



Identification of self-reported user behavior, education level, and preferences to reduce littering on beaches – A survey from the SE Pacific

Lucas B. Eastman^{a,b}, Paloma Núñez^a, Barbara Crettier^a, Martin Thiel^{a,c,*}

^a Universidad Católica del Norte, Biología Marina, Larrondo 1281, Coquimbo, Chile

^b Middlebury College, Middlebury, VT, USA

^c Centro de Estudios Avanzados en Zonas Áridas, Coquimbo, Chile

ARTICLE INFO

Article history:

Available online 14 March 2013

ABSTRACT

Beach litter is an environmental, health, and economic burden around the world. Reducing or eliminating beach litter requires a sound understanding of the beach users that often produce the litter. Education has consistently been promulgated as positively influencing environmental behaviors, though this is not well-investigated for the beach environment. In this citizen science project, school children surveyed the population in their various coastal communities in Chile, garnering over 900 responses nationwide. The survey included several domains concerning the problem of beach litter: demographic profiles of beach users (including education level), their littering behavior, and their disposition and preference towards solutions. Nearly half of the participants admitted to having littered in some way while the majority of those with college or graduate school education said they never litter, significantly more than lower education groups. A vast majority of the population endorsed a fine for beach littering. Community-level environmental education (for the entire population, including litterers) was the most common solution proposed by beach users, but was significantly less popular the more often the participant self-reported littering. Based on these results it is suggested that beach managers create multifaceted and localized solutions that involve several strategies (environmental education, fines, more trash cans) and also take into account the demographic profile of the beach users (including their education level), which could influence their littering behavior and support of potential solutions.

© 2013 Elsevier Ltd. All rights reserved.

1. Introduction

Beach litter is a problem on coastlines around the world (Derraik, 2002; Gregory and Andrady, 2003; Ivar do Sul and Costa, 2007). It poses a serious threat to coastal economies by repelling visitors and their tourist income (Ballance et al., 2000) and damaging marine life through entanglement, consumption of plastics, and transfer of invasive species (Williams et al., 2005; Gregory, 2009).

Clearly, human behaviors are the root causes of beach litter, but the factors that drive these behaviors are poorly understood, hampering the design of efficient intervention programs to reduce litter. Researchers have identified many variables that influence littering behaviors, ranging from social norms (Cialdini et al., 1990),

to personal cost–benefit analyses (Sutinen, 1997), to environmental and infrastructural causes (Finnie, 1973), and demographic factors, among others. The present paper focuses on the demographic aspects of littering behaviors and solutions. This information is necessary because of the increased realization among managers that understanding public opinion is key to proper beach management (Marin et al., 2009).

Earlier studies have shown that a minority of people admit to littering (e.g. Santos et al., 2005) and that a variety of demographic factors are associated with littering rates. For example, younger people generally litter more than older people, males litter more than females, and those living in rural environments tend to litter more than their urban counterparts (see Schultz et al., 2011 and references therein). There is also some evidence showing that religious conviction, marital status, and income affect littering behaviors (Al-Khatib et al., 2009). There has been very little similar research done on beach environments, which is surprising considering their tremendous economic importance (Houston, 2008) and evidence that beach visitors themselves contribute a large proportion of the litter on coastlines (e.g. Bravo et al., 2009). In

* Corresponding author. Universidad Católica del Norte, Biología Marina, Larrondo 1281, Coquimbo, Chile. Tel.: +56 51 209939.

E-mail address: thiel@ucn.cl (M. Thiel).

fact, to date there are just three beach-based studies that have looked at these demographic questions. Their findings suggest that age, income, gender, educational level, type of user (beach user vs. beach vendor), and local or non-local residency affect not only self-reported littering behaviors but also rates of preference for different methods of reducing beach litter (Santos et al., 2005; Dias-Filho et al., 2011; Slavin et al., 2012).

The present study sought to expand upon this knowledge by looking more in depth at the effect of one demographic variable – general education – on littering behaviors, but also on preference for solutions. Some work has shown that more education does not necessarily translate into better environmental behaviors (e.g., Kollmus and Agyeman, 2002) and for some environmentalists, education was an important but secondary motivator for their dedication to environmental careers (Chawla, 1999). However, greater awareness of environmental problems has been shown to be at least indirectly related to positive behaviors (Bamberg and Möser, 2007). It is also a common belief among the public that environmental problems are the result of a lack of awareness or education (Kollmus and Agyeman, 2002). This evidence demonstrates that the effects of education on environmental behaviors and attitudes need to be further studied.

This study was done with the goal of creating customized solutions that are both effective and supported by beach users, who are critical stakeholders (along with public and private beach managers) in beach management. Many solutions to beach litter have been established for decades, such as proper trash can infrastructure, using beach cleaning machines, fines, and environmental education, but one aspect that has been lacking from the literature on this issue is how to choose these measures wisely and appropriately for the specific community and context that a local manager faces.

