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Research Article

The Montana Deer and Elk Hunting Population: The Importance of Cohort Group, License Price, and Population Demographics on Hunter Retention, Recruitment, and Population Change

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ABSTRACT Big-game hunting is a valuable resource for outdoor recreation opportunities, an economic driver for state and local economies, and the primary mechanism for funding game and non-game wildlife management. However, hunting license sales are declining, leading many state wildlife management agencies to re-evaluate funding and management structures. Understanding the mechanisms behind such declines, and diagnosing the persistence of such trends is necessary to anticipate license fund fluctuations. To examine hunter recruitment and retention rates, we analyzed a data set of >490,000 deer and elk license records from 2002 to 2011 from the Montana Fish, Wildlife and Parks' Automated Licensing System. We used a temporal symmetry model in a mark–recapture framework to estimate hunter retention, recruitment rates, and population change, and then used population change estimates to forecast future hunter populations. We used covariates of gender, age, residency, and license price to improve model parsimony. Millennial generation hunters increased during the 11-year analysis, and this was driven by high recruitment rates of young hunters, especially women, but recruitment decreased dramatically as youth aged. Because Baby Boomers constitute such a large proportion of the hunting population, decreases in recruitment and retention in this cohort drove declines in the Montana hunter population. Increasing license price decreased the probability of recruiting and retaining hunters. The hunter population was stable until 2006, but has been declining since that time with nearly a 50% decline in hunter recruitment from 2002 to 2011. © 2014 The Wildlife Society.

KEY WORDS Baby Boomers, deer, elk, hunter recruitment, hunter retention, license price, license purchase probability, mark–recapture, Montana, Pradel model.

Hunting and the economic and cultural benefits that come from it have been an integral part of the North American model for wildlife management since the early 1900s (Decker et al. 2009). For many U.S. citizens, hunting is the primary draw to participate in outdoor recreation (Cordell et al. 2002) and it allows participants to identify a personal linkage of human reliance on natural environments (Peterson et al. 2010). Hunting provides historical expression of tradition and culture (Brown et al. 1995) and provides broad economic benefit to local businesses and communities (Sarker and Surry 1998, U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau 2006). Additionally, hunting is a major mechanism for managing wildlife populations (Brown et al. 2000, Riley et al. 2003, Campbell and Mackay 2009) and the predominant source of funding for wildlife conservation (Peterson 2004, Geist 2006, Williams 2010). Big-game hunting, especially of deer (*Odocoileus hemionus*, *O. virginanus*) and elk (*Cervus elaphus*), accounts for the overwhelming majority of hunting activity and expenditures in the United States (U.S. Department of Interior, U.S. Fish and Wildlife Service and U.S. Department of Commerce, U.S. Census Bureau 2006). Despite these benefits, the North American model for wildlife conservation is dependent upon public participation, and participation rate in hunting activities has declined since 1984 (Winkler and Warnke 2013). This dependence, and the reality of reduced funding revenue for wildlife conservation, has led wildlife professionals to propose alternate strategies for funding wildlife

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management (Manfredo and Zinn 1996; Jacobson et al. 2007, 2010). Even with recent increases in hunter participation rate (9% since 2006; U.S. Fish and Wildlife Service 2011*a*), wildlife agencies are investigating how to anticipate fluctuations in hunter populations, and how such fluctuations will affect wildlife management capacity and decision-making (Riley et al. 2003, Zinn 2003).

In Montana, hunting participation rates typically are some of the highest in the United States (U.S. Department of Interior, U.S. Fish and Wildlife Service and U.S. Department of Commerce, U.S. Census Bureau 2006), with much of the activity focused on big-game hunting (Eliason 2008, Montana Department of Fish, Wildlife, and Parks 2011). Deer and elk hunting provides approximately $50 million annually to wildlife conservation efforts by the state of Montana, providing >60% of the state's conservation agency revenue (Gude et al. 2012). Thus, decreases in hunter participation may have dramatic ramifications to the economy and wildlife management of Montana. The Montana Department of Fish, Wildlife and Parks (MFWP) has investigated trends in hunter recruitment and retention rates in hopes of proactively encouraging hunting interest from specific segments of the population (Gude et al. 2012). Gude et al. (2012) found that resident deer and elk license sales increased by 4% from 2002 to 2007, and that recruitment and retention of older male hunters would dramatically improve hunter participation.

