*Contributed Paper*

# Household Location Choices: Implications for Biodiversity Conservation

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**Abstract:** *Successful conservation efforts require understanding human behaviors that directly affect biodiversity. Choice of household location represents an observable behavior that has direct effects on biodiversity conservation, but no one has examined the sociocultural predictors of this choice relative to its environmental impacts. We conducted a case study of the Teton Valley of Idaho and Wyoming (U.S.A.) that (1) explored relationships between sociodemographic variables, environmental attitudes, and the environmental impact of household location choices, (2) assessed the potential for small household sizes in natural areas to multiply the environmental impacts of household location decisions, and (3) evaluated how length of residency predicted the environmental attitudes of people living in natural areas. We collected sociodemographic data, spatial coordinates, and land-cover information in a survey of 416 households drawn from a random sample of Teton Valley residents (95% compliance rate). Immigrants (respondents not born in the study area) with the lowest education levels and least environmentally oriented attitudes lived in previously established residential areas in disproportionately high numbers, and older and more educated immigrants with the most environmentally oriented attitudes lived in natural areas in disproportionately high numbers. Income was not a significant predictor of household location decisions. Those living in natural areas had more environmental impact per person because of the location and because small households (<3 people/household) were 4 times as likely in natural areas as large households. Longer residency in natural areas predicted less environmentally oriented attitudes, suggesting that living in natural areas does not foster more concern for nature. Because populaces are rapidly aging, growing more educated, and potentially growing more environmentally oriented, these patterns are troubling for biodiversity conservation. Our results demonstrate a need for environmentalists to make household location decisions that reflect their environmental attitudes and future research to address how interactions between education level, environmental attitudes, population aging, and household location choices influence biodiversity conservation.*

**Keywords:** aging population, conservation education, conservation planning, environmentalism, household location, land use, sociodemographics, sustainable development

Selecciones de Ubicación de Viviendas: Implicaciones para la Conservación de la Biodiversidad

**Resumen:** *Los esfuerzos exitosos de conservación requieren del entendimiento de conductas humanas que afectan directamente a la biodiversidad. La selección de la ubicación de viviendas representa una conducta observable que tiene efectos directos sobre la conservación de la biodiversidad, pero nadie ha examinado los vaticinadores socioculturales de esta selección en relación con sus impactos ambientales. Desarrollamos un estudio de caso en el Valle Teton de Idaho y Wyoming (E. U. A.) que (1) exploró las relaciones entre variables socio-demográficas, actitudes ambientales y el impacto ambiental de la selección de la ubicación de viviendas, (2) evaluó el potencial de viviendas pequeñas en áreas naturales para multiplicar los impactos ambientales de las decisiones de ubicación de viviendas y (3) evaluó cómo el tiempo de residencia vaticinaba las actitudes ambientales de la gente que vive en áreas naturales. Recolectamos datos socio-demográficos, coordenadas*

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*espaciales e información de cobertura de suelo en un muestreo de 416 viviendas de una muestra simple aleatoria de residentes del Valle Teton (tasa de conformidad 95%). Los inmigrantes (habitantes que no nacieron en la zona de estudio) con los niveles de educación más bajos y con las actitudes menos orientadas al ambiente vivían en áreas residenciales previamente establecidas en números desproporcionadamente altos, y los inmigrantes más viejos y con mayor educación con actitudes orientadas hacia el ambiente vivían en áreas naturales en números desproporcionadamente altos. El ingreso no fue un vaticinador significativo de las decisiones de localización de vivienda. Quienes vivían en áreas naturales tenían mayor impacto ambiental por persona debido a la localización y porque las viviendas pequeñas (<3 personas/vivienda) fueron cuatro veces más probables en áreas naturales que las viviendas grandes. El mayor tiempo de residencia en áreas naturales vaticinó menos actitudes orientadas hacia el ambiente, lo que sugiere que vivir en áreas naturales no fomenta mayor preocupación por la naturaleza. Estos patrones son problemáticos para la conservación de la biodiversidad debido a que las poblaciones están envejeciendo rápidamente, obteniendo mayores niveles de educación y, potencialmente, teniendo una mayor conciencia ambiental. Nuestros resultados demuestran la necesidad de que los ambientalistas tomen decisiones de ubicación de viviendas que reflejen sus actitudes ambientales y que se realice más investigación sobre cómo afectan a la conservación de la biodiversidad las interacciones del nivel de educación, las actitudes ambientales, envejecimiento de la población y la selección de ubicación de viviendas.*

**Palabras Clave:** ambientalismo, desarrollo sustentable, educación para la conservación, planificación de la conservación, población avejentada, sociodemografía, ubicación de viviendas, uso de suelo

