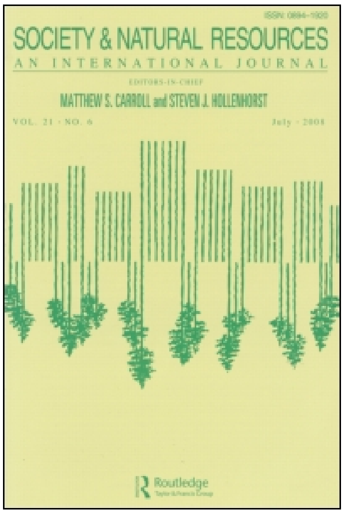

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Research Note

A Survey of Ungulates by Students Along Rural School Bus Routes

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*We tested the reliability and utility of students, Grades 1–8, to count mule deer (*Odocoileus hemionus*) and elk (*Cervus elephus*) along rural school bus routes in Kittitas County, Washington, from 2003 to 2004 as part of an investigation on wildlife response to rural development. Student and supervisor counts of deer and elk were similar ($\alpha = .05$). Student involvement was sustained by the presence of the supervisor and by providing a three-tiered incentives package to encourage participation. Our results demonstrate that students provide an opportunity for cost-effective long-term monitoring of changes in ungulate distribution along public transit routes. Beside providing information needed by wildlife managers, students and the community can benefit by increasing their ecological literacy and community participation.*

Keywords *Cervus elephus*, citizen science, deer, elk, *Odocoileus hemionus*, student science, wildlife monitoring

Managers often lack adequate data with which to manage wildlife. Lay citizens and public school students may provide a cost-effective means for data collection (e.g., Brown et al. 2001; Dvornich et al. 1995; Newman et al. 2003; Rock and Lauten 1996) while providing opportunities for public outreach and education (Galloway et al. 2006). Here, we describe a survey of two common prey species

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of cougar (*Puma concolor*), mule deer (*Odocoileus hemionus*) and elk (*Cervus elephus*), conducted by students riding rural school bus routes. This project is part of a partnership between the Washington Department of Fish and Wildlife and the Cle Elum–Roslyn School District to study cougar response to development in rural Kittitas County, Washington. Rural school bus routes traverse low-elevation habitats where deer and elk live during winter and present opportunities for students who ride buses to document the presence of wildlife over time along a fixed survey area. Our objectives were (1) to test whether counts by students along rural bus routes can provide reliable data for monitoring ungulate distribution and abundance and (2) to identify factors that influence student participation and data reliability.

Methods

We conducted a 7-week pilot study between April and June 2003 (year 1) to develop and test the survey methodology. All students in Grades 1–12 who rode buses along six rural routes attended an interactive training exercise. We instructed students to watch for and count deer, elk, and domestic livestock and to record observations on data forms during the trip to school in one morning trip per week. For each observation, students recorded the species, number of animals in the group, and the time from a large digital clock at the front of the bus. The senior author (supervisor) accompanied students on busses and collected independent counts to assess the reliability of student data and consistency of bus schedules.

Following the pilot year, we conducted a 17-week survey from November 2003 to April 2004 (year 2), in which we made three changes to the year 1 study protocol. First, students managed their own forms, whereas in year 1 bus drivers distributed and collected data forms. Second, only students in Grades 1–8 were included due to a lack of interest from older students in year 1. Third, we provided incentives to encourage sustained student participation using a three-tiered reward plan because we observed a decline in participation after 3 weeks in year 1. Students who participated for at least 3 weeks earned wildlife key chains, safety whistles, and stickers, while students participating for at least 5 weeks earned a lunch party and were entered into a lottery for a day-long field trip to a local zoo, and students participating for more than 10 weeks earned wildlife shirts, jackets, and hats.