The purpose of this study is to understand trends in hunter behavior and allow wildlife management agencies to plan for future changes in license sales and revenue. This information can be used for modifying ungulate population management and harvest strategies. This analysis extends the work conducted by Gude et al. (2012) but includes non-resident hunters, license price, and cohort effects. We clarify how changes in recruitment and retention affect annual hunter participation, investigate how hunter age and hunter cohort influence recruitment and retention, show how changes in license price affect recruitment and retention, and forecast future hunter population sizes. Understanding how such factors influence retention and recruitment is essential information for wildlife management agencies. The novel use of mark–recapture techniques for understanding hunter population dynamics is a valuable approach for agencies that analyze hunter recruitment and retention from electronic license data.

METHODS

In Montana, resident hunters aged 12 and older can acquire 1 or more licenses to harvest elk or deer. Individuals can purchase licenses over-the-counter or by applying to a limited-entry (drawing) pool. Licenses are valid across a wide geographic area or can be specific to a spatial area, species, age-class, and sex (Gude et al. 2012). The number of resident big-game hunting licenses is unlimited, but the number of non-resident big-game hunting licenses is controlled by state law. Hunters can apply for antlerless licenses. Antlerless licenses are issued to limit the size and growth of ungulate populations in Montana, and are liberalized when populations are robust. In 2002, MFWP developed the Automated Licensing System (ALS) that allows computer-based hunter license tracking using a unique hunter identification number. Prior to 2002, hunter license records were collected and managed as a paper-based system, then entered into an electronic database, increasing the likelihood of commission and omission errors.

Hunter Recruitment and Retention

We collected 10 years (2002–2011) of elk and deer hunter license records from the ALS to be analyzed in a mark–recapture framework. Because hunters must register through the ALS, and are assigned a unique identifier, we treated registered hunters as marked individuals within the Montana hunting population. Observation of hunters via license purchase is analogous to a mark–recapture problem where individuals are partially observed over time. The mark–recapture model uses license purchase history of each hunter to inform the probability that the hunter will recruit into the population, remain in the population, or leave the population. Similar to analysis of wildlife populations, we assigned individuals a 1 when purchasing a license (capture) and a 0 when they did not purchase a license for a particular year. Alternate techniques for exploring cohort and age impacts have used the intrinsic estimator with an age-period-cohort accounting approach (Winkler and Warnke 2013). The advantage of the mark–recapture approach is that it allows designation of cohort to groups of years, which allows parameters to be identifiable. The use of mark–recapture analysis does not rely on general characteristics of license sales totals but tracks license holders through time, using the characteristics that are unique to each individual license purchaser. We randomly selected 50,000 individuals from the dataset of 490,484 elk and deer hunters in the ALS. Analyzing the entire dataset of nearly 500,000 individuals was computationally exhausting and unnecessary because sample sizes of 50,000 individuals produced small estimates of variance around parameters.

We used a Pradel model, which is a temporal symmetry population model that uses a time-forward model to estimate apparent survival (φ), which is equivalent to hunter retention in this exercise, and a reverse-time model to estimate recruitment (f), which is equivalent to hunter recruitment (Pradel 1996). Hunter recruitment is when a person first buys a hunting license for elk or deer hunting. The Pradel model allows estimation of φ, f, and capture probability (p). Capture probability in this exercise is the probability of purchasing a license conditional on the individual remaining a hunter. We analyzed the mark–recapture data in Program MARK (White and Burnham 1999, Franklin 2001) and compared parsimony of models based on Akaike's Information Criterion with small sample size bias correction (AIC_c) and model weight (w_i; Burnham and Anderson 2002).

