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Original Article

Evaluating Relationships Between Hunting and Biodiversity Knowledge among Children

M. NILS PETERSON,[1] *Fisheries, Wildlife, and Conservation, Biology Program, Department of Forestry and Environmental Resources, North Carolina State University, Raleigh, NC 27695, USA*

TESSA CHESONIS, *Fisheries, Wildlife, and Conservation, Biology Program, Department of Forestry and Environmental Resources, North Carolina State University, Raleigh, NC 27695, USA*

KATHRYN T. STEVENSON, *Department of Parks, Recreation & Tourism Management, North Carolina State University, Raleigh, NC 27695, USA*

HOWARD D. BONDELL, *Department of Statistics, North Carolina State University, Raleigh, NC 27695, USA*

ABSTRACT We investigated how hunting participation and associated demographic variables relate to biodiversity knowledge among children. Past participation in hunting among elementary age children in North Carolina, USA, surveyed during 2014 was high (29%) and a positive predictor of student's ability to name native wildlife species after controlling for gender, ethnicity, and grade level. Minorities and girls had lower biodiversity knowledge scores and were less supportive of hunting. Our findings suggest children may view hunting differently than adults and that youth hunting programs, particularly those targeting very young children, may be fruitful ways to promote biodiversity knowledge. Such efforts, however, may be most valuable among minorities because Hispanic children had the lowest participation in hunting and Black children had both low participation rates and lowest biodiversity knowledge scores.

KEY WORDS biodiversity, children, education, ethnicity, gender, hunting, knowledge.

Over the past 3 decades, diverse groups have advocated immersing children in nature as a way to address problems ranging from attention deficit disorder and obesity to stress and poor performance in school (Chawla 2015). Many studies have investigated the benefits of nature, and suggest they start before birth because neonatal weight and survival are positively related to greenness around pregnant mothers' homes (Dzhambov et al. 2014). Children who spend more time in natural play areas or live near natural areas sleep longer, have lower blood pressure and lower stress levels, exhibit higher activity levels (which is linked to lower incidence of obesity), and may perform better on standardized tests (Wells and Evans 2003, Söderström et al. 2013, Gill 2014, Markevych et al. 2014, Wu et al. 2014). Further, some studies suggest nature-based activities may predict positive environmental attitudes and behaviors among adults, even if the effects are not immediately evident among adolescents (Chawla 1998, Wells and Lekies 2006, Stevenson et al. 2014*b*).

Despite the ballooning research in these domains, little to no research treats hunting as a focal nature-based activity, and very little focuses on biodiversity knowledge as an outcome of the nature-based activities. In Chawla's (2015) recent review, only 1 of the 25 benefits of time in nature was related to knowledge—learning about nature. Research within these domains typically focuses on affective questions such as emotional restoration and affiliation with nature. Further, this research often lumps many outdoor activities into groups. Wells and Lekies (2006) conducted one of the only studies that addressed hunting, but aggregated hunting and fishing as one activity and included it within a broader category labeled "experiences with wild nature as a child," which was positively related to pro-environmental attitudes among adults. In such cases recall bias may be compounded by treating hunting, fishing, and other wild nature activities as fungible.

We are unaware of research that has explored whether or how hunting relates to children's attitudes, behaviors, or knowledge. This represents an important gap in the literature because hunting may affect children differently than engagement in other outdoor activities, as it does among adults. Although some scholars assume children benefit from hunting in ways similar to how they benefit from other activities explored in recent research (e.g., Ryan and Shaw 2011), such assumptions may be unfounded based on insights from research focusing on adult hunters. Dunlap and Heffernan (1975) found that people participating in appreciative activities (e.g., birding or hiking) exhibited more environmental concern than people engaging in

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[1]*E-mail: nils_peterson@ncsu.edu*

consumptive activities including hunting. Since then, several studies have documented the same trend though with relatively weak effect sizes (Van Liere and Noe 1981, Peterson et al. 2008*a*). In a New York, USA, case study, Cooper et al. (2015) found that hunters and birdwatchers engaged more in policy advocacy and membership in environmental groups and clubs than did the general public, but these differences did not extend to more critical (Peterson et al. 2013, Chen et al. 2016) environmental behaviors of household energy and water conservation. Although these studies paint a mixed picture in regard to behavior and attitudes, questions about biodiversity knowledge, even among adults, remain unanswered.