## Introduction

To make conservation successful, conservation biologists must work to change the human behaviors threatening biodiversity (Ehrlich 2003; Freyfogle 2003; Orr 2003; Schwartz 2006). This daunting task requires understanding the determinants of environmental behavior. Psychologists have developed 2 primary models for predicting human behavior, the choice of which depends on the relative weight given to concern for others versus self in decision making. The norm-activation model (Schwartz 1977) suggests people attempt to engage in what they perceive as prosocial behavior. Rational choice models (Fishbein & Ajzen 1975; Ajzen 1991) suggest people weigh perceived positive and negative consequences to generate an attitude (positive or negative evaluation of an object) toward the behavior option. The relationship between attitudes and behavior, however, is constrained by perceived ability to perform the behavior. Permutations and combinations of these models have proliferated in environmental sociology and psychology literature (e.g., Stern et al. 1995; Dietz et al. 1998; Bamberg & Moser 2007). Although these models place varying emphasis on social norms and locus of control (the degree to which people consider themselves [vs. outside forces] in control) they have several similarities. The models all suggest that a person's position in society (e.g., age, class, race, gender, education level) influences attitudes toward the environment and that those attitudes shape intentions to act or behave in a particular manner.

These models of environmental behavior suggest successful conservation initiatives must consider how sociocultural context shapes public attitudes toward the environment and how those attitudes relate to behaviors that affect biodiversity conservation (Peterson et al. 2002; Freyfogle 2003; Schwartz 2006). Scholars studying relationships between social context, environmental attitudes, and environmental behavior, however, face several challenges. Attitudes must be evaluations of an object (what one is asked their opinion about), and those evaluations change for different objects (e.g., conserving biodiversity, a specific species, or an individual animal). Broader attitude objects (e.g., environmental conservation) provide more opportunity for generalization and cross-case comparisons, but can be difficult to measure relative to more focused attitude objects (e.g., protecting seal pups). Scales designed to tap broad environmental views (e.g., the New Environmental [or Ecological] Paradigm scale [NEP]) have addressed this challenge by consistently measuring environmental attitudes (Dunlap et al. 2000). Education, age, and possibly residence location (e.g., urban vs. rural) consistently explain variance in such scales (Buttel 1987).

The remaining challenges relate to how behavior is measured. Large-scale social surveys rarely measure actual behavior or behaviors with direct effect on the environment. Accordingly most past research relies on self-reported behaviors with indirect linkages to biodiversity conservation (e.g., signing petitions, voting, consumer choices, donations, entertainment choices, membership in clubs: Dietz et al. 1998; Johnson et al. 2004). What people say they do, however, often differs significantly from what they actually do (Argyris & Schön 1978; Argyris 1992). Environmentally oriented attitudes, intentions, and education do not guarantee more environmentally sensitive behavior (Stern 2000).

This challenge can be overcome by studying household location choices. Household location is a directly

observable and almost universal human behavior that affects biodiversity conservation directly (Friesen et al. 1995; Nilon et al. 1995; Kluza et al. 2000; Liu et al. 2003; Peterson et al. 2007). Choosing the type and location of one's home is potentially the most pervasive and direct link between human attitudes and intentions and their physical effects on the land. Classic research on home location choice indicates people selected locations that maximized utility (satisfaction with consumption of goods) under income constraints (Alonso 1964; McFadden 1978). Early metrics of utility focused on house features, proximity to work, attributes of neighbors, and small-town living (Speare, 1974; Duncan & Newman 1976; Michelson 1977; Blackwood & Carpenter 1978). Recently, research has turned to the role of nature, open space, parks, and natural amenities in household-location choices (Crump 2003; Austin 2004; Kaplan & Austin 2004; Vogt & Marans 2004). Results of these recent studies suggest household location decisions that maximize utility may lead to development pressure on environmentally sensitive areas.

Despite the pivotal role of household location decisions in conservation, little research has addressed the socioattitudinal predictors of those choices relative to their environmental impacts. This gap may relate to the difficulty associated with measuring and comparing environmental impacts of home locations and finding areas where most residents actually made explicit decisions regarding home locations. We used a case study in Teton Valley of Idaho and Wyoming (U.S.A.) to address this gap by evaluating the relationships among sociodemographic variables, environmental attitudes, and the environmental impacts of homes immigrants (respondents not born in the study area) chose to live in.