Herein, data from a national survey of beach users in Chile are presented. Located in the Southeast Pacific, Chile has an extraordinarily long coastline, extending over thousands of kilometers. Its coast features remarkably clean beaches, while others are relatively contaminated (Bravo et al., 2009). Chile also has a very strong economic interest in coastal activities such as tourism, fishing, and aquaculture (Barragán et al., 2005). Because of these activities and due to the fact that beach litter has almost entirely local origins, with a large proportion coming from beach visitors and little litter arriving from foreign sources (Bravo et al., 2009; Thiel et al., 2011, 2013), Chile presents a special opportunity for studying the behavior and attitudes of beach users. This is because the local sources of beach litter allow researchers to directly connect information they uncover via social surveys to the amount of litter on the beaches, and thus mold solutions based on their findings. Results from Chile can then be applied to the many other places around the world where beach litter has local sources and thus can inform managers about behavior to expect from their beach users and which anti-litter measures to implement.

We hypothesized that a minority of survey respondents would admit to littering on beaches as has been reported in other studies (Santos et al., 2005; Slavin et al., 2012). Moreover, we predicted that general education level of participants would be predictive of their self-reported littering behavior (more education → less littering) based on research showing positive effects of awareness/education on environmental behaviors (Bamberg and Möser, 2007). Also, we hypothesized that environmental education would be the most preferred solution (with consistency across demographic groups) regarding the problem of beach litter in line with one previous report (Santos et al., 2005) and common public perceptions of environmental problems as being a result of a lack of awareness (Kollmus and Agyeman, 2002).

2. Materials and methods

2.1. General approach

This study is based on a citizen science model in which the researcher creates a methodology, citizen volunteers collect data, and the researcher analyzes and interprets those data (Bonney et al., 2009). This model benefits scientists by providing large geographic range and sampling capability and also benefits citizens by educating them about scientific concepts (Evans et al., 2005; Silvertown, 2009). Citizen science forges partnerships with stakeholders in environmental problems wherein both the researchers and the citizen scientists learn and benefit from the experience (e.g. Dickinson and Bonney, 2012). The present study was supported by school children averaging 12 years of age to collect data. Other citizen science projects have successfully collaborated with young school children to collect reliable data on topics as diverse as invasive crab species (Delaney et al., 2007), groundwater quality (Peckenham et al., 2012), and human–coyote interactions (Weckel et al., 2010).

A survey was designed that was sent to schools located in communities along the entire Chilean coast, with special care taken to include schools from every region of Chile. Many of these schools had previously participated in similar environmental projects organized by our laboratory in which data on beach litter in Chile were successfully collected (e.g. Bravo et al., 2009). One professor or organizer at each school served as a contact to whom an appropriate number of surveys was sent along with free educational materials and a guide to implementing the survey properly, including a practice activity for the students to familiarize themselves with the survey questions and process. This guide and practice activity ensured that the students had read the survey out loud in class, understood the logic behind each question and what expected results would be like, and practiced surveying and recording the responses of their classmates, with the purpose of preparing the students for accurate data collection in the field. The professor also filled out a brief questionnaire about the characteristics of their class and community to ensure that the students carried out the survey correctly. Materials for the survey were also made available online at (see <http://www.cientificosdelabasura.cl/2010.php>).

The students walked to public places near their schools and interviewed the ambulant population there. This was done to capture input from a diversity of participants from the local community. The students simply approached pedestrians, asked them if they would participate in a quick survey, and then carried out the survey, generally with one student asking the questions and a partner recording the participant's answers (Fig. 1a). The professor then sent a package with the complete surveys back to the research offices in Coquimbo, Chile, where the data were reviewed and analyzed.

2.2. The survey

The survey included 26 items and was written and conducted in Spanish. It fit on one piece of paper if printed double-sided. It included a confidentiality and permission statement, as well as contact information of one of the authors. Each survey took about ten to fifteen minutes to answer.