Research addressing whether and how hunting relates to biodiversity knowledge among children, and how children perceive hunting, is critical for multiple reasons. First, the practice is surprisingly common: millions of children worldwide participate in hunting and 24% of children in the United States reported participating (Duda et al. 2003*b*). Therefore, learning how hunting may affect children, in any way, represents a valuable step toward understanding a culturally important practice. Second, knowing species exist is a logical precursor to having interest in the species and being willing to protect them. Leopold (1949:48) articulated this logic more eloquently, writing, "We grieve only for what we know. . .erasure of Silphium from western Dane County is no cause for grief if one knows it only as a name in a botany book." Further, knowledge may be a stronger predictor of behavior among children than among adults because ideological biases have stronger filtering impacts on adults (Stevenson et al. 2014*a*). Information about biodiversity knowledge among children would provide context for the few extant studies addressing the subject, which highlight troubling patterns. For example, Balmford et al. (2002) found that primary school children in the United Kingdom were better at listing Pokémon characters than native wildlife; Tanner (2010) found that biodiversity knowledge of fifth graders was skewed toward nonnative charismatic species with students able to list <4 native species on average. Third, intergenerational transfer of knowledge means what children know co-varies with what parents know at the household level (Zinn et al. 2002, Clark et al. 2017). Fourth, recruitment and retention of hunters with its attendant effects on wildlife management and conservation funding (Decker et al. 2001, Jacobson et al. 2010), depends largely on whether nontraditional groups (e.g., ethnic minorities, women) eventually engage in hunting (Floyd and Lee 2002, Schorr et al. 2014), and views of children provide a glimpse of how said groups may perceive hunting in the future.

Support for hunting has been addressed fairly extensively among adults (Duda and Young 1996, Bissell et al. 1998, Campbell and Mackay 2003, Duda and Jones 2009), but little research has explored the degree to which children support hunting or what factors predict such support (Duda et al. 2003*b*). Research among adults suggests support for hunting, in general, has remained steady between 70% and 80% for several decades, but such support declines rapidly to approximately 50% for sport hunting and 30% for trophy hunting (Duda and Jones 2009). Support is typically highest among less educated, rural, white males (MacKay and Campbell 2004, Duda and Jones 2009). Perhaps surprisingly, support for hunting appears lower among children (40% in grades 1–4) than among adults (Duda and Jones 2009). Hunter numbers declined in the 1980s and 1990s, with a large decrease from 14.1 million in 1990 to 12.5 million in 2006 (U.S. Fish and Wildlife Service 2007, Winkler and Warnke 2013).

We began addressing the need for research evaluating how hunting relates to biodiversity knowledge among children, and how children perceive hunting with a case study involving North Carolina, USA, elementary school children. We tested 3 hypotheses related to biodiversity knowledge: 1) children with hunting experience would list more native wildlife species than nonhunting children; 2) collectively children with hunting experience would list a more diverse suite of native species than nonhunting children; and 3) male children would list more native wildlife species than female children. Hypotheses 1 and 2 emerged from previous literature suggesting children that are surrounded by nature are more interested in the environment, and the logical extension that hunting is a form of nature-based recreation that may immerse people in nature more fully than many others (Dizard 2003, Wells and Lekies 2006, Sokos et al. 2014). Hypothesis 3 emerged from a long line of research suggesting males are better able to list wildlife species than females, perhaps as a result of gender socialization (Kellert and Berry 1987, Peterson et al. 2008*b*), with this trend emerging as early as age 4 (Huxham et al. 2006). Further, gender must be accounted for because it co-varies with hunting participation, with 80–90% of youth hunters being male (Duda et al. 2003*a*, *b*). We also account for ethnicity because previous research suggests strong environmental literacy differentials between White, Black, and Hispanic students in North Carolina (Stevenson et al. 2013). We tested 2 hypotheses related to support for hunting: 1) male children would support hunting more than female children; and 2) White children would support hunting more than non-White children. These hypotheses are rooted in previous research among adults finding ethnicity-related differences in support for hunting and gender socialization theory (MacKay and Campbell 2004, Huxham et al. 2006, Duda and Jones 2009). Gender socialization theory suggests peer groups and, to a lesser degree, parents teach children how to fill a gender role through norms for culturally appropriate ways of thinking and being, particularly those within sex-segregated peer groups (Harris 1995). Ethnographic research from many cultures suggests this socialization process treats hunting as a male activity (Condon and Stern 1993).