We tested 3 hypotheses: (1) older respondents, those with higher education levels, and those with more environmentally oriented attitudes preferentially choose household locations in natural areas, (2) the ecological impacts of household location decisions are magnified by smaller household size (i.e., fewer people per household) of people choosing to live in natural areas, and (3) length of residency predicts the environmental attitudes of people living in natural areas. We chose variables in the first hypothesis on the basis of previous environmental sociology research that suggests consistent, if weak, relationships between age, level of education, environmental attitudes, and behavior (Buttel 1987; Dunlap et al. 2000). We linked these variables to environmentally damaging choices of household location on the basis of qualitative insight from previous studies that suggest environmentally oriented, older, and highly educated people prefer environmentally sensitive areas (Stroud 1995; Peterson et al. 2002). The second hypothesis emerged logically from the first. If people with smaller household sizes (e.g., older, more educated, more environmentally oriented respondents) preferentially chose ecologically sensitive areas for homes, there would be more houses per person in those areas. The final hypothesis represents an exploration of feedback in the environmental behavior model and emerged from the philosophy of Aldo Leopold, who suggested living in natural surroundings can promote more environmentally oriented attitudes (Leopold 1949).

## Methods

### Study Area

Teton Valley includes Teton County, Idaho, and the portion of Teton County, Wyoming, west of the Teton Mountains. One study labeled Teton Valley the number one priority site for protection in the Greater Yellowstone Ecosystem on the basis of the threat of biodiversity loss (Noss et al. 2001). Immigration to Teton Valley, related to natural amenities and outdoor recreation, led to a 74% jump in population (3439–5999) and 85% (1123–2078) increase in household numbers during the 1990s (Smith & Krannich 2000; Peterson et al. 2006). Development accompanying the immigration lacked a general plan. Post-1990 development coincided with the first *Escherichia coli* outbreaks (see http://www.tetonwater.org) and near extirpation of native cutthroat trout (*Oncorhynchus clarki*) in the Teton River (Idaho Fish & Game 2005). Development threatens water quality, wetlands, migration corridors in the greater Yellowstone ecosystem (75% of which are already blocked; Berger 2004), and winter habitat for mule deer (*Odocoileus hemionus*) and elk (*Cervus elaphus*).

The development history of Teton Valley provides fertile ground for research on relationships among sociodemographic variables, environmental attitudes, and environmental behavior. Pronounced vegetation zonation within the Southern Rocky Mountain Steppe—Open Woodland—Coniferous Forest—Alpine Meadow province (Bailey 1995) makes environmental impacts of various household locations relatively easy to identify and compare. Elevation, gradient, slope exposure, and traditional agricultural practices make boundaries between forests, rangelands, wetlands, agricultural fields, and residential areas sharp and easy to delineate with aerial photography. The massive immigration event associated with environmental amenities meant that many residents considered the environment in their household location decisions, and minimal development restrictions meant immigrants could build homes anywhere not protected by federal or state legislation (e.g., wetlands). Finally, the pattern of household numbers outpacing population growth, a global phenomenon (Liu et al. 2003), provided opportunity to evaluate how household size mediated the effects of household location decisions.

### Data Collection

We conducted in-person interviews to assess demographic characteristics, environmental attitudes, and home location information for respondents. We chose personal interviews because they promised higher response rates than mail questionnaires (Dillman 2000), the ability to identify exact locations of homes, and the opportunity to verify landscape attributes identified through remote sensing. We purchased a sample (randomly selected from phone records) of Teton Valley residents ($n = 550$) from Survey Sampling (Fairfield, Connecticut; logistic constraints dictated sample size). We interviewed arbitrarily selected residents of Lansing, Michigan ($n = 18$), and Victor, Idaho (within the study area; $n = 23$) to pretest the questionnaire.

We attempted to visit each chosen interviewee during 4 time intervals (morning and evening on a weekday and on a weekend day) during July–August 2004. If visits failed and we could not locate a physical address with the aide of local informants we made initial contact via telephone. Interviewers defined acronyms, but answered other questionnaire-related queries by explaining questionnaire format, reading directly from the questionnaire, or stating "whatever it means to you" (Groves 1989:451). Because "local" versus "newcomer" divisions were observed in previous studies in this area (Smith & Krannich 2000; Peterson & Liu 2008), we designed interview protocol to assess the potential for interviewer bias. We used 2 local interviewers (i.e., third-generation natives born and raised in the community) and 2 newcomer interviewers (i.e., on their first-ever visit to the Intermountain West). All interviewers achieved >90% compliance, and neither response rates nor response content differed significantly between interviewers.

