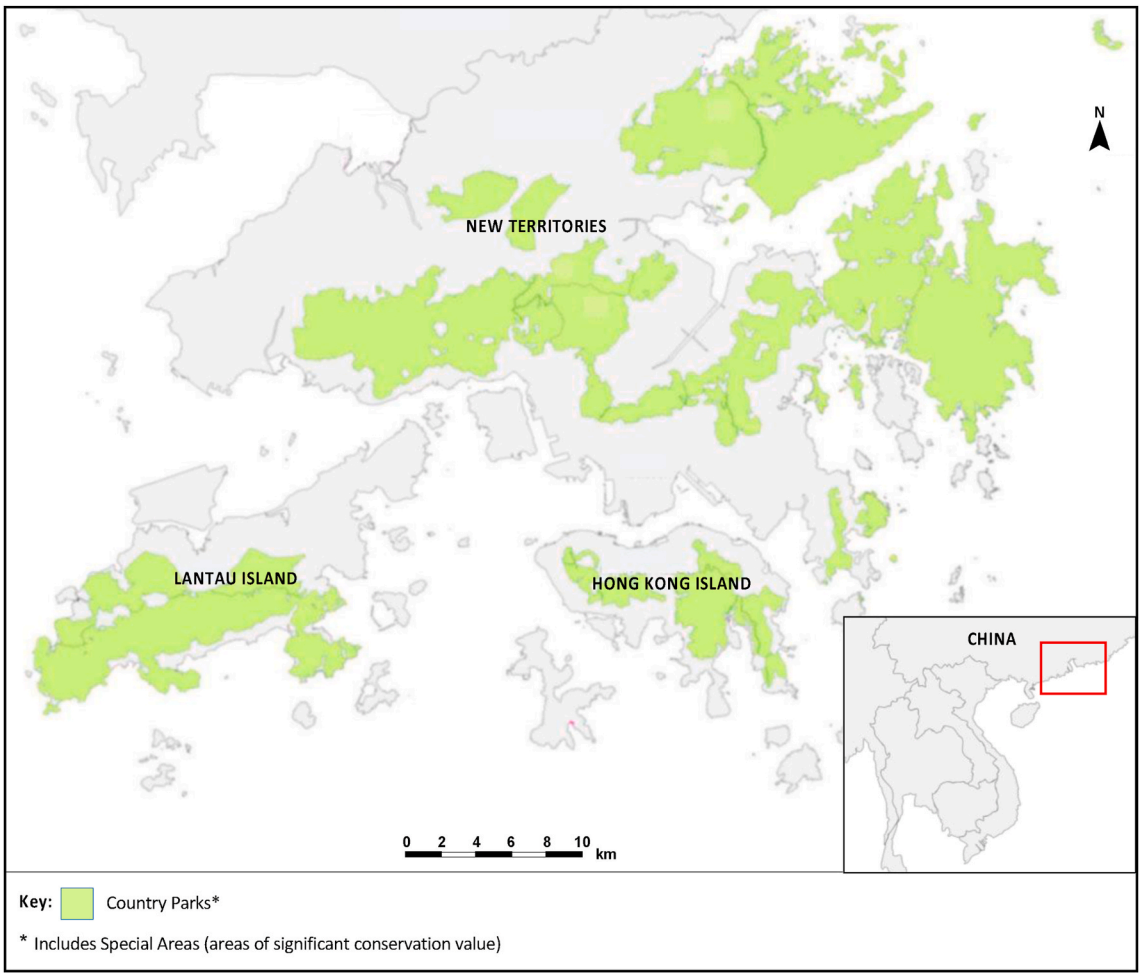

Fig. 1. Map of country parks in Hong Kong. Adapted with permission from Lo et al. (2006).

deepening, and the exposure, compaction and breaking down of the soil with some effects persisting even after seven months. In terms of conflict between different recreational uses, Newsome et al. (2011) commented that the thrill-seeking nature of adventure racers contrasted with the solitude that other park users sought, which could lead to conflict. Complaints received by the AFCD regarding trail runners in country parks substantiate this concern (Lee, AFCD, personal communication, February 12, 2018).

These issues are well recognised and there are existing initiatives to address environmental concerns by race organisers, NGOs and the government. For example, The Concern Group on Concretization of Hong Kong Natural Trails is engaging with the AFCD and overseas NGOs for the maintenance of trails using traditional methods, a number of race directors are working with the Green Earth NGO to reduce the environmental impact of their events and several races raise funds for environmental organizations (e.g. the Moontrekker race supports The Nature Conservancy).

3. Methods

3.1. Discrete choice experiment

To obtain quantitative measures of trail runners' preferences for a set of environmental characteristics, we make use of the discrete choice experiment (DCE) method. This stated preference method uses a public survey to elicit the preferences or values of respondents for specified changes in a good or service (Hensher et al., 2005). In the fields of market research and economics the DCE method is widely used to obtain information on public preferences that are otherwise not observable in consumer behaviour (Johnston et al., 2017).