We used the nonparametric Mann–Whitney *U* test to compare student participation between routes with and without the supervisor's presence and used chi-square (χ^2) tests to compare the proportions of participants by gender and grade between years. To evaluate validity of student collected data we grouped students into Grades 1–2, 3–5, and 6–8 and pooled counts of deer and elk as "ungulates." Because records were associated with specific times, we used the paired-sample Wilcoxon *T* test to compare individual student and supervisor ungulate counts during specific time intervals. To evaluate ungulate presence/absence we compared this binary value for a given survey between the supervisor and all students collectively. We conducted analysis using SPSS 16.0 and used nondirectional hypothesis tests with $\alpha = .05$. We report means ($\pm$ standard errors) and Z scores for results where the normal approximation is applicable.

Results

Along the 6 bus routes, 102 of 360 (28.3%) students participated in the survey. Student ridership declined by fewer than five students in year 2. Student participation per survey when the supervisor was present increased from means of 3.8 ($\pm$0.62) to 8.9 ($\pm$1.50) in year 1 ($U_{23,11} = 212.50$, $P < .01$) and from 3.4 ($\pm$0.27) to 6.8 ($\pm$1.17) riders in year 2 ($U_{79,15} = 908.00$, $P < .01$). In year 1, total participation for the 6 routes without supervisor presence declined in the first 3 weeks from a mean of 21.7 ($\pm$6.49) to 7.3 ($\pm$0.67) during the last 3 weeks of the survey. This is in contrast to year 2, when the mean weekly student participation for all routes was 15.7 ($\pm$1.53). Student participation by gender differed between years ($\chi^2_1 = 8.56$, $P < .001$). Males and females submitted 55.9% and 44.1% of surveys in year 1, and 42.1% and 57.9% of surveys, respectively, in year 2. Student participation by grade varied for both years (year 1: $\chi^2_7 = 37.34$, $P < .01$; year 2: $\chi^2_7 = 119.12$, $P < .01$), with the highest and lowest participation in Grades 3 (25.2%) and 8 (5.0%), respectively. We observed no differences in paired counts (Grades 1–2: $Z_{21} = -0.175$, $P = .861$; Grades 3–5: $Z_{25} = -1.287$, $P = .198$; Grades 6–8: $Z_{13} = -1.346$, $P = .178$) for 59 ungulate counts on 12 surveys where ungulates were observed by students or the supervisor. The supervisor and students reported ungulate presence/absence consistently for 22 of 23 surveys. Eighty-three percent of ungulate observations occurred on only two of the six routes.

Discussion

Although we observed an apparent trend by students in Grades 1–2 and 3–5 to "overcount" and Grades 6–8 to "undercount" ungulates compared to the supervisor, these differences were not significant. Students and the supervisor reported the presence/absence of ungulates consistently for 95.7% of surveys for which the supervisor was present, demonstrating the potential of this technique for effectively monitoring ungulate presence/absence. Incentives helped to sustain student participation in year 2 even as students had the additional responsibility of managing their own data forms. The relative increase in participation in year 2 by females may indicate that the incentives were more effective at motivating females than males. Limited sample sizes precluded our analysis of ungulate counts by gender.

Wildlife indices must be evaluated with caution (e.g., Anderson 2003), as they depend on observer skill (Sauer et al. 1994) and temporal consistency of survey effort (Robinson et al. 2000), as demonstrated in this study. Despite these limitations, we believe this approach has utility for long-term monitoring of ungulate presence–absence. Furthermore, there is a precedent for the use of rural mail carriers for surveys of relative wildlife abundance (e.g., Allen and Sargeant 1975; Applegate and Williams 1998). While we made no attempt to utilize distance sampling (Buckland et al. 1993), this technique could be a powerful tool for increasing accuracy and precision of wildlife surveys along public transportation routes if volunteer or student observers could be trained to measure or estimate distance accurately.

Student participation in science can help students achieve essential academic learning requirements, help to build capacity and ecological literacy, and provide social skills in decision making and civic involvement (Tudor and Dvornich 2001). Our example of using rural school bus routes to monitor ungulates may be adapted to other uses along public transportation routes, including busses, ferries, and trains, to monitor terrestrial and marine environments (e.g., Keple 2002), and may provide a framework to evaluate social interaction of the public and resource managers and human perception of natural resources.

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