We used the NEP scale (Dunlap et al. 2000) to measure environmental attitudes. The NEP scale measures broad attitudes toward the environment that influence attitudes toward a wide range of more specific environmental factors (e.g., forests, erosion, pollution, endangered species; Stern et al. 1995; Dalton et al. 1999; Dunlap et al. 2000). The NEP addresses 5 theoretical dimensions with 3 questions for each: endorsement of limits to growth, antianthropocentrism, belief in future ecocrisis, belief in a fragile nature, and rejection of human exemptionalism (i.e., the notion that humans are free to do as they please because they are exempt from the laws of nature). Scores can range from 15 to 75, but are often positively skewed. Environmentalists (e.g., members of known environmental organizations) consistently score higher on the NEP than the general public or members of nonenvironmental organizations (Dunlap & Van Liere 1978; Dunlap et al. 2000; Dunlap & Michelson 2002). Accordingly, the NEP has both predictive and known group validity. Use of the NEP facilitates comparison with other research because it is the most common measure of environmental concern (Stern et al. 1995). Some researchers question the internal consistency and dimensionality of the NEP (Dunlap et al. 2000), but high internal consistency for this study in Teton Valley (Cronbach's $\alpha = 0.87$) suggests use of the NEP as a single measure is acceptable (Dunlap et al. 2000).

We collected data for education level (1, <high school, to 7, graduate or professional degree), income (1, ≤14,999, to 9, ≥200,000), age, household size, ethnicity, and gender (Dillman 2000). During survey administration, we realized the importance of graduate education major (e.g., M.B.A. vs. M.S. in Wildlife Ecology) for immigrants, so we used follow-up contacts and notes from interview transcripts to determine majors for as many immigrants with advanced degrees as possible. We divided households into large (>2) and small (1 and 2) categories on the basis of mean household sizes in the United States (2.60), Idaho (2.64), and Wyoming (2.43) (U.S. Bureau of the Census 2001). We coded political affiliation as a 3-category variable (1, Republican; 2, Independent; and 3, Democrat). We coded residency (native vs. immigrant) as a binary variable from response to the following question: Have you lived all your life in Teton County?

We identified household location with address geocoding in ArcView 3.2 (Environmental Systems Research Institute, Redlands, California). We then used landmarks (e.g., tree lines, creek beds, notable buildings) and homestead attributes (e.g., lawn shape, roof type, house shape, topography, driveway shape and type) to locate and mark the exact location of each house on a digital aerial photograph. Immigrants to Teton Valley could choose to live in residential areas, agricultural areas, or natural areas. We classified the location of each house as occurring in one of these areas. Homes in existing residential areas required minimal new infrastructure (e.g., roads, sewer lines, power lines), and caused minimal fragmentation of natural land cover. Homes in agriculture areas, however, required road and power line construction, and either extension of sewer lines or, more likely, installation of septic systems. Finally, homes in natural land cover require new infrastructure construction, replace natural land cover, and magnify environmental damage by either immediate adjacency to wetlands and streams or destruction and fragmentation of critical elk and mule deer winter range (Skovlin 1982; Kie & Czech 2000) on low-elevation hillsides.

We used 2004 zoning maps from each municipality to delineate boundaries for residential areas (i.e., city limits). All households within city limits were categorized as residential unless they also occurred in a riparian zone (the latter areas were classified as natural land cover). Natural land cover was limited to wetlands and riparian zones on the valley floor and forest or rangeland areas on hillsides bordering the valley. We used the 2000 U.S. Census Bureau's TIGER\Line data sets to classify riparian zones as those within a 100-m area around streams

and rivers. We used the U.S. Fish and Wildlife Service's (2005) National Wetland Inventory to identify wetlands. The aforementioned pronounced vegetation zonation in this region (Bailey 1995) made visual identification of forest and rangeland on aerial photographs possible. Because forest and rangeland were limited to hillsides surrounding the valley, these land-cover types did not overlap with agricultural or residential areas. We categorized homes surrounded by crop fields as within agricultural areas unless they also occurred in a wetland or riparian zone.

### Data Analysis

All descriptive and inferential statistics were calculated with SPSS (Release 15.0.0, SPSS, Chicago, Illinois). Although we generated descriptive statistics for the entire sample, we focused analysis of household location on immigrants. We made this decision on the basis of the results of preliminary qualitative research that suggested natives had fundamentally different household location decisions (i.e., live in the home one was born in, build a home on parents' property) and lived in the area for different reasons (e.g., family vs. natural amenities). Our results in this study corroborated the latter finding.