The main theoretical underpinnings of the DCE method are derived from the characteristics theory of value (Lancaster, 1966) and random utility theory (McFadden, 1974). The characteristics theory of value posits that consumer behaviour is driven by the constituent characteristics of a good rather than the good itself. Random utility theory posits that measured consumer utilities should be treated as random variables to reflect that the observer lacks information on each goods' characteristics and alternatives as well as incomplete information on consumers (Caussade et al., 2005; Manski, 1977). The DCE method attempts to measure the preferences (random utilities) people have for environmental qualities (characteristics of the good they consume).

In practical terms, a DCE involves asking survey respondents to make repeated choices between alternative multi-attribute descriptions of a good or service. By observing the trade-offs that are made between attributes, it is possible to estimate their relative values (Hanley et al., 2001). By including one attribute that represents a monetary payment on the part of the respondent it is also possible to compute the WTP for changes in the other attributes (Pearce et al., 2002). In the present study, trail race participants were asked to choose between alternative options for conservation in country parks that would be funded through a surcharge to their race registration fee (country park use is free but for races organized in country parks there is an entry fee). By analysing the trade-offs that respondents make between conservation measures and registration fee, we are able to quantify trail runners' WTP for each measure.

A recurring issue in DCE applications is cognitive burden on the part

of respondents. There is evidence to suggest that individuals can be overwhelmed when presented with multiple choices between options that comprise many attributes and levels (Hanley, 2001; Mazzotta & Opaluch, 1995, pp. 500–515; Swait & Adamowicz, 1996). It is therefore necessary to limit the complexity of the choice task in terms of the number of attributes and levels and to test the capacity of respondents to process the choices they are asked to make (Johnston et al., 2017).

Hanley et al. (2001) and Hensher et al. (2005) provide practical guidelines for the development and implementation of a DCE. Modified for the context of this study, the steps for the implementation of the DCE methodology are: selection of attributes, experimental design, choice representation, pilot survey, main survey, and data coding and analysis.

3.2. Selection of attributes

An initial list of nine attributes was prepared based on a review of environmental NGO literature, conversations with NGOs and race directors and personal observation of trail races in Hong Kong country parks (Table 1). The over-arching selection criteria were, firstly, that attributes have to be related to the theme of sustainable country park use in line with the central objective of the study; secondly, the attributes have to be mutually exclusive to satisfy a requirement of the DCE framework (Hensher et al., 2005); and thirdly, the attributes have to be unambiguous so as to not unintentionally increase the level of unobserved variance.

The relevance and suitability of attributes was assessed through a process of stakeholder interviews and a survey of trail race participants. Stakeholder interviews were conducted with representatives of 20 trail race events encompassing the spectrum of race types, from family-oriented outings less than 10 km to ultramarathons of 100 km or more; NGOs active in areas related to trail racing or country park sustainability; and the AFCD. During each interview, the objective of the research was explained, the initial attributes described, and opinions sought on the proposed payment vehicle of a surcharge payable by race participants for each race entered as well as the proposed attributes.

Table 1 indicates which attributes were included at each stage of the survey development with the number of attributes progressively reduced based on survey findings.

The following preliminary list of attributes was prepared based on a review of environmental NGO literature, discussions with local NGOs and race directors and personal observation of trail races:

- Drinking water fountains: whilst water is provided during races there are no permanent water fountains in Hong Kong country parks. If installed, they could be used by runners when training and by the general public, reducing the need for single-use plastic bottles.
- Biodiversity conservation: Hong Kong country parks are home to a number of species of conservation concern that would benefit from supportive initiatives. As an iconic species representative of Hong Kong's unique biodiversity, the CITES Appendix I listed Chinese pangolin (Manis pentadactyla) was chosen to illustrate this attribute.
- Trail maintenance: the use of concrete for trail maintenance is very unpopular among trail runners in Hong Kong (Wang, 2017). A local stakeholder organization, The Concern Group on Concretization of Hong Kong Natural Trails, promoting the use traditional trail maintenance techniques has proven to be very popular and could be supported.
- Green race auditing: race directors have started to implement measures to improve sustainability. Third party green race auditing, using, for example, the standards established by the Council for Responsible Sport, would provide an objective rating for race participants wishing to assess race environmental impacts.
- Litter collection: runners are particularly sensitive to country park litter. Clean up campaigns are often conducted and could be given additional support.
- Environmental education: the benefits of environmental education in raising environmental awareness are well known (e.g. Jose et al., 2017; Varela-Candamio et al., 2018). Programmes on sustainable country park use for park users could be financed.
- Reforestation: it is unlikely that reforestation would occur in Hong Kong through natural succession alone (Corlett & Bierregaard, 1997). Well-designed reforestation programmes, many of which are already being implemented, could be supported.
- Clean energy: using commercially available solar powered batteries clean energy could be provided for country park events.
- Pollution monitoring: runners are particularly vulnerable to air pollution (Rundell, 2012) which has been linked a variety of ailments (Wang, 2016). Current monitoring stations are deployed in Hong Kong urban areas only. Air pollution is highly heterogeneous (Yi et al., 2015) and so additional monitoring devices located in country parks could be beneficial for runners wishing to understand local pollution levels.

