

Prediction Indicators for Voluntary Carbon-Offset Purchases Among Trail Runners

**M. Nils Peterson
Howard D. Bondell
Megan-Beth L. Fratanduono
Kevin Bigsby
Melissa McHale
North Carolina State University**

Voluntary carbon offsets (VCOs) represent a rapidly growing tool for addressing climate change, but few, if any, studies have focused on predictors of VCO purchasing behavior in association with sport events. Data for this exploratory study were collected from race registration records and interpolated from the U.S. Census. This paper uses multivariate regression analysis to predict VCO purchases among trail runners. We found females, older participants, participants running longer events, and participants living in communities in which people had high education levels relative to income were more likely to purchase VCOs. Purchasing a VCO appeared to be a household level decision because across trail races and years, matching VCO purchasing behavior was 20% higher within households than for individual runners who participated in multiple races. Real time online publishing of VCO purchasers' names did not increase VCO purchases. Our findings suggest runners motivated by affiliation were more likely to purchase VCOs, and that descriptive (based on what others do) norms had little impact on purchasing behaviors. Efforts to promote VCOs should target subjective norms and households instead of individuals.

Address correspondence to: Nils Peterson, Fisheries, Wildlife, and Conservation
Biology Program, North Carolina State University, Box 7646, Raleigh, NC 27695.
Email: nils_peterson@ncsu.edu

Practices that reduce greenhouse gas (GHG) emissions are urgently needed to reduce the social and ecological costs associated with anthropogenic climate change (IPCC, 2007). The costs associated with changing temperatures, intensification of extreme weather patterns, and rising sea levels may reduce global welfare by an amount equivalent to a reduction in per capita consumption of up to 20% (N. Stern, 2007). Emission markets, taxes, and subsidies have been discussed and in some cases implemented as tools to reduce greenhouse gas emissions. Economic theory, however, suggests market based solutions will provide emission reductions at the lowest cost (Hepburn, 2007).

While a variety of market based policy approaches have been proposed, they can be divided into mandatory (e.g., the Joint Implementation provisions of the Kyoto Protocol) and voluntary models (MacKerron, Egerton, Gaskell, Parpia, & Mourato, 2009). Individual consumers and businesses can choose to purchase voluntary carbon offsets (VCOs) to offset emissions from activities they engage in. Prior to the global recession in 2008 VCOs were growing exponentially and projected to reach \$4 billion USD by 2010 (Harvey & Corre, 2007). Activities funded by VCO purchases (e.g., reducing fuel wood requirements for a rural community) can secure additional benefits by protecting wildlife habitat and water quality, and improving human health.

Initial research on VCO markets has largely focused on hypothetical behaviors (e.g., stated preference methods in surveys) and attributes of the hypothetical VCO markets (e.g., certification). These studies have targeted airline passengers because they are making large discretionary purchases with disproportionately large impacts on GHG emissions. Brouwer et al. (2008) found $\frac{3}{4}$ of European, Asian, and North American air travelers stated they would support mandatory carbon offsets, however, half of those travelers stated they would not pay if offsets were voluntary. Female gender and income were positively correlated with willingness to pay VCOs among airline passengers (Brouwer et al., 2008; MacKerron et al., 2009). Ticket prices, distance traveled, co-benefits (e.g., biodiversity conservation, human health), and verification of VCOs (MacKerron et al., 2009) all shaped willingness to pay. Most (76%) Swedish air travelers did not have previous knowledge of the possibility of VCO purchases; however 70% of them agreed they would consider future purchases after being given information about VCOs (Gössling, Haglund, Kallgren, Revahl, & Hultman, 2009). Surprisingly, awareness of global climate change was negatively related to willingness to alter travel behavior (McKercher, Prideaux, Cheung, & Law, 2010). Further, Dawson et al. (2010) found that even polar bear viewing tourists in Canada were generally unaware of the contribution their behaviors made to climate change.

We build on this research with a study of VCO purchasing behavior among trail runners in the U.S. This step is critical both because what people say they will do often

differs significantly from what they will actually do (Argyris, 1992; Argyris & Schön, 1978; P. C. Stern, 2000), and because behavioral intentions and the behavior itself are two distinct elements in most theoretical models of environmental behavior (Ajzen, 1991; Bamberg & Moser, 2007; Sutton, 1998). Trail running competitions proved a good case study because they represent a growing and global form of outdoor recreation (Getz, 2008). Between 1997 and 2009 the sport grew from 64 races with 17,900 participants to 1,923 races with 540,363 participants (unpublished data American Trail Running Association). Trail running also represents a growing class of sporting events which rely on nature.