We used $t$ tests to compare natives and immigrants, and one-way analysis of variance (ANOVA) to compare the immigrants choosing to live in each of the 3 areas (residential, agricultural, and natural; $\alpha = 0.05$). If ANOVA was significant, we used Duncan's range test to evaluate differences among means ($\alpha = 0.05$). When data failed to meet ANOVA assumptions (i.e., normality and equality of variance), we used chi-square tests of independence for comparisons. We used binary logistic regression to control for correlations between education, age, gender, income, and environmental attitudes and to select variables significantly related to choosing households in natural areas. We measured the performance of variables for predicting whether respondents chose a household location inside a natural area with receiver-operating-characteristic (ROC) curves and area-under-the-curve (AUC) estimates (McFall & Treat 1999). A perfect prediction method would yield a point in the upper left corner of ROC space (0,1), and 100% of the ROC area being AUC. This point represents predictions of all the true positives and no false positives. Random guesses give points along a diagonal "line of no discrimination," and if on average a prediction method yields points along this line, the AUC equals 50%. This approach is ideal for evaluating effect size when phenomena have just 2 states of concern and a skewed prevalence (e.g., 85% of respondents live outside natural areas).

To test our hypothesis that older respondents, those with higher levels of education, and those with more environmentally oriented attitudes preferentially choose household locations in natural areas, we evaluated household location preferences with an adapted habitat-selection ratio (Thomas & Taylor 1990; Lopez et al. 2004). A selection ratio ($S$) for respondent group $X$ (e.g., people with high school educations, people scoring in the top 10% on the NEP) would be calculated as $S = (XN/XA)/(TN/TA)$, where XN is the number of group X households in natural areas, XA is total number of group X households in all areas, TN is total number of households in natural areas, and TA is total number of households in all areas. From the logistic-regression analysis, we calculated a selection ratio for each education level, age group (9 equal intervals), and group of NEP scores divided by deciles (9 values that divide scores into 10 equal parts). To test the hypothesis that the ecological impacts of household location decisions are magnified by smaller household size of people choosing to live in natural areas, we determined whether large and small households had different likelihoods of occurring in natural areas with a chi-square test. Finally, we determined whether length of residency predicted environmental attitudes of people living in natural areas by calculating Pearson's correlation coefficients between years of residency in each area and NEP.

### Results

The final compliance rate was 95% ($n = 416$; sampling error 4.8%). Of the 550 households in our original sample, 66 contacts were incorrect (e.g., resident deceased or moved), 20 refused to provide an interview, and we could not contact respondents at 48 households. Our sample aligned with 2000 census data in terms of sex (46% female) and ethnicity (90% non-Hispanic Whites, 6% Hispanic; U.S. Bureau of the Census 2001). Median annual family income was \$35,000–\$49,999, 7% of respondents had annual family incomes below \$15,000, and 90% were below \$100,000. Only 5% of the respondents had less than a high school education, and 40% held at least a 4-year college degree. Mean respondent age was 46.

Most (74%) respondents were immigrants. Immigrants were younger ($\bar{x} = 44.4$) than natives ($\bar{x} = 51.7$; $p < 0.001$). Immigrants had higher education levels than natives ($\chi^2 = 23.32$, df = 6, $p < 0.001$) and twice the percentage of college graduates (45% immigrant vs. 23% native). We identified majors for 65% ($n = 31$) of immigrants with advanced degrees, and 26% of them majored in environmental fields (e.g., ecology, forestry, wildlife biology, botany, zoology). Income distributions were not significantly different between immigrants and natives. Natives were more likely to be Republican (48%) than immigrants (30%; $\chi^2 = 11.04$, df = 1, $p = 0.001$). Immigrants and natives chose the location of their household for different reasons ($\chi^2 = 62.93$, df = 2, $p < 0.001$). Immigrants chose household location primarily on the basis of natural amenities and economic considerations (e.g., jobs, cost of living; Table 1). Few immigrants cited home

**Table 1. Primary reason for home location choices of natives and immigrants moving to natural areas, agricultural areas, and residential areas in Teton Valley.**

| | *Primary reason for household location (%)* | | |
|---|---|---|---|
| *Group* | *natural amenities* | *economic constraints* | *home place* |
| Natives | 34 | 16 | 56 |
| Natural-area immigrants | 72 | 14 | 14 |
| Agricultural-area immigrants | 58 | 23 | 19 |
| Residential-area immigrants | 47 | 39 | 14 |

or family as primary considerations in their household-location decision. Conversely, natives cited home or family as their primary consideration for household location nearly twice as often as natural amenities and rarely cited economic considerations (Table 1).

New ecological paradigm scores ranged from 23 to 75, with a mean of 51.74. Natives scored significantly lower ($\bar{x} = 45.5$) on the NEP scale than immigrants ($\bar{x} = 51.7$; $p < 0.001$). Immigrant groups moving to natural areas also chose the location of their household for different reasons than immigrants moving to other areas ($\chi^2 = 13.36$, df = 4, $p < 0.01$). Immigrants moving to natural areas chose their household location based on natural amenities more often than other immigrants (Table 1). Immigrants moving to residential areas were most likely to cite economic reasons. Few respondents from any immigrant group cited home or family as primary considerations in their household location decision (Table 1).