Focusing on the target user group, trail race participants in country parks, an initial survey of 126 participants at two trail race events was used to elicit preferences for each of the proposed attributes. Respondents were asked to select their six most preferred services based on the premise that an additional fee would be charged on top of the race entry fee for each race entered, which would be used to finance their selections. The top five preferred attributes were selected for inclusion in the DCE. We note that although air quality is a major concern in Hong Kong, air pollution monitoring was not selected as an attribute because respondents believed that the government Air Quality Health Index (AQHI) is a sufficient indicator of air pollution in country parks. A number of respondents also questioned the need for further funding for Environmental Education, Litter Collection and Reforestation citing the numerous existing initiatives by NGOs, schools and other organizations for these services.

3.3. Experimental design

The experimental design of a DCE defines the attributes used to describe alternative options, the levels that each attribute can take, the combination of attribute levels in each option, the combination of options in each choice card, and the number of separate choices respondents are asked to make.

The experimental design in the present study includes the five selected attributes described above comprising four environmental characteristics and one payment vehicle. In our experimental design, all four environmental attributes are defined by two levels, i.e. each conservation measure is either provided or not. This binary description of service provision does not allow the measurement of preferences for finer degrees of provision but is intended to simplify choices for respondents and minimize cognitive burden. The payment is defined by four levels (HKD 40, 80, 120 and 160; which is equivalent to USD 6.85, 13.71, 20.56, 27.41).[2] Payment levels were established by considering the average race entry fee, a percentage of this fee as a surcharge that would be considered reasonable and differences between levels that are sufficiently large for respondents to distinguish between them.

Since the representation of all possible combinations of attribute levels across options would generate an infeasible number of choices, a fractional factorial design was used to limit the number of choices and ensure orthogonality (statistical independence of attributes and levels). The statistical design was generated using Sawtooth software[3] to

[2] All Hong Kong dollar amounts, except those stated in the survey examples, have been converted to US dollars using the 2017 World Bank purchasing power parity (PPP) conversion factor of 5.837 (World Bank, 2019).

[3] Orem, Utah, United States (2016) https://www.sawtoothsoftware.com/. Accessed on 29 September 2017.

Table 1
List of attributes.

Attribute	Description	Image	Attribute Survey	Pilot Survey	Final Survey
Drinking water fountain	Construction and maintenance of water fountains		✓	✓	✓
Biodiversity conservation	Fund conservation initiatives for endangered species in Hong Kong		✓	✓	✓
Trail maintenance	Repair of sections of country park trails using traditional techniques		✓	✓	✓
Green race auditing	Independent evaluation of trail races' environmental credentials		✓	✓	✓
Surcharge on race fee*	Payment of a surcharge when registering for a trail race in a country park	N/A	✓	✓	✓
Litter collection	Fund and organize clean up campaigns and educate the public		✓	✓	
Environmental education	Environmental education programme on sustainable country park use		✓	✓	
Reforestation	Reforestation programme using native species		✓	✓	
Clean energy	Provision of such clean energy systems in country parks for public use		✓		
Air pollution monitoring	Installation of a network of air pollution monitoring devices		✓		

* The surcharge on race fee acts as the payment vehicle.

optimize the combinations of attribute levels within and across choice cards to enable the statistical estimation of the influence of each attribute level on respondent choice (i.e., respondent preferences). We manually checked and modified the statistical design to avoid the occurrence of dominant options, i.e. the case that one option was superior to the other across all attributes. We note that a common alternative to using orthogonal designs are so-called efficient designs that are able to produce more reliable parameter estimates with an equal or smaller sample size (Rose, Bliemer, Hensher, & Collins, 2008). The experimental design defines 40 choice cards divided into 8 sets of 5 cards. Each respondent was asked to select their preferred option out of three options on a choice card; and asked to repeat the choice process over the 5 cards in one set of cards. Of the three options on each choice card, one option is held constant across all cards. The constant option was used to provide an opt-out, for which the four environmental attributes are not provided and no additional payment is made.

3.4. Choice representation

The attribute levels defining each option are represented on choice cards using photographs to provide respondents with a visual support for understanding the differences between options. For the environmental attributes, the absence of the provision of a service is represented as a blank. The representation of attributes and choice cards were tested for comprehension during the pilot survey and found to effectively communicate the provision and non-provision of each service. An example choice card is represented in Fig. 2.

3.5. Pilot survey of trail race participants

A pilot survey of 30 race participants at events was conducted to test the representation, understanding and definition of attributes in the DCE. At this stage, the design included six and eight choice cards per respondent, each option was defined by eight attributes (see Table 1) and the payment vehicle was defined as a percentage increase in race registration fee (10%, 20% and 30%). Whilst the respondents had no difficulty in understanding the concept of a surcharge to their race fee for each race entered, the method of calculating the absolute monetary contribution as a percentage of registration fees, which are variable across participant and distance categories, proved to be too cumbersome and obtuse. Additional findings of the pilot survey were that 43% of the respondents felt the fee level of 30% of the entry fee was excessive; 30% felt there were too many attributes to consider, making choice selection difficult; and 47% felt that eight choice cards were too many, whilst 17% felt that even six choice cards were too many. Finally, 17% noted without being solicited that the inclusion of one or more of the services of litter collection, reforestation and environmental education, was not justified since numerous NGOs and educational institutions were already providing these. On this basis, the final design includes five choice cards per respondent, with each option defined by five attributes (see Table 1) and the payment vehicle defined as discrete monetary increases in the race registration fee.