We incorporated individual covariates of gender, age, and birth cohort to improve estimates of hunter retention and recruitment. Also, we included individual covariates of age squared (age^2) and age to the third power (age^3) to investigate nonlinear responses of hunter recruitment and retention to age. We incorporated cohort effects because an individual's cohort can play a role in long-term social views, and these views can affect the likelihood of an individual becoming involved in hunting (Winkler and Warnke 2013). We included Traditionalists (born 1900–1945), Baby Boomers (born 1946–1964), Generation Xers (born 1965–1980), and Millennials (born 1981–2000; Lancaster and Stillman 2002). We were able to use age and cohort covariates because an individual's cohort was a categorical covariate based on birth year and did not change throughout the study. Cohorts include more than one age class covariate, making both cohort and age class covariates estimable. We modeled recruitment and retention temporally, allowing time-specific (yearly) estimates. Additionally, we included year-specific covariates of the number of deer and elk antlerless licenses sold. Antlerless licenses are used to index the amount of hunting opportunity and, correspondingly, the status of deer and elk populations in general. Antlerless licenses are issued to limit the size and growth of wildlife populations in Montana, such that antlerless hunting opportunity is liberalized when populations are robust. Finally, we used covariates of resident and non-resident license price to determine how license price affects hunter retention and recruitment.

We modeled capture probability (license purchase probability) as fully time-dependent for all models, meaning that we let this parameter vary annually and did not constrain it using covariates. We did not constrain p because a mathematical relationship exists between p, φ, and f, and forcing all parameters to be modeled using covariates would cause estimation problems. We model-averaged estimates of parameters and their variances to incorporate model selection uncertainty (Burnham and Anderson 2002). We estimated variances of the overall lambda, recruitment, and retention estimates using the delta method (Williams et al. 2001).

Hunter Population Changes

We assessed hunter population changes using estimates of hunter retention and recruitment to calculate population growth (λ), and estimated the proportional contribution parameter (γ) to assess the influence retention and recruitment have on hunter population growth. Lambda is the annual rate of population change, with values <1 indicating a declining population and values >1 indicating an increasing population. The proportional contribution parameter is a metric that illustrates whether φ or f influences the population growth rate more, and is defined as the ratio of φ to λ (Nichols and Hines 2002). The assumptions of the Pradel model for our exercise of assessing hunter population growth are 1) the study area does not change in size or boundary; 2) individuals experience no behavioral response to capture, or electronic application, in this case; and 3) there is little heterogeneity in captures among years (Nichols and Hines 2002). Our study area did not change in size or boundary, the Pradel model is relatively robust to capture heterogeneity, and violations of the second assumption produce little bias in single estimates of long-term λ, but can create bias in time-specific estimates of λ (Nichols and Hines 2002). The advantages of estimating λ using mark–recapture methods are that sampling variation can be incorporated into the estimation process, individual-specific covariates can be incorporated to refine models and parameter estimates, and the decomposition of sampling and process variation accurately depicts true population trend (Franklin 2001, White et al. 2002). The proportional contribution parameter is analogous to elasticity analyses for matrix population models (Gude et al. 2012), but γ is time-interval specific and allows better understanding of temporal dynamics of hunter retention and recruitment influences on λ (Nichols and Hines 2002). We projected future hunter populations by using individuals from the 2011 Montana hunting population, coupled with age-specific lambda estimates from the most parsimonious model of recruitment and retention.

RESULTS

Big-Game License Sales 2002–2011

In 2002, 187,691 resident and non-resident hunters purchased at least 1 elk or deer license in the state of Montana. The number of hunters peaked in 2008 with 202,584 individuals purchasing at least 1 deer or elk license, but by 2011, the number of hunters dropped to 191,974 individuals. The mean annual number of resident and non-resident hunters was 163,334 ($\pm$3,783 SD) and 32,881 ($\pm$1,254 SD), respectively. The greatest number of hunters was age 43–59 each year, which increased in the population until 2010. Most other age cohorts, except age 60+ declined each year (Fig. 1). Total antlerless elk and deer licenses sold in 2002 was 81,746, but this number increased to 139,338 by 2008, and declined to 93,821 by 2011. The ratio of males to females in the hunter population was 4.8:1.