The survey was designed with specific goals – to understand the behavior, knowledge, evaluation, and disposition of people to solve the problem of beach litter in their country. It also had a demographic information section (without individual identifiers) so as to be able to identify if personal characteristics had effects on the surveyed population's answers. The survey underwent a pilot test with a school in La Serena, Chile, in April 2010, after which several

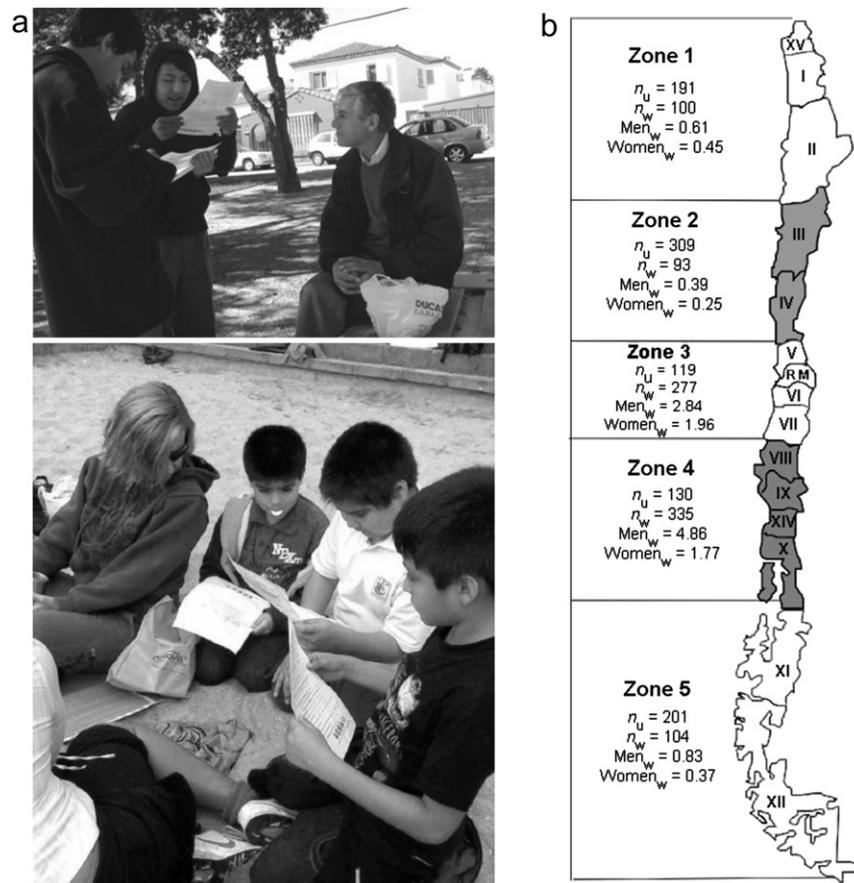


Fig. 1. (a) School children surveying members of their beach communities. (b) Subdivision of Chile into five major zones based on cultural, geographic, and socioeconomic factors (for further details see Bravo et al., 2009). Each zone combines several of the political regions of Chile (marked by roman numerals). n_u refers to the unweighted sample, n_w refers to the weighted sample, which was used in the analyses. Men_w and $Women_w$ refer to the weights applied to the responses from men and women from each zone.

items were improved and adjusted (for final survey see <http://www.cientificosdelabasura.cl/2010.php>).

2.3. Quality control for the sample

Of the 38 schools that received materials, 30 returned variable numbers of complete surveys. Of these responses, some schools could not be considered for various reasons. For example, in one instance the children mistakenly surveyed themselves instead of the population in their community. In another community, the children who carried out the interviews were considered to be too young to accurately write down the participant's responses – these were eliminated as a form of quality control. Responses from a school on Easter Island could not be included because its geographical, biological, and cultural characteristics were considered too different from those of continental Chile.

Surveys were also scanned for blank and nonsensical answers. Only surveys in which >80% of all questions had been answered were included in the analysis. If answers were unreasonable or unrelated to the question asked, these were marked as if the question had been left blank, and the rest of the survey was used in the analysis. A total of 909 surveys were included in the final analysis.

2.4. Statistical and analytical procedure

For the analysis the country was subdivided in five large zones. This methodology was used by Bravo et al. (2009) and divides the

country into zones based on climatic, geographic, and socioeconomic factors (Fig. 1b). To ensure that the sample was representative of the country in general and that no zones were overrepresented in the analysis, the sample was weighted using SPSS Statistics on the basis of location and sex. Thus, zones that were sampled more heavily or had disproportionate responses from one sex were weighted to reflect the true proportion of males and females based on the 2002 Chilean national census (see Fig. 1b).

Upon receiving the data, several categories of responses were created that facilitated the analysis. For the littering behavior question, the participants had been provided with a range of five possible answers, which were categorized into three groups: when the participants responded that they did the behavior “frequently” or “generally” they were characterized as *Frequent*, if they did the behavior “almost never” or on “exceptional occasions”, they were classified as *Occasional*, and those who responded that they “never” engaged in the behavior were simply maintained as *Never*. Also, the participants were asked how many years of education they had, and based on their answers they were divided into four groups: 8 years, 12 years, 12 years + technical training, and college or graduate school. These groups are used in the education analyses.