METHODS

We measured students' knowledge of wildlife species and native wildlife species using a simple survey that minimized time taken from class (Text S1, available online in

Supporting Information). First, wildlife was defined as "all animals that live in nature." Second, students were asked "What are your 5 favorite kinds of wild animals in the world? Please put them in order with your most favorite first. If you don't know the name of 5 animals, just list as many as you can." Third students were asked, "What are your 5 favorite kinds of wild animals that live in North Carolina? Remember put your most favorite first. If you don't know the name of 5 animals, just list as many as you can." We also asked students 4 additional questions: 1) Do you hunt?; 2) Do you think people should hunt?; 3) Are you a boy or a girl?; and 4) What is your race or ethnicity?

The final instrument was developed with pretesting among both 3rd and 5th grade students. We administered the first draft to 2 classes of 5th graders ($n = 32$). We asked them to circle questions that were hard to understand and describe how to make improvements. After making changes to several items, we administered a second draft to 2 classes of 3rd grade students ($n = 37$) and asked for written feedback. Finally, we completed cognitive interviews with 12 students to identify versions of questions that were easier to understand (Desimone and Le Floch 2004). One key concern was whether children interpreted hunting as attempting to kill wild animals. Throughout all pretesting and cognitive interviews, no students reported being confused by the meaning of "do you hunt" and no students provided alternative interpretations differing significantly from attempting to kill wild animals, usually with a gun.

For this study, we chose to focus on 3rd and 5th graders because they represent the earliest ages when outdoors experiences are linked to environmental knowledge and attitudes (Carrier et al. 2014). All research was reviewed and approved by the North Carolina State University Institutional Review Board for the Use of Human Subjects in Research (IRB #3793). We developed a stratified random sample of elementary school children across North Carolina by randomly selecting 60 schools from a list of all public schools with 3rd and or 5th grade classes, creating a list of all 3rd and 5th grade teachers, followed by randomly selecting 118 teachers and their classes for participation. Of these, 36 teachers responded (30.5% response rate), and 21 consented to participate (58.3% compliance rate). In March 2014, we visited 16 classrooms (we could not visit 5 because of scheduling conflicts) and surveyed 440 students. Researchers handed out the instrument (Text S1, available online in Supporting Information) and students filled it out in class.

We calculated a survey margin of error of 4.7% to facilitate interpretation of results given in percentages. This estimate was calculated based on a sample size of 440 and population size of 260,086 children 8 or 10 years old (typical ages for 3rd and 5th grade) in North Carolina (NC Office of State Budget and Management 2015 estimate; https://www.osbm.nc.gov/facts-figures/demographics; accessed 8 Jan 2016). We used binomial logistic regression models for each of 2 dependent variables: native wildlife listed and native wildlife listed minimally specific to the family classification. We did not model global species listed because nearly all students correctly named 5 potential species and there was too little variance in the variable to facilitate modeling. We created the native wildlife listed variable by counting the number of native species each respondent correctly listed out of 5 in their potential list of favorite species. Responses did not receive credit if they were mythical creatures (e.g., unicorn), domestic species (e.g., cow), or nonnative species with no free-ranging populations in the state (e.g., tiger [*Panthera tigris*]), but did receive credit if they were general names referring to groups of species (e.g., frog [Anura]). Coding for the native wildlife listed minimally specific to the family classification variable was similar with the exception that names for groups of species only received credit if they were considered specific at the family level of classification (e.g., treefrog [Hylidae]). Independent variables in these models included whether students had been hunting, gender, ethnicity, and grade. We did not analyze all minority groups separately in the logistic regression model because of sample size constraints for Asian ($n = 8$) students and limitations on statistical power imposed by dividing ethnicity into more categories. For the logistic regression model, we created a dummy variable for whether students were White or non-White. We provide descriptive statistics for Black, Hispanic, and Native American students where relevant. We did notice some confusion among students regarding the meaning of Native American, with some students believing the category reflected living in America, so these results should be interpreted with caution. We also included a random effect for school to account for the likelihood that responses to the knowledge question within a school were related by factors besides random chance (e.g., similar economic background or geographic attributes related to biodiversity knowledge).