3.6. Main survey of trail race participants

The full survey of 380 race participants at four events was conducted by a team of five English and Cantonese speaking enumerators. The four

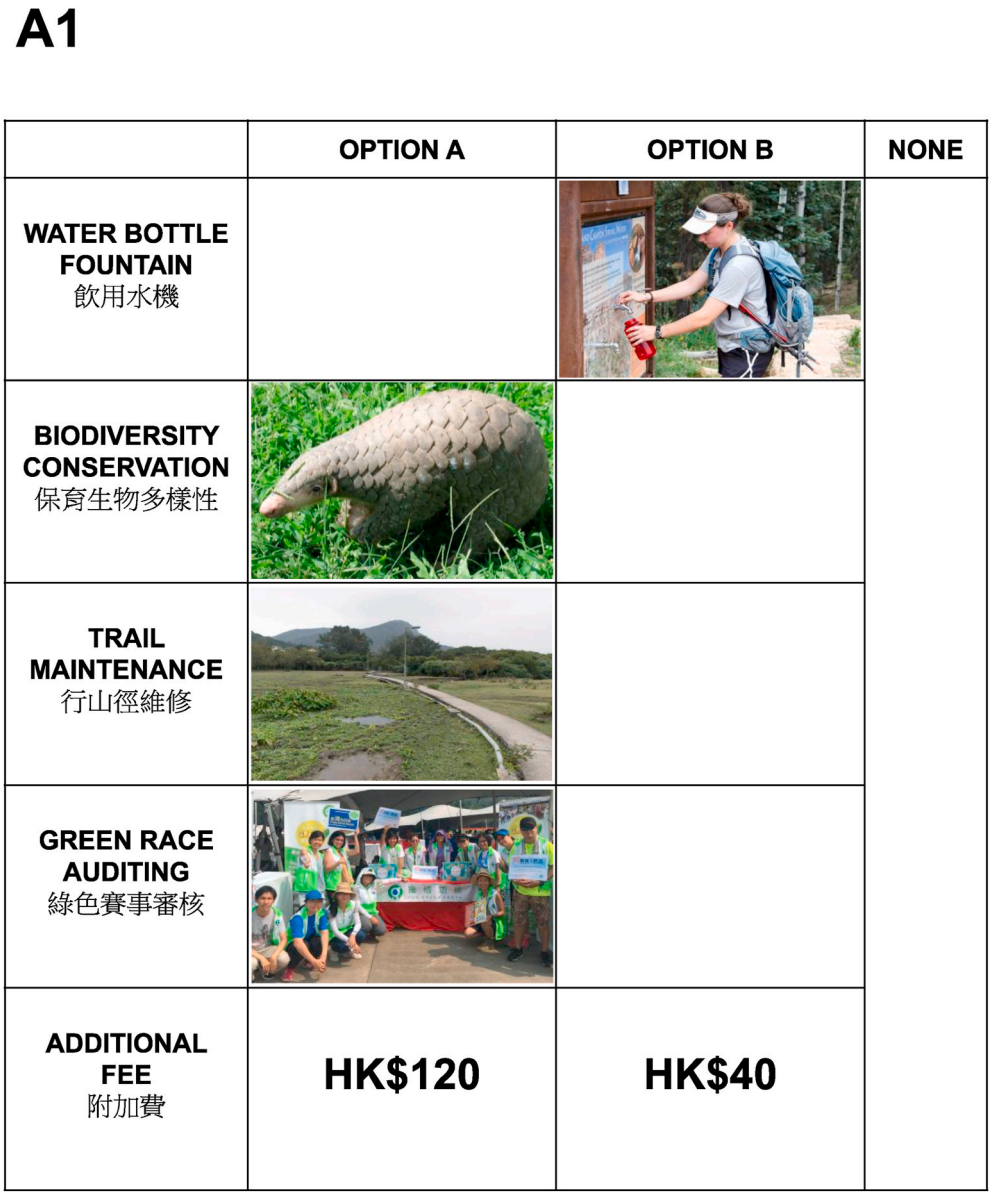

Fig. 2. Example choice card. A blank cell signifies an attribute would not be funded, as explained to respondents as part of the survey introduction.

race events were selected to represent a wide range of distances and participant types (see Table 2 for details). A sample frame was defined using information from race organisers on participant characteristics including gender, age and residence (Hong Kong or overseas). Race participants were intercepted and interviewed after finishing the race.

3.7. Analysis of the discrete choice experiment

Choice data were analysed using multinomial logit (MNL) and mixed multinomial logit (MMNL) regressions to examine the relative influence of each attribute level on respondent choice. The estimated coefficients can be interpreted as the marginal utility of each attribute level.