Chi-square tests of independence were used as well as post hoc z-tests when making statistical claims for several comparisons, including preferred solution vs. self-reported littering behavior, education level vs. self-reported littering behavior, zone vs. self-reported littering behavior, and education level vs. preferred solution of users.

Table 1
Demographic characteristics of the weighted sample.

Characteristic	% of respondents
<i>Sex (n = 909)</i>	
Male	50.1
Female	49.9
<i>Occupational status (n = 888)</i>	
Employed	66.3
Homemaker	23.1
Student	9.3
Other	1.3
<i>Education level (n = 906)</i>	
8 years	23.3
12 years	39.3
12 years + technical training	16.9
College or graduate school	20.6
Average age (n = 889)	39.22 (SD 14.45)

Table 2
Answers to a survey question regarding littering behavior, with answers also subdivided by education group.

	Frequency of response		
	Never	Occasional	Frequent
<i>Littering question</i>			
How often do you litter on your community's beaches? (n = 894)	56.6	30.8	12.6
<i>Demographic group</i>			
8 years	48.5	33.5	18.0
12 years	55.0	31.7	13.3
12 years + technical training	51.6	36.6	11.8
College or graduate school	72.6	21.5	5.9
Geographical zone (min and max %)	50.9–65	23.2–37.5	9.7–18.2

3. Results

3.1. Characteristics of the sample

The final sample of completed surveys that was evaluated was $n = 909$. The quantity of respondents for individual questions varied slightly from the total n because of blank or outlier answers. The only outliers that were removed were two responses from participants who suggested fines for beach litterers that were many orders of magnitude greater than all other fine suggestions. After weighting, the sample was evenly distributed among men and women. Most participants were employed, and the majority had completed 12 years of school (Table 1).

3.2. Self-reported littering behavior

The survey included a question that attempted to identify user behaviors regarding beach littering, and many (43.4%) participants

admitted to littering in some way (Table 2). Self-admitted littering behavior on beaches was similar among the five Chilean zones (see last row of Table 2). A Chi-square test showed that educational level of the participants was associated with self-reported littering behavior ($\chi^2 = 30.885$, $df = 6$, $p < 0.001$). The differences were most notable in the proportions of beach users who reported that they never littered (Table 2). Here, the proportion was lowest among the survey participants with only eight years of education, with approximately 50% of them responding that they never litter on the beach. In contrast, more than 70% of participants with university education responded that they never litter on the beach (Table 2). The proportion of the most educated users who responded that they never litter was significantly higher than in each of the other education groups ($p < 0.05$). Few participants across education groups reported that they are Frequent litterers, but of those who did the participants with the least education were three times as likely to report themselves as Frequent litterers than those with university education were (18% versus 6%).

3.3. Preferred solutions of beach users

The solution to reduce beach littering that was considered the best by participants was environmental education (for the whole community, including litterers). The next most preferred solutions were a fine for offenders, constant cleaning, and more trash cans (Table 3). There was very low preference for restrictions on summer visitors and incentives/regulations for private business. There was a significant association between the preferred solutions of participants and their self-reported littering behavior ($\chi^2 = 42.922$, $df = 12$, $p < 0.001$). Those beach users who admitted littering frequently were less supportive of environmental education (21%) than those who littered occasionally (30% selected environmental education, but $p > 0.05$) or never (41%, $p < 0.01$). Support of a fine was consistently high across littering groups. Those who littered frequently also supported restrictions on summer visitors (13%) and constant cleaning (25%) more than the other groups (but the only significant differences were between the Never and Frequent groups) (Fig. 2).

When asked specifically if there should be a fine for someone who litters on the beach in their community, 94% of all survey participants responded "yes." Participants were free to suggest the value of the fine, which resulted in a median proposed fine of \$38 USD (based on the May 2010 exchange rate between the US dollar and Chilean pesos) with a range of \$0–\$3800 (5th percentile = \$3.8, 95th percentile = \$222.4).

Additionally, there were differences in participants' preferences for solutions depending on their education level ($\chi^2 = 97.997$, $df = 12$, $p < 0.001$). Participants with a college or graduate level education supported environmental education more frequently

Table 3
Relationship between participants' education level and support for solutions to the problem of beach litter.