Models of Hunter Retention and Recruitment

We developed 336 models to evaluate hunter recruitment and retention in Program MARK. Models did not vary in how capture probability (license purchase probability) was modeled. Capture probability steadily declined from 2002 (0.874 ± 0.004 SE) to 2006 (0.740 ± 0.003 SE), then increased until 2012 (0.864 ± 0.004 SE). Nonlinear age effects (age^2, age^3) had no impact on model parsimony, but the best models included covariates of residency, gender, age, and yearly license price for recruitment and retention. The most parsimonious model incorporated all age cohorts to model hunter recruitment, but only Baby Boomer and Millennial birth cohorts in retention. The next most supported model used all age cohort covariates for retention and recruitment (Table 1). The only other model with any AIC$_c$ weight used Baby Boomers and Generation Xers to explain retention and all age cohorts to explain hunter recruitment (Table 1). The amount of antlerless hunting opportunity was not useful as a predictor of recruitment or retention in any of the well-supported models.

Based on the most parsimonious model, being a resident decreased hunter recruitment compared to non-residents

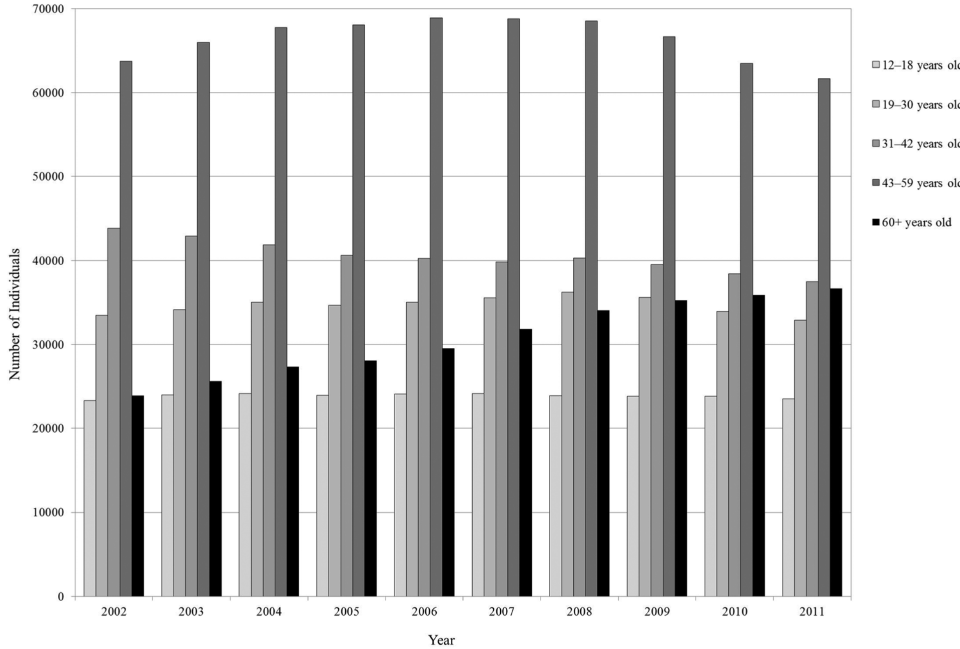

Figure 1. Number of individuals from age groups in the Montana deer and elk hunter population, 2002–2011.

(logit-scale $\beta = -1.21 \pm 0.15$ SE, henceforth all β will be on the logit scale) and increased hunter retention compared to non-residents ($\beta = 0.29 \pm 0.14$ SE). Being a male hunter increased the probability of hunter retention ($\beta = 0.84 \pm 0.02$ SE) compared to females, but women had a greater probability of being recruited into the hunting population ($\beta = 0.62 \pm 0.02$ SE). Within a birth cohort, as age of the hunter increased, the probability of remaining a hunter decreased slightly ($\beta = -0.0015 \pm 0.0006$ SE) and being recruited into the population decreased ($\beta = -0.052 \pm 0.001$ SE). Resident license price had a negative impact on hunter retention and recruitment ($\beta = -0.070 \pm 0.005$ SE, $\beta = -0.063 \pm 0.005$ SE, respectively). The probability of becoming a hunter for a 30-year-old male resident dropped from 0.09 to 0.07 as deer license price increased from \$16 to \$20. The probability of remaining a hunter for a 30-year-old male resident decreased from 0.94 to 0.92 as deer license price increased from \$16 to \$20. Non-resident hunters showed decreased retention and recruitment rates with increasing license price ($\beta = -0.0042 \pm 0.0002$ SE, $\beta = -0.0014 \pm 0.0002$ SE, respectively). For a 30-year-old male non-resident hunter, when the deer license price increased from \$578 to \$794 (as it did from 2010 to 2011), the probability of remaining a hunter decreased from 0.74 to 0.53, whereas the probability of becoming a hunter decreased from 0.28 to 0.22.