Utility of a respondent for option i is explained by the following utility function:

$$U_i = V(X_{1l}, X_{2l}, \ldots, X_{kl}) + \varepsilon_i$$

A respondent's utility consists of a deterministic and in principle observable component V_i and a random and unobservable component ε_i. The random and unobservable component represents the idiosyncrasy of the respondent that is unobservable to the analyst. The observable component V_i consists of k attributes (X) and their corresponding levels (l) presented in option i that is chosen. The observable component V_i can be further explained with the following equation:

$$V_i = \beta_{1l} X_{1l} + \beta_{2l} X_{2l} + \ldots + \beta_{kl} X_{kl}$$

Where β_{kl} is a coefficient representing the utility derived from attribute X_k with level l. These utilities are estimated in the regression models by fitting the observed data to the experimental design. The selection of one option over another in a choice card implies that the utility associated with that option is greater than the utility of the other. Comparison of estimated marginal utilities for each attribute level reflect relative preferences and can be used to compute rates of exchange between attributes.

The dependent variable in the regression is binary and indicates whether an option is chosen or not; the explanatory variables are the attribute levels defining the option. The estimated coefficients for the explanatory variables quantify the relative influence of each attribute level on respondent choice. Attribute levels for the environmental characteristics are coded as dummy variables (taking either the value 0 or 1) and the absence of each environmental characteristic is used as a reference level and omitted from the regression equation. The payment attribute is coded as a continuous variable to enable more straightforward computation and interpretation of WTP for specific changes in the environmental attributes.

The MMNL is used to explore preference heterogeneity in the sample. This model allows a relaxation of the assumption that preferences are constant across the sample by treating selected attributes in the model as random instead of fixed parameters. In the present case, the environmental attributes are treated as random parameters in order to identify heterogeneity across individuals in terms of their preferences for environmental management. The number of replications of simulated draws from which the random parameters are drawn is specified at 1000 using Halton draws and we assume that the random parameters follow normal distributions. The payment attribute is treated as a fixed parameter to facilitate the computation of WTP for changes in the environmental attributes. The data has a panel structure in that each respondent answered five choice questions, and this is accounted for the MMNL specification. The analysis was conducted using R software (R Core Team, 2018) and code developed by the Choice Modelling Centre at the University of Leeds (CMC, 2018).

Table 2
Trail races attended for the main survey.

Race	Date	Distance (km)	Entry Fee (USD)	Sample size
Oxfam Trailwalker	17–19.11.17	100	None[a]	88
King of the Hills HK	26.11.17	18.5 33	25.70 25.70	90
MSIG Lantau	3.12.17	16 27 50	44.54–75.38 56.54–83.95 66.82–102.45	136
North Face 100	16–18.12.17	50 100	94.23–128.49 205.59–239.85	66

**Fee depends on registration date with discounts for early registration.
[a] Participants must raise a minimum of USD 1302 per team of four.

3.8. Interactions with socio-demographic characteristics

The choice data were further analysed using a multinomial logit (MNL) model with a set of interaction terms to explore heterogeneity in preferences across respondents with different socio-demographic characteristics. Interaction terms were defined between the payment attribute and respondent age, gender, income, visitation rate to country parks, and a binary variable indicating whether the respondent makes donations to environmental causes. The purpose of these interaction terms is to identify whether these socio-demographic characteristics explain any significant differences in WTP for environmental management.

3.9. Estimation of marginal willingness to pay

Mean marginal WTP for the provision of each service together with 95% confidence intervals are derived using the method developed by Krinsky and Robb (1986). This method involves a Monte Carlo simulation taking draws from a multivariate normal distribution, which accounts for both the standard errors of the estimated parameters and the parameter covariances. Draws from the Monte Carlo simulation of the multivariate normal parameter distribution are used to compute mean and median marginal WTP values and to construct confidence intervals around these values. The use of percentiles to construct the confidence intervals does not predetermine the upper and lower bounds to be symmetrical (Bliemer & Rose, 2013). Note that the estimation of confidence intervals for WTP does not make use of the estimated standard deviations of the environmental attribute random parameters and that aggregation of WTP evaluated at the mean of the random coefficients potentially does not approximate the actual welfare gain (Train, 2016).

3.10. Estimation of aggregate willingness to pay

Estimating an aggregate WTP involves multiplying the mean WTP for a package of environmental services by the relevant population of beneficiaries. The mean WTP for a package of environmental services including trail maintenance, water filling stations and biodiversity conservation is computed by summing the WTP for each service. Precise data on the annual number of trail running events and participants is not available as the AFCD does not divulge this information but, with a few assumptions, the number of trail race participants can be estimated. As indicated by the AFCD, approximately half of the 300 events organized in country parks are trail running races. The AFCD caps many events at 500 participants and although there are several exceptions (e.g. Oxfam has over 1000 participants) there are several events below this limit. We therefore consider a range of 300–700 participants per race, which gives a range of 45,000–105,000 race participants per year.

4. Results

4.1. Descriptive statistics

The majority of respondents (68.9%) visited country parks more than ten times in the past 12 months, which is not surprising considering the majority of trail runners not only race in country parks but also train

there. Of the respondents 43.4% were aged 18–34, 44.2% were 35–40 and 12.4% over 50; 74.5% were male, which is in line with race participant demographics. Over half the trail race participants interviewed have high incomes compared to the general Hong Kong population, with 51% of respondents indicating that their monthly income is USD 5140 or above compared to USD 4506 for the 75th percentile of all employees in Hong Kong of (Census and Statistics Department 2017).