Solution	Demographic group				
	8 years (n = 177)	12 years (n = 324)	12years + technical training (n = 128)	College or graduate school (n = 163)	Geographical zone (min and max %) (n = 796)
Environmental education	16.0	34.3	31.7	60.9	30.2–44
Fines for offenders	28.4	29.3	33.6	24.4	23.5–41.8
Constant cleaning	22.2	15.3	15.4	5.6	13.2–19.1
More trash cans	23.6	12.1	14.0	6.5	7.7–17.8
Restrictions on summer visitors	8.3	7.9	2.7	1.9	0–9.4
Other	0	0.3	2.6	0.5	0–2.2
Incentives/regulation of private business	1.5	0.7	0	0.3	0–2.3

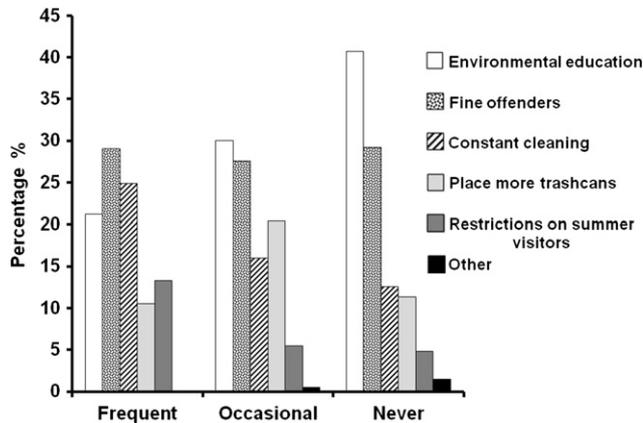


Fig. 2. A comparison of participants' self-reported frequency of littering (Frequent, Occasional, or Never) with their preferred solutions to the problem of beach litter. "Incentives/regulations" was combined into the "other" group because it comprised <1% of responses.

(61%) than any other education group ($p < 0.01$) (Table 3). Fining those who litter was a consistently preferred solution across education groups at an approximately 30% preference rate, with no significant differences between groups. Restrictions on summer visitors was a more popular solution with those in the lower education brackets (8 and 12 years), but was not one of the top solutions for either of those groups. Lastly, there was little variation in preference for solutions across the five Chilean geographical zones (see last column of Table 3).

4. Discussion

4.1. Littering behavior

An important limitation of self-reported data of undesirable behaviors is that people tend to underreport how often they do them (Fisher, 1993). Other studies have documented that approximately one-third of the participants denied littering when research teams had just observed them doing so (Schultz et al., 2009; Bator et al., 2011). Considering this, these data should not be interpreted as reflecting the true frequency of littering behaviors, but can serve as a low estimate of these behaviors and as a basis for comparison with other self-report studies. However, 13% of our sample admitted to being "Frequent" litterers, suggesting a certain degree of honesty in our sample, especially since being a frequent litterer is a highly undesirable social trait. Moreover, Slavin et al. (2012) reported low rates of self-reported littering in their Australian beach sites and these rates were associated with low amounts of litter found on the beaches.

This survey revealed that a significant proportion (~45%) of Chileans admitted to littering in some way (Table 2), nearly approaching the majority, and more than we had hypothesized. Two separate studies, one from Brazil and another from Australia, reported that 25% of their samples admitted to littering on the beach (Santos et al., 2005; Slavin et al., 2012). Another study reported that 16% of Brazilian beach users self-reported abandoning their trash in the sand (Dias-Filho et al., 2011). The differences between the present data and the data from these studies could be cultural, but could also be due to differences in survey questions. The results presented here seem to be closer to self-reports of littering behavior from non-beach environments: one large American study identified the self-reported littering rate as ~45% in public spaces (Schultz et al., 2009); one Palestinian study (Al-Khatib, 2009) showed that 42% of children admitted to littering glass on

the streets. Interestingly, Al-Khatib (2009) reported that approximately 70% of their adult Palestinian sample admitted to littering in the streets. Thus, the present study seems to be in the mid-range of estimates of self-reported littering across environments. The data suggest that beach littering may be a very common behavior in Chile and that it occurs across diverse segments of the population. Future studies are needed to better understand the connection between self-reported and observed environmental behaviors.

4.2. Solutions preferred by beach users

Community-level environmental education was the most commonly proposed solution to the problem of beach litter, consistent with our hypothesis and other research showing a belief in environmental education as a key solution to littering problems (Ballance et al., 2000; Kollmus and Agyeman, 2002; Leujak and Ormond, 2007). The results from the present study are comparable to user preferences reported by Santos et al. (2005) and Dias-Filho et al. (2011). However, Santos et al. (2005) showed marked differences in their participants' endorsement of other options such as more frequent cleaning, more trash cans, and a fine (Table 4). In a study based on littering in streets, Al-Khatib et al. (2009) found little support for public awareness campaigns and more preference for appealing to people's religious convictions to motivate them to litter less, i.e. using social norms. The second most popular solution in the present study (and one that the vast majority of the sample believed should be enforced regardless of other solutions) was a fine for beach litterers. One other study also showed that a majority of beach users (73–98%) on three beaches in South Africa believed a fine (independently of other solutions) was desirable (De Ruyck et al., 1995).