Compared to Generation Xers and Traditionalists, being a member of the Baby Boomer generation had a positive impact on retention ($\beta = 0.21 \pm 0.02$ SE), whereas being in the Millennial generation decreased retention ($\beta = -0.23 \pm 0.02$ SE). For recruitment, the Traditionalist generation recruitment probability decreased at a lower rate than Baby Boomers ($\beta = 0.79 \pm 0.03$ SE). Compared to Baby Boomers, being a member of Generation X or the Millennial generation decreased the probability of being recruited into the hunting population more precipitously ($\beta = -0.55 \pm 0.02$ SE, $\beta = -0.75 \pm 0.04$ SE, respectively).

Baby Boomers showed the highest hunter retention rates, whereas Millennials typically showed the lowest retention rates (Table 2, Figs. 2 and 3). Within male residents,

Table 1. Akaike's Information Criterion (AIC_c), AIC_c difference (Δ_i), AIC_c model weight (w_i), and parameters (K) for the most parsimonious models and null model of license retention and recruitment of Montana deer and elk hunters from 2002 to 2011. We modeled capture probability as time-dependent for all models. We programmed license price to include only resident price for resident hunters and non-resident price for non-resident hunters. Birth cohorts included Traditionalists (born 1900–1945), Baby Boomers (born 1946–1964), Generation Xers (born 1965–1980), and Millennials (born 1981–2000).

Model name	AIC_c	Δ_i	w_i	K
License retention (residency, gender, age, license price, Baby Boomer, Millennial) License recruitment (residency, gender, age, license price, all age cohorts)	499,768.4	0.00	0.49	27
License retention (residency, gender, age, license price, all age cohorts) License recruitment (residency, gender, age, license price, all age cohorts)	499,768.8	0.43	0.40	28
License retention (residency, gender, age, license price, Baby Boomer, Generation X) License recruitment (residency, gender, age, license price, all age cohorts)	499,771.4	3.00	0.11	27
License retention (constant) License recruitment (constant)	525,278.4	25,510	0.00	12

Table 2. Geometric mean probability of recruitment (±SE), retention (±SE), lambda (±SE), gamma (±SE) of male and female resident and non-resident deer and elk hunters in Montana from 2002–2011. We used a resident license fee of $20 or a non-resident license fee of $794 for these estimates. Lambda is population growth and gamma is the proportional contribution parameter.