We assessed species diversity among children's responses by counting the number of species listed by children who reported hunting and those who did not and adjusting the estimate for nonhunting children to account for sample size differences. Specifically, we randomly selected 124 respondents from the 300 nonhunting children and compared the number of species identified within that pool to the number identified by the 124 students who reported hunting. This adjustment was not used in regression models or descriptive statistics, and is directly analogous to standard species richness estimation using catch per unit effort approaches.

We used a logistic regression model for the nominal binary dependent variable reflecting whether students thought people should hunt, and included whether students hunted, gender, ethnicity, and grade as independent variables. We controlled for hunting participation to ensure the most important predictor of support for hunting, participation in the activity, did not generate spurious findings for gender and ethnicity, which have well-documented hunting participation biases (e.g., >90% of youth hunters reported being White; Duda et al. 2003*a*). This ensured gender and ethnicity effects were not spurious relationships created by gender or ethnicity biases in hunting participation. We used

Table 1. Predictors of students' opinion that people should hunt ($n = 410$) among primary school children (3rd and 5th grades) in North Carolina, USA, during 2014.

Variable	β	Odds ratio	SE β	*P*
Hunter[a]	1.223	3.397	0.153	<0.001
Ethnicity[b]	−0.294	0.745	0.119	0.01
Sex[c]	−0.264	0.768	0.118	0.03
Grade[d]	−0.610	0.543	0.248	0.01
Intercept	1.116	3.053	0.690	0.09

[a] Coded 0 = nonhunter, 1 = hunter.
[b] Coded 0 = White, 1 = non-White.
[c] Coded 0 = male, 1 = female.
[d] Coded 0 = 3rd, 1 = 5th.

t-tests to compare demographic attributes of our sample to those of the population.

RESULTS

We received 440 completed surveys. Respondents were primarily 5th graders (79%), female (53%), and White (46%), with fewer African American (21%), Hispanic (10%), and Native American (10%) students. Many students had hunted (29%), but more male students (38%) had hunted than female students (22%). White students reported having hunted more often (42%) than Native American (30%), Black (18%), or Hispanic (9%) students. Nearly half of the students thought people should hunt (47%). These percentages reflect an oversampling of non-White students (state measure 48.1% non-White) and particularly Native American students (state measure is 1.4%; Aud et al. 2012). Similarly, we oversampled females (state: 46.8%, sample: 52.7%, $t_2 = 2.39$, $P = 0.017$) and students attending rural schools (state: 54.9%, samples: 77.8%, $t_2 = -16.38$, $P < 0.001$). There was not a difference between the percent of students who had hunted in urban versus rural areas (urban: 26.5% hunters; rural: 30.0% hunters; $t_2 = 0.93$, $P = 0.35$).

As one might expect, hunting participation was by far the most important predictor of believing people should hunt, but male gender and White ethnicity were significant positive predictors, confirming our hypotheses and conforming to previous findings among adults (Table 1). Students who had hunted had >3 times greater odds of thinking people should hunt than other students. Conversely, females had 0.75 the odds of thinking people should hunt as males (Table 1). Only 38% of females thought people should hunt, whereas 57% of male students did. A slightly larger split in support was evident among White (60%) and non-White (36%) students. Support for hunting was lower among Hispanic students (21%) than among Black students (47%), and Native American students (27%). Although these differences are larger than our margin of error (4.7%), they should be interpreted with caution because of some confusion among children regarding the meaning of Native American. Grade was negatively related to believing people should hunt, with 5th graders having half the odds of thinking people should hunt of 3rd graders (Table 1).