When considered simultaneously in a binary logistic regression, age (Wald = 13.42, $p < 0.001$), level of education (Wald = 8.15, $p = 0.004$), and environmental attitudes (Wald = 5.67, $p = 0.017$) predicted whether immigrants chose to live in natural areas, and neither income ($p = 0.078$) nor gender ($p = 0.62$) were significant (Table 2). The AUC values for age (0.61), education level (0.64), and NEP (0.61) corresponded to moderate effect sizes (McGraw & Wong 1992) for predicting household locations in natural areas (Table 2).

**Table 2. Logistic regression and area-under-the-curve (AUC) results for the model predicting whether respondents choose to locate their households in natural areas in Teton Valley of Idaho and Wyoming.**

| *Independent variables* | *Beta*[a] | *AUC* |
|---|---|---|
| New ecological paradigm score | 0.034** | 0.605 |
| Education level (1–7)[b] | 0.191** | 0.638 |
| Age | 0.026** | 0.610 |
| Gender (female, 1; male, 0) | 0.098 | 0.514 |
| Income (1–9)[c] | 0.089 | 0.577 |

[a] *Significance:* **p < 0.01.
[b] *Education ranged from 1, less than high school, to 7, graduate or professional degree.*
[c] *Annual household income ranged from 1, ≤ 14,999, to 9, ≥ 200,000.*

Immigrants moving to the 3 types of areas (residential, agricultural, and natural areas) had significantly different mean ages ($F = 15.53$, $p < 0.001$, $p < 0.05$ for all post hoc tests). Those moving to natural areas were the oldest ($n = 80$; $\bar{x} = 49.7$) followed by those moving to agricultural areas ($n = 159$; $\bar{x} = 44.8$) and those moving into residential areas ($n = 67$; $\bar{x} = 37.0$). Older immigrants preferentially chose houses in natural areas (Fig. 1).

Immigrants moving to natural areas had higher education levels than immigrants moving to agricultural or residential areas ($\chi^2 = 42.81$, df = 12, $p < 0.001$). Those with graduate or professional degrees moved to natural areas at twice the rate (29%) they moved to agricultural areas (15%) and 10 times the rate (3%) they moved to residential areas. This relationship was also pronounced at the college graduate level (natural area = 63%, agricultural area = 41%, residential area = 34%). Immigrants with at least some college education preferentially chose to live in natural areas, and immigrants with associate's degrees or less preferentially chose not to live in natural areas (Fig. 1).

Immigrants choosing to live in different areas had significantly different NEP scores ($F = 5.27$, $p = 0.006$). Immigrants moving to natural areas exhibited significantly higher NEP scores ($\bar{x} = 57.46$, $p < 0.05$, SE = 1.29, $n = 79$) than those moving to agricultural ($\bar{x} = 53.43$, SE = 0.91, $n = 160$) and residential areas ($\bar{x} = 51.59$, SE = 1.40, $n = 67$) which were not significantly different. Although the relationship between NEP percentile and household location appeared random at intermediate NEP levels, immigrants with lowest NEP scores moved to natural areas at half the availability rate and immigrants with highest NEP scores moved to natural areas at double the availability rate (Fig. 1).

Respondents with small households (1 and 2 persons) were almost 4 times as likely to live in natural areas as respondents with larger households ($\chi^2 = 16.63$, $p < 0.001$; Fig. 2). Years of residency in natural areas was negatively related to NEP ($r = -0.24$, $p < 0.05$), and controlling for age, education level, political affiliation, and income made little difference in this relationship (partial correlation = −0.22, $p = 0.052$). We observed a similar relationship in agricultural areas (partial correlation = −0.20, $p = 0.011$), but the relationship was insignificant in residential areas (partial correlation = −0.06, $p = 0.698$).

## Discussion

Measuring environmental behavior in terms of household location rather than recycling, watching nature-related television, or donating money to environmental organizations produced different results than previous studies