Hunter characteristics	Birth years	Recruitment	Retention	Lambda	Gamma
Male					
Resident					
Millennial	1981–2000	0.089 (0.024)	0.920 (0.001)	1.011 (0.025)	0.910 (0.021)
Generation X	1965–1980	0.044 (0.011)	0.918 (0.001)	0.964 (0.012)	0.953 (0.011)
Baby Boomer	1946–1964	0.031 (0.009)	0.931 (0.001)	0.963 (0.009)	0.966 (0.009)
Traditionalist	1900–1945	0.023 (0.009)	0.913 (0.001)	0.937 (0.010)	0.974 (0.009)
Non-resident					
Millennial	1981–2000	0.274 (0.058)	0.472 (0.002)	0.750 (0.060)	0.630 (0.048)
Generation X	1965–1980	0.150 (0.034)	0.522 (0.002)	0.675 (0.036)	0.773 (0.038)
Baby Boomer	1946–1964	0.109 (0.028)	0.567 (0.002)	0.679 (0.030)	0.835 (0.033)
Traditionalist	1900–1945	0.081 (0.030)	0.507 (0.003)	0.592 (0.032)	0.857 (0.042)
Female					
Resident					
Millennial	1981–2000	0.152 (0.039)	0.797 (0.001)	0.953 (0.040)	0.836 (0.033)
Generation X	1965–1980	0.079 (0.020)	0.827 (0.001)	0.909 (0.021)	0.911 (0.019)
Baby Boomer	1946–1964	0.056 (0.015)	0.852 (0.001)	0.910 (0.016)	0.936 (0.015)
Traditionalist	1900–1945	0.041 (0.016)	0.819 (0.002)	0.863 (0.017)	0.949 (0.017)
Non-resident					
Millennial	1981–2000	0.410 (0.070)	0.278 (0.002)	0.690 (0.072)	0.403 (0.040)
Generation X	1965–1980	0.246 (0.049)	0.319 (0.002)	0.568 (0.051)	0.562 (0.047)
Baby Boomer	1946–1964	0.185 (0.042)	0.361 (0.002)	0.548 (0.044)	0.658 (0.049)
Traditionalist	1900–1945	0.139 (0.047)	0.307 (0.002)	0.451 (0.050)	0.680 (0.068)

Generation Xers, Traditionalists, and Millennials had similarly low hunter retention rates (Fig. 2). The Millennial generation showed the highest recruitment rates, but, as with each birth-cohort group, showed dramatic declines in recruitment with age (Table 2, Figs. 2 and 3).

Trends in the Hunter Population

Model-averaged probability of hunter retention decreased from 0.893 (±0.001 SE) in 2002 to 0.834 (±0.003 SE) in 2011 and hunter recruitment rates decreased from 0.190 (±0.003 SE) in 2002 to a low of 0.087 (±0.001 SE) in 2009, then stabilizing at approximately 0.096 in 2010 and 2011 (Fig. 4). Declines in retention and recruitment were reflected in the decrease in hunter population growth from 1.083 (±0.004 SE) in 2002–2003 to 0.930 (±0.004 SE) in 2010–2011 (Figs. 4 and 5). The geometric mean of lambda from 2002 to 2011 was 0.995 suggesting the hunting population was near stable over the 10-year period. Future projections over 10 years suggest the population could drop from approximately 190,000 in 2012 to between 165,000 and 171,000 individuals by 2021 (Fig. 5). Proportional contribution parameter estimates indicate that retention of hunters had a greater contribution to hunter population growth than did recruitment ($\gamma > 0.5$; Table 2). For example, if we assume the hunter population would most resemble estimates from 2011, when $\varphi = 0.83$ and $f = 0.096$, then the population would require a 9% increase in hunter retention to remain stable, or a 200% increase in recruitment to become stable.

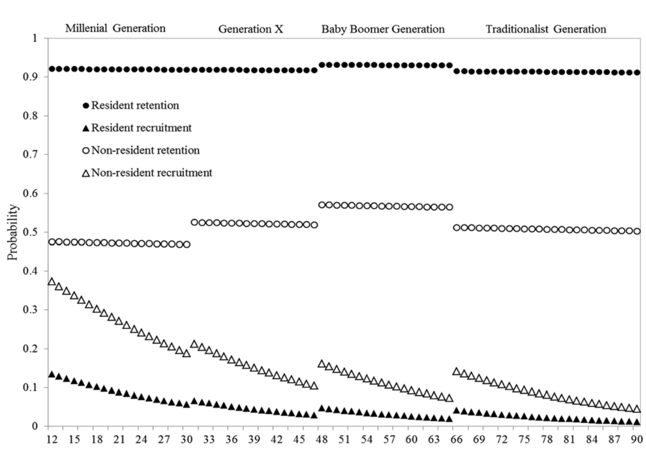

Figure 2. Age-specific license recruitment and retention rates for male deer and elk hunters aged 12–90 in Montana from 2002 to 2011, assuming resident license fee of $20 and non-resident license fee of $794.