Respondents selected the option of not making any payment in 14% of the choices made, and 19 individuals or 5% of the total sample preferred not to pay anything for all five of the choices they made. Information obtained in follow up questions indicates that these 19 individuals were protest bidders. The reason they all gave for not wanting to support an environmental surcharge was they felt that the government should be solely responsible for the upkeep of the country parks. Data from these respondents have not been used in the analysis.

4.2. Data analysis

4.2.1. Discrete choice experiment results

The results of the MMNL regression analysis are presented in Table 3. The adjusted Rho-squared is a measure of the explanatory power of the model, or how well the variation in choice can be explained by the variation in attributes. The Rho-squared statistic of 0.25 is in line with values recommended by Louvière et al. (2000) and also referenced by Christie et al. (2007), suggesting an acceptable level of performance in choice prediction.

The mean parameter estimates (μ) for the environmental services Water Bottle Fountain, Biodiversity Conservation and Trail Maintenance are all statistically significant and positively related to the probability of selecting an option. The derived standard deviations (σ) for the random parameters are also statistically significantly different from zero, indicating the presence of a high degree of heterogeneity over the sample population with regard to individual-level preferences for the environmental attributes. The alternative specific constants (ASC A, ASC B) measure the propensity to select options A and B respectively in place of the no payment option and can be interpreted as the marginal utility associated with contributing to environmental management of country parks irrespective of the specific services offered. The estimated coefficients on ASC A and ASC B are individually statistically significant (robust t-ratios 5.2 and 6.3 respectively) and not statistically different from each other (Wald statistic = −0.076). The attribute Green Race Auditing has a non-significant influence on choice selection, suggesting that respondents do not view this as an important aspect of sustainable country park use. The estimated coefficient for the payment vehicle (Fee) is statistically significant in explaining respondent choice (robust t-ratio = −5.92) and, as expected, has a negative influence on the probability of choosing an option.

The interaction terms between the payment vehicle and socio-demographic variables (age, gender, income, visits and donations to environmental causes) estimated in separate MNL models were not statistically significant. This analysis did not identify any specific characteristics that explain heterogeneity in WTP for environmental management across individual trail runners.

Table 3
Mixed multinomial logit results and willingness to pay with 95% confidence interval.

	Coefficient	Robust SE	WTP (USD)	WTP (Low)	WTP (High)
ASC (A)	1.345***	0.259	24.05	17.03	31.61
ASC (B)	1.412***	0.223	25.44	19.18	33.28
Water (μ)	0.655***	0.170	12.05	5.61	20.81
Water (σ)	2.435***	0.242			
Biodiversity (μ)	1.023***	0.142	18.92	11.99	30.20
Biodiversity (σ)	−1.897***	0.208			
Trails (μ)	1.329***	0.155	24.39	16.17	37.11
Trails (σ)	2.090***	0.206			
Green Audit (μ)	−0.011	0.122			
Green Audit (σ)	−1.310***	0.170			
Fee	−0.962***	0.163			
Number of respondents		380			
Number of observations		1900			
Number of Halton draws		1000			
Log-likelihood		−1545.859			
Adjusted Rho-squared		0.2545			
AIC		3113.72			
BIC		3174.77			

*** indicates statistical significance at the 1% level. ASC = alternative specific constant; AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion; SE = standard error; WTP = willingness to pay.

4.2.2. Aggregate annual willingness to pay

The estimated mean WTP for a package of environmental services including trail maintenance, water filling stations and biodiversity conservation is USD 55.35 per race participant with a 95% confidence interval of USD 33.78–88.13. Using estimates for race participant numbers, the aggregate annual WTP for this bundle of environmental services was computed (see Table 4). It should be noted that these estimates are speculative and that more detailed information is needed to determine more accurate figures. Using the central estimates of mean WTP and annual participant numbers, the aggregate value that trail race participants would derive from improved environmental services is estimated to be USD 4.15 million.

5. Discussion

5.1. Trail runners' willingness to pay for sustainable country park use

To translate or capture the value that recreationists derive from the use of natural areas such as Hong Kong's country parks into a source of financing for environmental management, a practical payment vehicle that is acceptable to stakeholders is needed. An entry fee to country parks, for example, would not only be very difficult to implement but politically unacceptable considering the principle of open access on which the country park system was founded. We find, however, that there is a very high level of support for the proposed surcharge to race fees to fund environmental services in country parks. A large majority (95%) of sampled runners were willing to pay for conservation measures in Hong Kong's country parks through this mechanism. The underlying motivations as evidenced from the survey results, as well as comments made to interviewers during the survey, are that trail running race participants are aware of the pressure country parks are under from increased use and feel partially responsible for the degradation. Regarding other stakeholders, the results of interviews with government officials, NGO staff, and race organisers show that an additional sum

Table 4
Estimated aggregate annual values for improved environmental services in Hong Kong country parks including trail maintenance, water filling stations and biodiversity conservation (USD/year; millions).