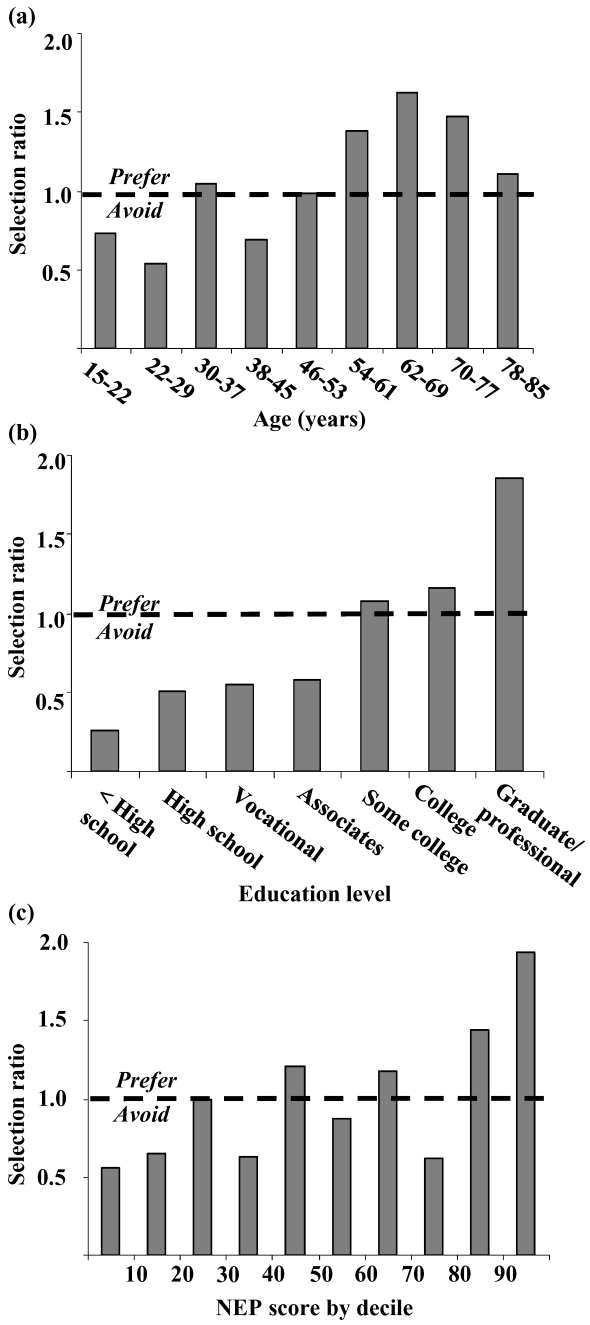


*Figure 1. Relationship between the weighted percentage of immigrants choosing to live in natural areas and (a) age (9 equal intervals); (b) education level; and (c) new ecological paradigm (NEP) score (reported in deciles; 9 values that divide scores into 10 equal parts).*

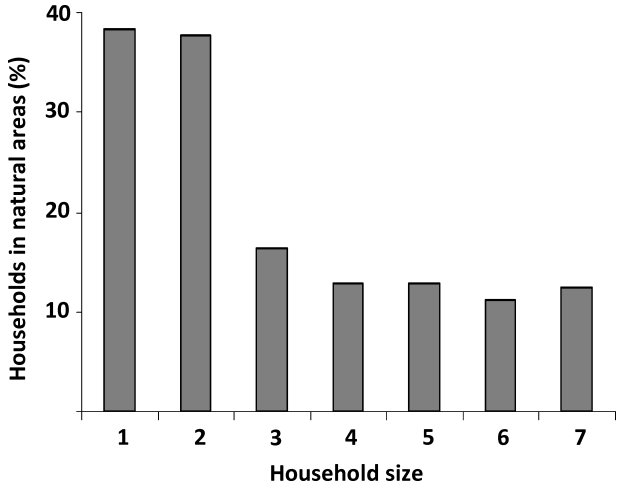


*Figure 2. Relationship between household size (average number of people per household) and the percentage of respondents choosing to live in natural areas.*

that showed either no relationship or a weak positive relationship between education level, environmentally oriented attitudes, and proenvironmental behavior (Dietz et al. 1998; Nord et al. 1998; Johnson et al. 2004). Household location, as an indicator of environmental behavior, yielded a negative relationship between age, education level, NEP, and proenvironmental behavior. Older highly educated immigrants with environmentally oriented attitudes chose to live in natural areas (e.g., riparian zones, wetlands, critical winter range for wildlife) in disproportionately high numbers, whereas immigrants with the lowest levels of education and least environmentally oriented attitudes chose to live in previously established residential areas in disproportionately high numbers.

In Teton Valley natural areas were the most difficult to develop owing to permitting, but older persons, those with higher education levels, and the most environmentally oriented immigrants still choose to live in them. For most of these respondents (72% of those living in natural areas), household location was an explicit choice motivated by natural amenities. Income did approach significance in our results and was significant if we did not control for education level. This suggests income may provide the means to choose a home in a natural area, but factors associated with a college education provide additional motivation for the choice.