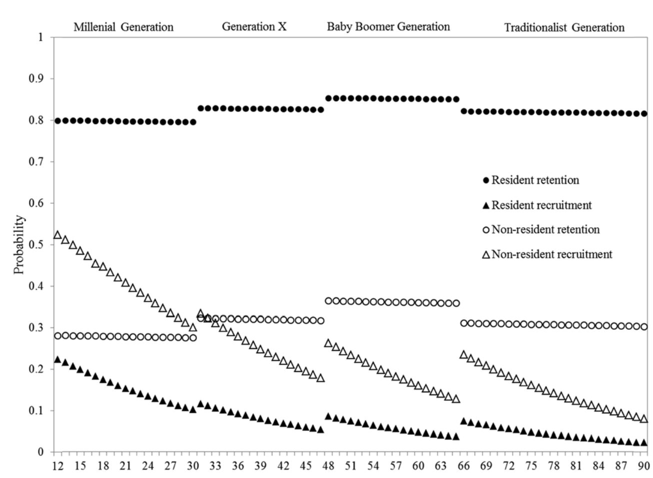

Figure 3. Age-specific license recruitment and retention rates for female deer and elk hunters aged 12–90 in Montana from 2002 to 2011, assuming resident license fee of $20 and non-resident license fee of $794.

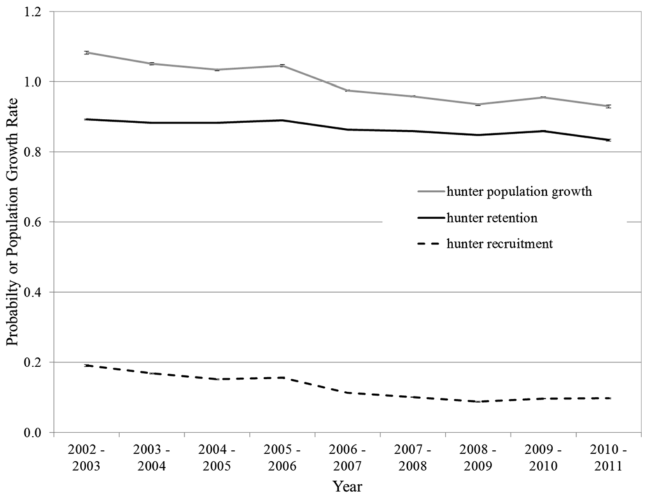

Figure 4. Model-averaged estimates of deer and elk hunter recruitment, retention, and population growth (λ) for Montana hunters from 2002 to 2011. Yearly estimates ($\pm$SE) are based on a random sample of 50,000 hunters from license database of 490,484 hunters. Population growth rates >1 indicate a growing population.

DISCUSSION

With approximately 13 million hunters spending over $20 billion in the United States (Sharp and Wollscheid 2009), license sales and hunting-related expenditures are economic drivers for wildlife management and outdoor recreation-based local economies. Understanding trends in sales is vital for anticipating agency funding changes and developing alternate funding bases (Anderson et al. 1985, Decker and Enck 1996, Teisl et al. 1999). Declines in hunter participation for most game species have been known since before the 1990s (Enck et al. 1993, Heberlein and Thomson 1996, U.S. Fish and Wildlife Service 2011*b*). However, these declines may be regionally specific; Montana increased in hunter license sales and population from 2002 to 2007 (Gude et al. 2012). These findings are not surprising in Montana where hunting is part of the cultural values of many Montana citizens (Eliason 2008) and natural resource tourism provides substantial economic influx (Wilton and Nickerson 2006). We confirmed the population increases identified by Gude et al. (2012; $\lambda = 1.04$ from 2002 to 2007), but this analysis suggests the increase was short-lived as hunter population decreased starting in 2006 (Fig. 4). The decline is driven by an approximately 50% decrease in deer and elk hunter recruitment (Fig. 4), and we found a clear discrepancy between resident and non-resident recruitment rates, with residents showing greater retention, but lower recruitment rates (Figs. 2 and 3). Non-residents may have higher recruitment because hunting in Montana may be a once-in-a-lifetime event that is highly coveted, whereas resident hunters are retained more easily because they have a stronger tie to hunting in their home state. Non-resident license sales are regulated by legislation in Montana, and this limitation on license sales may hinder non-residents remaining hunters, but hunting in Montana is sufficiently appealing that it attracts new hunting recruits.