Trail Race Participants	Aggregated annual WTP (USD; millions)		
	Low	Mean	High
45,000	1.52	2.49	3.97
75,000	2.53	4.15	6.61
105,000	3.55	5.81	9.25

Total number of race participants estimated for a range of participants per race based on available government data. Runners would make a payment for each race joined.

payable in the form of a surcharge on top of the race entry fee would be an acceptable and implementable solution.

Many DCEs applied to natural resource usage consider the trade-off between alternative benefits (e.g. Horne et al., 2005; Koemle & Morawetz, 2016) rather than the preference for more sustainable use. However, whilst no DCEs applications were found that specifically address trail running, a number of studies that consider natural area use in general and that hypothesize the implementation of a payment (e.g. Biénabe and Hearne 2006; Reynisdottir et al., 2008) as well as a study by Chen and Jim (2012), using a contingent valuation method, all found respondents were willing to pay a fee to be used for resource management. This raises an important distinction between this study and others which limits the validity of making comparisons. Other studies reviewed invariably juxtaposed the payment of a fee with a status quo of free natural resource use whereas the runners interviewed for this study were already paying a race entry fee, which perhaps made them more willing to accept an environmental surcharge.

5.2. Preferences for environmental services

The clear preference for trail maintenance using traditional techniques is perhaps not surprising for two reasons. Firstly, the concreting of trails is a practice that trail runners have long objected to from an aesthetic point of view as well as practical perspective in that concrete running surfaces may precipitate injuries (Agnew, 2017). Secondly, a leading local runner has recently spearheaded a popular and effective movement to halt the use of concrete and instead use more visually harmonious methods, which has helped raise the trail running community's awareness of this matter.

The positive WTP for bottle filling stations at various country park locations confirms the expectation that trail runners desire an alternative to single-use bottles. It is perhaps also to be expected that runners would be willing to fund an investment that directly benefits them. Similarly, Christie et al. (2007) found, when looking at preferences for natural resource use, that different user groups, such as cyclists and bird watchers, favoured attributes that directly benefited their mode of use.

A less obvious result is the strong support for biodiversity conservation. Although biodiversity in country parks is not directly related to trail running, we find that trail runners place significant value on biodiversity conservation. The underlying motivations for this finding could be a combination of aesthetic enjoyment (trail runners enjoying viewing and hearing wildlife while they run) and non-use value derived from the existence of biodiversity in Hong Kong's country parks. This possible explanation would seem to be substantiated in a study by Juutinen et al. (2011) that found the most highly valued national park feature was an increase in biodiversity. Conversely, we do not find any evidence of negative associations with biodiversity, for example that various species such as the Eurasian wild boar (*Sus scrofa*), the country park population of which has increased significantly in recent years (Leung, 2019), could be seen as pests to trail runners.

The non-significant influence of Green Race Auditing was not expected given that it was selected on the basis of the attribute survey results, which indicated an interest in a service that would allow participants to determine how environmentally friendly races are. The DCE results, however, indicate a lack of interest in an environmental auditing scheme. There are two possible explanations for this outcome. It could be that the support for auditing found during the attribute survey was a manifestation of a desire to do the right thing by contributing to a policy that would allow a selection of more environmentally friendly events but when presented with the choice of paying for this service, personal preferences rather than civic duty held sway. Also, it is possible that there was a lack of comprehension as to what auditing entailed and the benefits it conferred.

Finally, the positive and significant coefficients for ASC (A) and ASC (B) indicate that trail race participants are strongly supportive of increasing environmental management of country parks irrespective of the specific services provided, or conversely that they do not support the status quo.

5.3. Implications for funding of country park maintenance

The estimates for the annual value derived from better environmental services by trail race participants of USD 2.49–5.81 million are indicative of the potential revenues from introducing a surcharge on race fees, a range that equates to 2.1%–4.8% of AFCD's entire 2017 budget of approximately USD 120 m for country parks as well as nature conservation (Hong Kong Government, 2018).

Also, although 5% of the runners in our sample objected to paying anything and could decline to take part in trail running races in protest, it is highly likely that there would be more than enough people willing to take their place given that most races are fully subscribed and demand for places is observed by all race directors interviewed to far exceed supply.

5.4. Management application

There is a growing awareness among the target audience of this study (race organisers, NGOs and the AFCD) of the need for a more sustainable use of Hong Kong's country parks by event organisers. The AFCD's revised guidelines introduced restrictions on events to minimize adverse environmental impacts (AFCD, 2015) and there is also now a requirement that event organisers include a Green Management Plan together with their application (AFCD, 2018). At the same time, the AFCD continues to adopt a policy of command and control, imposing more sustainable practices rather than adopting a more participatory approach. For example, there is a feeling amongst a number of race directors interviewed that there is a lack of stakeholder consultation when the AFCD introduced the aforementioned guidelines. Despite this lack of opportunity for stakeholders to influence government policy, country park stakeholders have taken it upon themselves to initiate more sustainable practices and support country park conservation. For example, a local NGO, Urban Spring, is establishing a network of potable water sources in Hong Kong and is in discussion with the AFCD to provide installations in country parks. Also, another local NGO, Green Earth, is already helping a number of race organisers reduce their environmental impact and plans to launch a Green Event campaign to promote more environmentally-friendly practices. This study provides important data for stakeholders on the preferences for sustainable country park use as well as practical mechanisms to realize these preferences. Should the government wish to make good on its promise to engage with stakeholders, this research presents it with a methodology for identifying user preferences and raising funds to support such preferences, a methodology that could equally be applied to different user groups in the general context of natural area management.