The proportion correct for global wildlife listed was high (89%), as it was for specific global wildlife listed (87%). The proportion correct was lower for native wildlife species ($\bar{x} = 65\%$) and specific native wildlife species (60%). We found support for each of our hypotheses regarding probability of correctly listing native species; hunting participation and male gender were positive significant predictors (Table 2). Hunters correctly identified a greater proportion of native species than nonhunters (73% vs. 63%; Table 2) and male students had a greater proportion correct than female students (66% vs. 57%; Table 2). Similarly, White students correctly identified a greater proportion of native species than non-White students (71% vs. 61%; Table 2); Hispanic (64%) and Native American (65%) students had greater proportion correct than Black students (55%). Results were the same for the wildlife listed minimally specific to the family level, although ethnicity became marginally significant (Table 2).

Our results did not support the hypothesis that children who hunted would list a more diverse suite of native species than nonhunting children. In fact, the number of species identified by students overall and for native species was remarkably similar after adjusting for sample size. Cumulatively, children who hunted ($n = 124$) identified 106 species, 72 of which were actually native wildlife species in North Carolina. The randomly selected subsample of nonhunting children ($n = 124$) identified 108 species, 71 of which were native wildlife species in North Carolina. In total, children who did not hunt ($n = 300$) identified 147

Table 2. Predictors of proportion of 5 native wildlife species correct, and specific native wildlife species correct, among students ($n = 408$) in North Carolina, USA, primary schools (3rd and 5th grades) during 2014.

	Native species				Specific native species			
Variable	β	Odds ratio	SE β	*P*	β	Odds ratio	SE β	*P*
Hunter[a]	0.241	1.272	0.119	0.04	0.277	1.319	0.115	0.02
Ethnicity[b]	−0.247	0.781	0.117	0.04	−0.199	0.820	0.113	0.08
Sex[c]	−0.365	0.694	0.100	<0.001	−0.308	0.735	0.097	0.002
Grade[d]	0.208	1.231	0.233	0.37	0.184	1.202	0.223	0.41
Intercept	0.362	1.436	0.608	0.56	0.133	1.142	0.585	0.82

[a] Coded 0 = nonhunter, 1 = hunter.
[b] Coded 0 = White, 1 = non-White.
[c] Coded 0 = male, 1 = female.
[d] Coded 0 = 3rd, 1 = 5th.

species, 92 of which were native wildlife species in North Carolina. As one might expect given our regression results, children who hunted not only listed more native species per child, they listed each native species more often than children who did not hunt. Species where this trend produced differences outside our margin of error were: deer (*Odocoileus virginianus*; hunter = 56%, nonhunter = 39%), snakes (Colubridae, Viperidae, Elapidae; hunter = 35%, nonhunter = 27%), bears (*Ursus americanus*; hunter = 33%, nonhunter = 27%), foxes (*Urocyon cinereoargenteus*, *Vulpes vulpes*; hunter = 29%, nonhunter = 20%), fish (Osteichthyes; hunter = 16%, nonhunter = 11%), and squirrels (*Glaucomys* spp., *Sciurus* spp.; hunter = 15%, nonhunter = 10%). Rabbits (*Sylvilagus* spp.) were the only native species mentioned at a greater rate by nonhunting children (14%) than children who hunted (8%). When all wildlife species were considered, versus native species, nonhunting students were more likely to list predatory cats (lion [*Panthera leo;* hunter = 36%, nonhunter = 46%], tiger [*P. tigris;* hunter = 36%, nonhunter = 43%], cheetah [*Acinonyx jubatus;* hunter = 20%, nonhunter = 26%]) and bears (Ursidae; hunter = 26%, nonhunter = 31%), and less likely to list deer (hunter = 27%, nonhunter = 15%), wolves (*Canis lupus*; hunter = 31%, nonhunter = 18%), and monkeys (Simiformes; hunter = 25%, nonhunter = 19%).