In this paper we model VCO purchases among trail runners participating in events during 2009 and 2010. We also evaluate the effect of year, since the registrants in the first year purchased VCOs early in 2008 before the global economic recession. We test four specific hypotheses: (1) VCO purchases reflect household level decisions for trail runners; (2) income and education are positively related with likelihood of VCO purchases; (3) trail runners motivated by affiliation (e.g., older, female) are more likely to purchase VCOs than their counterparts; and (4) making a runner's VCO purchase public contributes to VCO purchases by setting descriptive norms.

Background

All data were collected or extrapolated from registration records for the 2009 and 2010 Little River (LR) and Uwharrie Mountain (UM) runs in North Carolina, USA. Online registration forms for all races included a check box for purchasing a \$3 VCO. The annual LR runs consisted of 7k and 10-mile distances, and started in 2005. In 2009 and 2010 an online list of registrants was updated daily and clearly indicated whether each runner had purchased a VCO by noting "with carbon offset" next to the name of each runner who purchased a VCO. The UM runs started in 1991, included 8-mile, 20-mile and 40-mile distances. The UM run did not make VCO purchase information available to participants. Both runs are managed by the same group of trail runners and started adding the option to purchase VCOs to event registration in 2007.

We accounted for household effects (Hypothesis 1) because households may be the social unit where many consumption decisions are made (Liu, Daily, Ehrlich, & Luck, 2003; Wheelock & Oughton, 1996), and because households may mediate the relationship between outdoor recreation and environmental behavior (Peterson, Hull, Mertig, & Liu, 2008). Specifically, decisions to purchase VCOs may be made at the household level as much as, or more than, the individual level. Hypothesis 2 stems from previous research and economic theory. Presumably higher socio-economic status would equate to lower effective costs for a VCO costing a set amount, and socio-economic status is often positively correlated with environmental behavior (Brouwer et al., 2008; Chen et al., 2011; MacKerron et al., 2009).

Hypothesis 3 stems from subjective norm theory. Subjective norm theory suggests behavior can be shaped by what a person believes others think they should or should not do (Cialdini, Reno, & Kallgren, 1990; Fishbein & Ajzen, 1975). The influence of subjective norms varies with the importance a subject places on the opinions of others (the more important affiliation with a group is, the more powerful subjective norms are). Because the races in this study were organized and promoted by the trail running community, subjective norm theory would suggest participants motivated by affiliation with the trail running community would be more likely to purchase the VCOs being promoted by their own community. Although the registration dataset did not allow measurement of affiliation motivations explicitly, previous research suggests older runners, runners racing longer distances, and female runners are most likely to be motivated by affiliation with the running community. Specifically, older runners were motivated by life meaning and affiliation with other runners more than younger runners (Leedy, 2000; Ogles & Masters, 2000). Female runners were motivated by psychological well-being, and affiliation with other runners more than male runners (Ogles & Masters, 2003). Runners participating in longer races tended to run more and have a longer history of running than runners participating in shorter races (Leedy, 2000). Accordingly, positive relationships between VCO purchases and female gender, age, and race distances would support hypothesis 3.

Hypothesis 4 suggests descriptive norms, what other people do in a particular context (Cialdini et al., 1990), could influence VCO purchases. Descriptive norm theory would predict higher VCO purchases for the LR event where runners were able to see other runners purchasing VCOs through the online publication of purchase records. Descriptive norms can be triggered when even one person displays a behavior (e.g., picking up litter) (Cialdini et al., 1990), so seeing a majority of participants purchase VCOs should not be required to trigger a descriptive norm.

Methods

Participants

Our sample included a total of 2,073 registrants over the 4 races. This sample included 1,526 unique individuals, originating from 1,366 different households. There were 923 runners for LR (2009 = 431, 2010 = 492) and 1,150 runners for UM (2009 = 557, 2010 = 593). Just over half of UM runners (57%) purchased VCOs, compared to less than half of LR runners (43%). Runners were 62% male and 38% female. Mean age was 40 (SD = 10.86), median household income was 60,825 USD, mean education level (2.99, SD = 0.41) corresponded with “some college.”

Materials

We analyzed data using SAS/STAT software, Version 9.2 of the SAS System for Windows (SAS Institute Inc., 2009). Race registration records included names, addresses, gender, age, VCO purchases, and race distance. We used home addresses to interpolate education and income for each participant based on US Census data at the census block group level. We recognize limitations of interpolated data, but consider it a useful tool for making the first exploratory evaluations of relationships with VCO purchases.