4.3. Influence of education

The most educated (college or graduate school level) participants in the sample were most supportive of environmental education, while those with the least education (8 years) were generally more supportive of immediate solutions such as more trash cans and constant cleaning. This could perhaps reflect a preference for more practical and hands-on solutions among this latter group. These differences between demographic groups were unexpected and differ from a report from Santos et al. (2005) showing consistent support of environmental education across socioeconomic groups.

Self-reported littering was much less common among the most educated group of beach users in Chile, consistent with our hypothesis. If these self-reports approximate real littering behaviors (as discussed above), this effect could be explained by increases of environmental awareness and positive social norms (known contributors to pro-environmental behaviors – Bamberg and Möser, 2007) via formal education as university students are informed of current problems and influenced by pro-environmental behaviors around them. Similar results to this study were reported in Brazil

Table 4

Beach users' preferences of solutions in the present survey and in Santos et al. (2005).

Solution	Present survey	Santos et al. (2005)
Environmental education	30.7	42.6
Fine	24.8	7.7
Constant cleaning	13.4	4.1
More trash cans	11.2	36.7
Business regulation/incentives	1.0	N/A
Restrictions on summer visitors	5.2	N/A
Distribution of plastic bags	N/A	9.9

(see Fig. 1B in Dias-Filho et al., 2011), though the effects of both general school education and environmental education on environmental behaviors have not always produced concordant results. Evidence for public education campaigns to reduce littering has been mixed (Harris et al., 1990; Taylor et al., 2007), and some authors (e.g. Schultz et al., 2011) have suggested that media outreach campaigns against littering only produce small changes in behaviors if any, and their effectiveness depends on the characteristics of the programs (Roales-Nieto, 1988; Geller, 1989). Regarding general school education, in one review of reasons for why people act environmentally, the authors noted that more education does not necessarily mean increased pro-environmental behavior (Kollmus and Agyeman, 2002). In a survey of professional environmentalists, education was only the fifth most mentioned reason for how they came to be environmentalists (Chawla, 1999). Research on participant behaviors in other marine environments such as coral reefs and the intertidal zone has shown that education and knowledge did not lead to better behaviors (Alessa et al., 2003; Oigman-Pszczol et al., 2007). However, there is also evidence for the opposite conclusion, including one meta-analysis of the psychosocial determinants of environmentalism, which stated that knowledge about an environmental problem is “an important indirect determinant of pro-environmental behavior” (Bamberg and Möser, 2007). This implies an effect of education, but until more research identifies the relationship between general education level and littering behaviors, public education campaigns are likely just one piece of the puzzle of solving environmental problems.

4.4. Implications for management

The present results suggest several strategies for the reduction of litter on beaches in Chile and other parts of the world. First, environmental education and fines are preferred solutions among beach users, indicating that there is likely to be support for community managers or local governments that institute these two solutions to beach littering. In addition, the present study provides a range for a fine that is likely to be accepted by the populace, which could be adjusted by managers according to the socioeconomic characteristics of their beach users. A multifaceted approach is thus recommended, in concordance with other authors (Sutinen, 1997; Schultz et al., 2011), which could include the solutions listed in the survey (environmental education, fines, beach cleaning, more trash cans, incentives and regulations for business) as well as others suggested in the literature (e.g. applying social norms against litterers, or targeting smokers) (Schultz et al., 2011; Ariza and Leatherman, 2012). Programs that combine several efforts instead of focusing on one are likely to give better results. For example, a program in which volunteers and students clean beaches as part of an environmental lesson plan could be a successful combination of both cleaning and education (Rees and Pond, 1995; Bravo et al., 2009). Also, identifying the demographic characteristics of beach users such as their education level can be useful for managers, who can use that information to customize solutions to users, leading to more effective programs and wider acceptance of them with their local public.

5. Conclusions

This study examined the demographics, littering behavior and preferences for solutions of beach users in Chile by using a citizen science method in which school children across the country surveyed people in coastal towns. A significant portion of respondents admitted to littering on beaches, but these answers varied depending on the education of the respondent such that self-reports of littering on the beaches were lower among those with more education. Community environmental education was the

most popular solution among participants when prompted with a series of alternatives, but these responses also varied according to education of the user. Because of the effects of education seen in this study, it is suggested that beach managers carry out similar efforts to understand the demographics of their beach users so that they can choose, keeping in mind that education of beach users will likely be a determining factor in the success of any beach litter management program.

Acknowledgements

Special thanks go to Professor Michelle McCauley (Middlebury College, USA) and Raúl Quintanilla (UCN, Chile), who provided extremely helpful comments and suggestions for the analysis of the survey results. We also thank the teachers and students from the schools across Chile who participated in this project for their enthusiasm and dedication. Lastly, we thank the reviewers and especially Sergio González for their constructive comments. A portion of this project was funded by a Sustainable Study Abroad grant from Middlebury College to the first author.