DISCUSSION

Our findings suggest childhood hunting may have a critical role to play in both the lives of children and how children learn about biodiversity. First, when hunting was defined by children, nearly a third believed they participated in some way. Our estimate is slightly greater than the one previously reported in the literature (24%; Duda et al. 2003*b*), though that estimate was unusually high relative to estimates for adults that are often reported around 4% (U.S. Department of the Interior and U.S. Department of Commerce 2007, 2012). Self-reported estimates among children, however, likely include far more than actually purchase licenses (the metric typically used for measuring adult participation). Children may have a broader interpretation of what constitutes hunting than adults and include informal and unsanctioned forms of hunting such as shooting at birds with pellet guns. Future research could explore both the prevalence of such activities and how they may differ from formal government-sanctioned and adult-supervised forms of hunting. Our finding that the gender divide in hunting participation is much lower among children than adults may bode well for the future role of hunting in promoting biodiversity knowledge among children, although some research suggests female children are more likely to stop outdoor activities during their teenage years and be recruited into hunting at later ages than male children (Archer and McDonald 1990, Rodriguez et al. 2016). Conversely, hunting participation and support for hunting was extremely low among Hispanic children, the fastest growing demographic group in North America, suggesting hunting may do less to promote biodiversity knowledge among children in the future unless the wildlife managers coordinating game management begin to specifically target outreach efforts to Hispanics (Lopez and Brown 2011).

Given the unexpectedly high prevalence of hunting among children, it was exciting to find hunting experience predicted biodiversity knowledge among children. This implies child-focused hunting programs may provide one avenue to promote biodiversity conservation. Although knowing species exist is only a first step toward biodiversity conservation, it is a logically necessary one. Our findings regarding the relationships between gender and ethnicity and biodiversity knowledge fit those established among adults (Peterson et al. 2008*b*), and general trends reported for environmental knowledge among children where females and many minority groups lag behind their counterparts (Stevenson et al. 2013). However, the ethnicity gap in this study was driven primarily by low scores among Black students, with Hispanic students scoring similarly to White students. Thus, the persistent and troubling isolation from nature identified for African Americans may expand to biodiversity knowledge among children (Floyd and Johnson 2002, Van Velsor and Nilon 2006, Peterson et al. 2012). Although our methods do not allow us to explicitly extricate ethnicity from socioeconomic status, a common shortcoming within studies on ethnicity and recreation (Floyd 1998), the large differences between Black and Hispanic students suggest cultural dynamics at play beyond family income and income-associated opportunities to interact with wildlife.

Although we did not intend to explore the role of rhetoric on children's assessments of hunting, our findings shed light on the subject. Previous research suggests the way hunting is framed in terms of hunter motivations, its purpose, and imagery associated with it has profound effects on adult perceptions of the activity and support for it (Campbell and Mackay 2009). Similarly, in our study, when children were asked if "people should hunt" only about half responded affirmatively, but >90% responded affirmatively when asked if it was "okay for a boy/girl to hunt" in a previous study (Duda et al. 2003*b*). Although children's opinions may have changed over the 10 years between these studies, virtually all other attitudes and participation rates assessed over time have remained stable, suggesting the rhetorical differences elicited profound differences among children.

Future research can address several limitations of this study. First, qualitative research could further elucidate how children understand the concept of hunting. Although our pretesting suggested most children interpreted hunting as attempting to kill wild animals, usually with a gun, there are many variations of this activity, some of which may be illegal (e.g., attempting to kill small birds typically protected by the Migratory Bird Treaty Act). Indeed, some children may interpret attempts to capture insects and herpetofauna as hunting. Children's understanding of the term 'Native American' presents another potential weakness of this study, which may merit changes in future research. Although confusion about the term did not emerge in pretesting, several respondents in the main survey indicated they

considered being born in the United States as being equivalent to being Native American. Future research that allows respondents to specify whether they were adopting this born in the United States interpretation would ensure more valid findings related to actual Native Americans. Perhaps more than anything, our results highlight the need for future research exploring the relationships between immersive wild nature activities and the biodiversity knowledge, attitudes, opinions, behaviors, and well-being of children. This domain may play an important role in the lives of children and hold keys to the future of biodiversity conservation.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article at the publisher's web-site. A copy of the questionnaire is provided in this material (Text S1).