5.5. Limitations of the study and avenues for further research

There are a number of limitations with the application of the DCE we identify here and could potentially be addressed in subsequent research. Although care was taken to construct a survey with a payment vehicle that was as realistic as possible, stated preference valuations have an inherent hypothetical bias which could result in respondents to volunteer to pay higher sums than they would otherwise do, if payments actually had to be made. Every effort was made to avoid cognitive overload, nevertheless, it is still possible that respondents still found the choice process complex thereby reducing the reliability of their answers. Faced with overwhelming complexity, respondents may have tended to seek alternatives such as opting out or could have simply selected without consideration (Tversky & Shaffir, 1992).

Biodiversity is a particularly complex concept that is best represented using a multi-attribute description (Bartkowski et al., 2015). To avoid excessive cognitive burden, a single proxy in the form of a

threatened species was used but it is recognised that this does not adequately represent diversity of species in Hong Kong's country parks or the role that biodiversity plays in the ecosystem.

The face-to-face survey approach has a higher efficacy than remote surveys (Blair et al., 2013) but may have given rise to a desire to appease or select higher payment levels than if choices were made in anonymity. To avoid sampling bias, interviewees were selected to match race demographics and the races were selected to cover the complete spectrum of race types. However, the sampling method was not randomized and this lack of randomization may have introduced bias. For practical reasons runners were interviewed after the race, at the finish line (runners often arrive shortly before the start of the race and are busy with race preparations) where they proved to be highly amenable to participating in the survey. However, the decision to support environmental services by paying a sum on top of the entry fee would probably be made in circumstances entirely separated from the race itself and under which respondents might be less inclined to donate. The use of fixed payment levels, whilst improving the questionnaire's intelligibility, could possibly have been perceived as being too low or too high in relation to the race entry fee. Again, for practical reasons, the order of choice cards in each interview was fixed. If the respondent's focus were to have diminished as the interview progressed, then choice cards presented at the end may have been subject to less consideration (Hensher et al., 2005). Conversely, if respondents developed an understanding of the choice process and their own preferences in the course of the interview, later responses might be more reliable than earlier responses. Finally, although care was taken to avoid any duplication of the services included in the DCE and services that are already supported by the race organisers, some overlap was unavoidable. Respondents who perceive that race organisers already provide a service might potentially express a lower WTP for them.

Future research could attempt to address these limitations and further substantiate the findings of this study. Fixed payment amounts could be replaced by payments as a percentage of the entry fee; and to circumvent the cumbersomeness of this payment format, the survey could be tablet-based in order to automate the calculation of fees. A tablet-based survey would also facilitate the randomization of choice set ordering. A split sample approach could be used to test the effect of alternative sampling and survey modes (e.g. face-to-face interviews, online, finish line, start line).

Future DCE applications could also be used to measure the preferences of other country park users such as mountain bikers, hikers, photographers etc. For funding environmental services.

Finally, the AFCD's response to degradation caused by runners has been to restrict race courses to designated trails. Morey et al. (2002) found that mountain bikers were WTP a fee for access to better trails as an alternative to banning or restricting trail use. It would be interesting to study the acceptance of such a model among trail runners as an alternative use of an environmental fee, with funds raised to be used for trail maintenance as a compensatory measure for allowing the use of non-designated trails.

6. Conclusion

The growth in interest in trail running and racing can be seen as positive phenomenon in terms of health, social interaction and a greater appreciation of and respect for the natural environment. The increased use of natural areas for trail running races and other organized sporting events has, however, resulted in increased environmental degradation including littering, erosion and disturbance to wildlife.

The results of this study show that there is strong support for a funding mechanism that would allow for a more responsible and sustainable use of natural areas in Hong Kong by trail runners. Indeed, the recently formed Hong Kong Trail Running Association has expressed an interest in the implementation of this proposal (as communicated in recent discussions), not only for the purpose for which is was conceived, but also as a tool to differentiate its members from other event organisers and thus gain a competitive advantage. Further research is needed to validate the findings of this study and extend the analysis to other user groups. Fund raising, however, is only half the challenge and efficacy in the use of funds is crucial to the success of environmental management. Whilst engaging with country park stakeholders (race participants, race directors, NGOs and the AFCD), it was observed that many feel a lack of direct engagement in the process of environmental management. The implementation of a practical and effective fund-raising mechanism to support environmental services in country parks could provide an opportunity for users to have an input to country park management. By encouraging and enabling this and other participatory programmes, the government could facilitate a more sustainable use of natural areas, working with the community to complement government resources and at the same time forging a more conciliatory relationship.

Author contribution statement

Samuel Ribet: Conceptualisation, Methodology, Investigation, Writing - original draft, Project Administration; Luke Brander: Methodology, Formal Analysis, Writing - original draft.

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