References

- Alessa, L., Bennett, S.M., Kliskey, A.D., 2003. Effects of knowledge, personal attribution and perception of ecosystem health on depreciative behaviors in the intertidal zone of Pacific Rim National Park and Reserve. *Journal of Environmental Management* 68, 207–218.
- Al-Khatib, I.A., 2009. Children's perceptions and behavior with respect to glass littering in developing countries: a case study in Palestine's Nablus district. *Waste Management* 29, 1434–1437.
- Al-Khatib, I.A., Arafat, H.A., Daoud, R., Shwahneh, H., 2009. Enhanced solid waste management by understanding the effects of gender, income, marital status, and religious convictions on attitudes and practices related to street littering in Nablus – Palestinian territory. *Waste Management* 29, 449–455.
- Ariza, E., Leatherman, S.P., 2012. No-smoking policies and their outcomes on U.S. beaches. *Journal of Coastal Research* 28, 143–147.
- Ballance, A., Ryan, P.G., Turpie, J.K., 2000. How much is a clean beach worth? The impact of litter on beach users in the Cape Peninsula, South Africa. *South African Journal of Science* 96, 210–213.
- Bamberg, S., Möser, G., 2007. Twenty years after Hines, Hungerford, and Tomera: a new meta-analysis of psycho-social determinants of pro-environmental behaviour. *Journal of Environmental Psychology* 27, 14–25.
- Barragán, J.M., Castro, C., Alvarado, C., 2005. Towards integrated coastal management in Chile. *Coastal Management* 33, 1–24.
- Bator, R.J., Bryan, A.D., Schultz, P.W., 2011. Who gives a hoot: intercept surveys of litterers and disposers. *Environment and Behavior* 43, 295–315.
- Bonney, R., Cooper, C.B., Dickinson, J., Kelling, S., Phillips, T., Rosenberg, K.V., Shirk, J., 2009. Citizen science: a developing tool for expanding science knowledge and scientific literacy. *BioScience* 59, 977–984.
- Bravo, M., los Angeles-Gallardo, M., Luna-Jorquera, G., Núñez, P., Vásquez, N., Thiel, M., 2009. Anthropogenic debris on beaches in the SE Pacific (Chile): results from a national survey supported by volunteers. *Marine Pollution Bulletin* 58, 1718–1726.
- Chawla, L., 1999. Life paths into effective environmental action. *The Journal of Environmental Education* 31, 15–26.
- Cialdini, R.B., Reno, R.R., Kallgren, C.A., 1990. A focus theory of normative conduct: recycling the concept of norms to reduce littering in public places. *Journal of Personality and Social Psychology* 58, 1015–1026.
- Delaney, D.G., Sperling, C.D., Adams, C.S., Leung, B., 2007. Marine invasive species: validation of citizen science and implications for national monitoring networks. *Biological Invasions* 10, 117–128.
- De Ruyck, A.M.C., Soares, A.G., McLachlan, A., 1995. Factors influencing human beach choice on three South African beaches: a multivariate analysis. *GeoJournal* 36, 345–352.
- Derraik, J.G.B., 2002. The pollution of the marine environment by plastic debris: a review. *Marine Pollution Bulletin* 44, 842–852.
- Dias-Filho, M., Silva-Cavalcanti, J.S., Araujo, M.C.B., Silva, A.C.M., 2011. Avaliação da percepção pública na contaminação por lixo marinho de acordo com o perfil do usuário: estudo de caso em uma praia urbana no Nordeste do Brasil. *Revista da Gestão Costeira Integrada* 11, 49–55.
- Dickinson, J.L., Bonney, R. (Eds.), 2012. *Citizen Science: Public Participation in Environmental Research*. Cornell University Press, Ithaca, New York, p. 279.
- Evans, C., Abrams, E., Reitsma, R., Roux, K., Salmons, L., Marra, P.P., 2005. The neighborhood nestwatch program: participant outcomes of a citizen-science ecological research project. *Conservation Biology* 19, 589–594.
- Finnie, W.C., 1973. Field experiments in litter control. *Environment and Behavior* 5, 123–144.