Our results suggest a serious challenge for biodiversity conservation. Achieving socially and environmentally desirable goals (i.e., higher education levels, an aging population, and more environmental attitudes) may promote the household threat to natural areas. Moreover, each of these goals is being achieved. Expressions of environmentally oriented attitudes are becoming more prevalent (Dunlap & Michelson 2002), the rate of Americans achieving at least a bachelor's degree rose from 5% to 27% in the last 50 years (Stoops 2004), and the number of households of older persons will boom on global, continental, and national scales in the future (J.L. et al., unpublished data). The contribution of older individuals to household proliferation will be significant on all the aforementioned scales due to the increasing number of

older persons, the decreasing mean number of people in their households, and the increasing size of their homes (J.L. et al., unpublished data). Other contemporary demographic trends (e.g., increasing divorce rates) also reduce household size and increase the number of households (Yu & Liu 2007).

Although the negative relationship between NEP and time as a resident in natural areas was weak, it suggests living in natural areas does not necessarily promote more environmentally oriented attitudes. The decline in NEP associated with residency time may be explained by immigrants assimilating the local culture (Peterson & Liu 2008). These changing environmental attitudes pose a greater problem now than in the past because population in Teton Valley has nearly tripled since 1990, and the small household size of people choosing to live in natural areas leads to more houses per capita than in the past.

These findings carry particular importance for other regions where household proliferation associated with natural amenities threatens biodiversity (Hansen et al. 2005). Although the potential cases of this phenomenon are too numerous to list, housing development in rural areas with natural amenities threatens bird diversity in the Puget Sound region, Washington (Marzluff 2005; Robinson et al. 2005), fish species in the Northern Highland Lakes District, Wisconsin (Sass et al. 2006), Key deer (*O. virginianus clavium*) in Florida (Lopez et al. 2004; Peterson et al. 2004), biodiversity conservation in the Greater Yellowstone Ecosystem (Rasker & Hansen 2000), and panda (*Ailuropoda melanoleuca*) conservation in Wolong Nature Reserve, China (Liu et al. 1999, 2001).

Our results suggest that knowledge of natural or environmental science alone cannot address these conservation challenges. Many immigrants choosing to build homes in riparian areas or on hillsides held advanced degrees in related fields such as wildlife ecology, fisheries, zoology, and forestry. One biologist, a recent retiree from Idaho Fish and Game, pointed out this issue long before it was supported by survey results. He spoke loudly so his voice would carry over the nail guns that were tacking his new home together, saying: "the biggest problem is the loss of winter range (for mule deer and elk), and I've now become part of it because my wife won't live in town." These findings suggest even education rooted in systems principles (Berkowitz et al. 1999) may fail to address the conservation challenges associated with household location decisions. Systems-based education efforts that highlight connectivity, reciprocal effects and feedback, nonlinearity, and thresholds may make the complex effects of household location on biodiversity comprehendible (Berkowitz et al. 1999; Liu et al. 2007*a*, 2007*b*), but will not necessarily trump social pressure or other factors promoting engagement in environmentally damaging behavior.

## Conservation Implications

Our findings demonstrate the need for explicit consideration of household location decisions on resource use and biodiversity conservation, and development of ways to experience pristine environments besides building houses on them (e.g., conservation development; Pejchar et al. 2007). Linking household location decisions to environmental attitudes represents a critical step for biodiversity conservation. Environmentally conscious decisions about home appliances, food consumed, family planning, voting, donations, activism, and transportation alone will not protect biodiversity unless people make the environmentally conscious decision regarding their home. Moreover, framing biodiversity conservation in terms of household impacts promotes social justice (fair distribution of opportunity, costs, and rewards in society [Rawls 1993]), by shifting the burden of conservation from the backs of individuals with the lowest education levels and little income to individuals with the highest education levels and more personal wealth (Peterson et al. 2007). A household perspective for biodiversity conservation expects environmentalists with higher levels of education to sacrifice what they want (e.g., a home on a river, on a mountain side, or on fragile desert soils) before expecting the poor or individuals with lower levels of education to sacrifice what they need for basic living (e.g., heating, health care, college education for their children) in the name of biodiversity conservation.

This study highlights several critical questions for future research. First, how will population aging influence household location decisions and their ecological impacts? Preliminary research on the topic suggests modern retirement communities may have unusually large detrimental effects on the environment and biodiversity conservation (Stroud 1995). These effects, however, have yet to be quantified or projected into the future. Second, how can education efforts be modified to promote both environmental attitudes and a coherent relationship between those attitudes and household location decisions? Third, how can conservation biologists help create a positive relationship between environmental attitudes and environmentally sensitive household location decisions? Research rooted in conservation psychology (Clayton & Brook 2005; Saunders et al. 2006) could help answer why people might not link what may be their most important conservation-related behavior, choosing where they live, to their environmental attitudes.

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