Procedure

Multivariate logistic regression analysis was performed to model the probability of the purchase of a VCO jointly as a function of the registration characteristics of the individual, as well as the event. The multivariate approach ensured any significant variable made a unique contribution to predicting VCO purchases. To account for the fact that multiple racers were from the same household, as well as the fact that these runners may have participated in more than one of the four events considered, we included a random effect to treat the household as a cluster in the analysis. This induces correlation among the responses from registrants within the same household both within a race and across races. Hence, the model captures the effect that members of the same household are more likely to purchase or not purchase the VCO as a group as opposed to independent random deviations within the household. This Generalized Linear Mixed Effects Model was fit using PROC GLMMIX in the SAS software.

The random effect creating a cluster for households was used to test hypothesis 1. Hypothesis 2 was tested using education level and income level. Gender, runner age and event distance were included as variables to test hypothesis 3. We tested hypothesis 4 by using a dummy variable for the event (LR or UM). Due to skewness in the distribution of income, which is common with economic variables, we transformed income by its natural log. An interaction term of event by year was used to account for the fact that the difference in VCO purchases between the two events was not constant over the two years. Finally, an interaction term of event by racing distance was also included, as the difference between purchases for longer races versus shorter races could vary across the LR and UW events.

Results

Regression results support hypothesis 1 by suggesting household member purchases of VCOs were correlated; runners from a single household tended to either buy VCOs together or not at all (Table 1; Household ID covariance parameter). Interestingly VCO purchases were internally consistent (shared choice to purchase or not purchase) within and across races in which household members participated more often (84%) than among multiple races in which the same individual participated (64%). Results were mixed for the second hypothesis because education from the census block of participant's homes was positively correlated with VCO purchases whereas income was negatively correlated with VCO purchases (Table 1). Keeping in mind that this correlation represents the effect after holding the other variables fixed, the result has a natural interpretation. Participants who had high education levels relative to income levels were more likely to purchase VCOs than individuals who had low education levels relative to income levels. Examining each of the two variables marginally, they were both positively related to VCO purchases.

We found support for hypotheses 3 because variables linked to affiliation motivations (race distance, female gender, and age) were positively correlated with VCO purchases (Table 1). Inclusion of the interaction term for event by racing distance, suggested that the effect of distance differed between the two events. In the LR event, the odds of a VCO purchase was multiplied by a factor of $\exp(0.06825) = 1.07$ for each extra km in the race, so that a racer in the longer of the 2 LR races was approximately 1.85 more likely to purchase a VCO given everything else was the same. Meanwhile, the interaction coefficient almost exactly canceled out the distance coefficient, therefore a racer in the UM event was equally likely to purchase a VCO regardless of which distance they were running. This finding may be explained in part by the UM event lacking a short distance option available in the LR event. Females were more likely to purchase VCOs (51%) than males (44%; Table 1). Results did not support hypothesis 4 because participation in the race where VCO purchases were publically advertised was negatively related with VCO purchases (Table 1).

When considering the differences across the two years and the two races, the interaction again needs to be taken into account. The negative effect of year suggests that there was a significant decrease in VCO purchases in 2010 compared with 2009 for the LR event. However, the interaction effect of year by event, again almost exactly canceling out this effect, shows a slight increase in purchases in 2010 compared with 2009 for the UM event (Table 1). Comparing the two events is more complex in that they included different distances; hence simply looking at the coefficients for the event does not give a clear picture, as the distance effect is confounded with the event.

Table 1.

Multivariate Logistic Regression model results for predicting purchase of voluntary carbon offsets among trail runners.

Variable	<i>B</i>	<i>SE B</i>	<i>t</i> -value	<i>p</i> -value
Household ID ¹	0.9364	0.1519	6.16	<.0001
Intercept	1.6919	1.7546	0.96	.3351
Year ²	-1.5773	0.1600	-9.86	<.0001
Event ³	0.2946	0.3481	0.85	.3977
Event x Year	1.6606	0.2161	7.68	<.0001
Gender ⁴	0.5020	0.1212	4.14	<.0001
Age	0.01898	0.005518	3.44	.0006
Event Distance	0.06825	0.02065	3.31	.0010
Event x Event Distance	-0.06899	0.02096	-3.29	.0011
Education ⁵	0.3109	0.1867	1.67	.0963
Ln (Income) ⁶	-0.2802	0.1888	-1.48	.1383

¹Covariance parameter

²Coded so 2009 = 0 and 2010 = 1

³Coded so Little River = 0 and Uwharrie Mountain = 1

⁴Coded so male = 0 and Female = 1

⁵Mean education level of census block

(Coded so 1 = Not high school graduate and 4 = College graduate)