- Fisher, R.J., 1993. Social desirability bias and the validity of indirect questioning. *The Journal of Consumer Research* 20, 303–315.
- Geller, E.S., 1989. Applied behavior analysis and social marketing: an integration for environmental preservation. *Journal of Social Issues* 45, 17–36.
- Gregory, M.R., 2009. Environmental implications of plastic debris in marine settings hitch-hiking and alien invasions – entanglement, ingestion, smothering, hangers-on, hitch-hiking and alien invasions. *Philosophical Transactions of the Royal Society of London, Series B* 364, 2013–2025.
- Gregory, M.R., Andrady, A.L., 2003. Plastics in the marine environment. In: Andrady, A.L. (Ed.), *Plastics and the Environment*. John Wiley and Sons, Inc, pp. 379–401.
- Harris, C.C., McLaughlin, W.J., Rawhouser, D.K., 1990. Comprehensive evaluation of information/education programs to reduce impacts on the Lower Salmon River. *Journal of Environmental Management* 31, 19–28.
- Houston, J.R., 2008. The economic value of beaches – a 2008 update. *Shore & Beach* 76, 22–26.
- Ivar do Sul, K.A., Costa, M.F., 2007. Marine debris review for Latin America and the wider Caribbean Region: from the 1970's until now, and where do we go from here? *Marine Pollution Bulletin* 54, 1087–1104.
- Kollmus, A., Agyeman, J., 2002. Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research* 8, 239–260.
- Leujak, W., Ormond, R.F.G., 2007. Visitor perceptions and the shifting social carrying capacity of South Sinai's coral reefs. *Environmental Management* 39, 472–489.
- Marin, V., Palmisani, F., Ivaldi, R., Dursi, R., Fabiano, M., 2009. Users' perception analysis for sustainable beach management in Italy. *Ocean & Coastal Management* 52, 268–277.
- Oigman-Pszczol, S.S., Oliveira, A.E.S., Creed, J.C., 2007. Perceptions of coral in a coastal tourist town in Brazil. *Coral Reefs* 26, 667–670.
- Peckenham, J.M., Thornton, T., Peckenham, P., 2012. Validation of student generated data for assessment of groundwater quality. *Journal of Science Education Technology* 21, 287–294.
- Rees, G., Pond, K., 1995. Marine litter monitoring programmes – a review of methods with special reference to national surveys. *Marine Pollution Bulletin* 30, 103–108.
- Roales-Nieto, J.G., 1988. A behavioral community program for litter control. *Journal of Community Psychology* 16, 107–118.
- Santos, I.R., Friedrich, A.C., Wallner-Kersanach, M., Fillman, G., 2005. Influence of socio-economic characteristics of beach users on litter generation. *Ocean & Coastal Management* 48, 742–752.
- Schultz, P.W., Large, L.B., Tabanico, J., Bruni, C., Bator, R., 2009. Littering Behavior in America: Results of a National Study. *Keep America Beautiful and Action Research*, San Marcos, CA.
- Schultz, P.W., Bator, R.J., Large, L.B., Bruni, C.M., Tabanico, J.J., 2011. Littering in context: personal and environmental predictors of littering behavior. *Environment and Behavior*. <http://dx.doi.org/10.1177/0013916511412179>.
- Silvertown, J., 2009. A new dawn for citizen science. *Trends in Ecology and Evolution* 24, 467–471.
- Slavin, S., Grage, A., Campbell, M.L., 2012. Linking social drivers of marine debris with actual marine debris on beaches. *Marine Pollution Bulletin* 64, 1580–1588.
- Sutinen, J., 1997. A socioeconomic theory for controlling marine debris: is moral suasion a reliable policy tool? In: Coe, J.M., Rogers, D.B. (Eds.), *Marine Debris: Sources, Impacts, and Solutions*. Springer-Verlag, Inc, pp. 161–170.
- Taylor, A., Curnow, R., Fletcher, T., Lewis, J., 2007. Education campaigns to reduce stormwater pollution in commercial areas: do they work? *Journal of Environmental Management* 84, 323–335.
- Thiel, M., Bravo, M., Hinojosa, I.A., Luna, G., Miranda, L., Núñez, P., Pacheco, A.S., Vásquez, N., 2011. Anthropogenic litter in the SE Pacific: an overview of the problem and possible solutions. *Journal of Integrated Coastal Zone Management* 11, 115–134.
- Thiel, M., Hinojosa, I.A., Miranda, L., Pantoja, J.F., Rivadeneira, M.M., Vásquez, N., 2013. Anthropogenic marine debris in the coastal environment: a multi-year comparison between coastal waters and local shores. *Marine Pollution Bulletin*. <http://dx.doi.org/10.1016/j.marpolbul.2013.01.005>.
- Weckel, M.E., Mack, D., Nagy, C., Christie, C., Wincorn, A., 2010. Using citizen science to map human-coyote interaction in suburban New York, USA. *Journal of Wildlife Management* 74, 1163–1171.
- Williams, A.T., Gregory, M., Tudor, D.T., 2005. Marine debris – onshore, offshore, seafloor litter. In: Schwartz, M.L. (Ed.), *Encyclopaedia of Coastal Processes*. Springer, pp. 623–628.