⁶Natural log of Median Income of census block

Discussion

Our results suggest VCO purchases among trail runners reflect household level decisions. Purchasing behavior of different runners in the same household was more tightly coupled over the two years and between races than the purchasing behavior of single individuals in the same contexts. Previous research suggests a household member's participation in outdoor recreation is as strong a predictor of an individual's environmental attitudes as an individual's own participation (Peterson et al., 2008). This study extends those findings to predicting environmental behavior, and suggests household related environmental behaviors may be more consistent than individual behaviors. Future research should explore the degree to which these findings apply for other demographic groups and in other locations. Such research has great importance because many GHG intensive activities including residential heating and automobile transport reflect household level decisions with household-level economies of scale (Liu et al., 2003).

Finding participants who were highly educated relative to income levels were more likely to purchase VCOs than individuals who were less educated relative to income levels, could be explained by people with education and jobs in fields related to education and the environment making less money relative to years of education than people in other fields (e.g., marketing, business, or engineering). Future research could assess environmental behavior differences among such education and employment types to test this explanation. Our findings may differ from previous stated preference research suggesting positive relationship between income and VCO purchases (Brouwer et al., 2008; MacKerron et al., 2009) for several reasons: actual behavior often differs from claims about behavior (Argyris, 1992; Argyris & Schön, 1978; P. C. Stern, 2000), we used average income from the runner's census block to interpolate income, or VCO cost was small (\$3) relative to the runner's median income. Year effects, however, suggest the \$3 cost was meaningful because VCO purchases only declined for the race that spanned the onset of the great recession (LR).

Subjective norms may have influenced VCO purchases more than descriptive norms because variables linked to affiliation motivations (event distance, age, and female gender) were positively correlated with VCO purchases (Leedy, 2000; Ogles & Masters, 2003), but participation in the event where VCO purchases were publically advertised was negatively related with VCO purchases. These findings support the hypothesis that people most motivated by affiliation within the trail running community felt more pressure to follow subjective norms promoting VCO purchases. Our findings suggest VCOs can contribute to offsetting the carbon footprint of some outdoor recreation activities without mandatory payments or using descriptive norms to document the prevalence of a behavior (Cialdini,

2003). These findings should be interpreted with caution, however, given the strength of affiliation motivations were based on known relationships from the literature and not directly measured.

Gender related impacts on VCO purchases were consistent with previous stated preference research (Brouwer et al., 2008; MacKerron et al., 2009), but may be explained by factors beyond affiliation motivations. Research suggesting more altruistic behavior among females than males (Dietz, Kalof, & Stern, 2002), and more environmentally oriented attitudes among females than males (Dietz et al., 2002; Zelezny, Chua, & Aldrich, 2000), suggests subjective norms, altruism, and environmental attitudes may interact in their contributions to the gender gap in VCO purchases identified in this study. Future research should attempt to isolate these effects.

Unclear linkages between VCO purchases and impacts on climate change may explain the negative relationship between advertising VCO purchases and percent of participants making VCO purchases. For descriptive norms to influence environmental behavior they must be associated with observed behavior, but seeing the effects of the behavior may be more important than the actual prevalence of a behavior. For instance, experiments demonstrating the importance of descriptive norms found that whether a park was clean or dirty had a larger effect on whether subjects littered than whether or not subjects saw other people litter in the park (Cialdini, 2003). Thus even if respondents saw a list documenting half of their fellow runners were buying VCOs, they did not see any impact of the purchases or lack thereof. This issue raises a critical challenge associated with addressing the climate change impacts of sports events. Climate change results from collective global human behaviors. No one act such as participating in a sports event or purchasing a VCO creates a visible impact on climate change. This fact will present serious challenges for efforts to offset the carbon footprint of sports events through VCOs.

We see two challenges for efforts to promote VCOs in association with sports events: 1) VCO purchases reflect individual responses to a collective problem, and 2) VCO purchases among most social groups probably will not have independent impacts on climate change. This study suggests subjective norms among participants may help trail runners overcome concerns about free-riders when addressing the collective problem through individual actions. The potential inefficacy of VCOs, however, presents a greater challenge. Research on state, municipal, and corporate efforts to address their impacts on climate change (Betsill, 2001; Moon & Bae, 2011; Wheeler, 2008) may provide some useful insight for efforts to address climate change impacts through voluntary behaviors. For instance, even if efforts to offset the carbon footprint of environmentally conscious recreation fail to impact climate change they can make operations less energy intensive, promote sustainable

forms of energy production, improve local air quality, raise awareness of environmental impacts associated with tourism, and reinforce environmental values among tourists.

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