The Millennial generation showed the greatest population growth in the hunter population (Table 2), and if retention rates can be increased, may be the segment of the population sustaining hunter participation in the future. The characteristics of the Millennial generation present challenges for hunter recruitment and retention. In particular, Millennials are of a generation with higher technological aptitude, with an expectation of immediate reward for effort, and likely with an upbringing that sheltered them from threatening environments (Millenbah and Wolter 2009). Successful recruiting may use electronic media that allows access to hunting information and highlights the conservation value of hunting (DiCamillo and Schaefer 2000, Holsman 2000). Declines in youth hunting have been recognized since the 1980s, and focused efforts have been made to increase youth recruitment and retention into the hunting population (DiCamillo 1995, Enck et al. 2000).

A growing demographic in the Montana hunter population is women, who show the highest recruitment rates (Table 2, Fig. 3). This trend is true throughout the United States (Bissell et al. 1998), prompting suggestions to develop gender-specific recruitment strategies (Floyd and Lee 2002, Poudyal et al. 2008). Females tend to be attracted to hunting as a method of spending time with male companions (Adams and Steen 1997), and as male recruitment and retention wane, the potential for increasing female enrollment likely will decrease (Heberlein et al. 2008). Females tend to be recruited in their twenties by male companions (Adams and Steen 1997), but these Montana data identify higher recruitment rates for women younger than 20, suggesting youth-specific recruitment strategies for women may be effective.

Baby Boomers are the segment of the population with the second highest growth (Table 2). The Baby Boomer generation identifies itself with a strong affiliation to rural America, and grew up following a time when the United States was undergoing rebounding economic growth in the

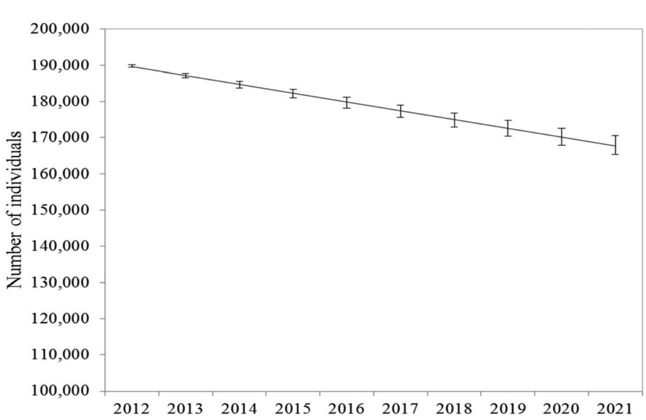

Figure 5. Montana deer and elk hunter population projections from 2012 to 2021, assuming $\lambda = 0.9865$ ($\pm$0.0009 SE), based on the model in which recruitment and retention were assumed constant from 2002 to 2011. Estimates are based on mark–recapture analysis of a random sample of 50,000 individuals from the hunting population of 490,484 hunters between 2002 and 2011.

1940s, when citizens had more time and appreciation for outdoor recreation, when wildlife populations were bountiful after decades of overharvest, and when hunting was an extension of the broadly appreciated need to provide for one's family (Winkler and Warnke 2013). Similar to Wisconsin, Montana hunter population dynamics were explained by birth cohort groups that included Baby Boomers as a large, consistent portion of the hunter population (Winkler and Warnke 2013). The maturation of this reliable hunter-advocate portion of the population may mean improvements in retaining and recruiting hunters among senior members of the population. However, as older individuals age they eventually lose interest in the time and effort required to hunt, or are physically unable to participate in hunting or fishing (Murdoch et al. 1996, Mehmood et al. 2003).

This study reiterates the importance of recruiting and retaining hunters from the Baby Boomer generation (Gude et al. 2012), and illustrate the importance of increasing recruitment and retention among younger generations. As older cohorts leave the population and younger generations (Millennials and Generation Xers) age, the hunter population may decrease. Prioritizing methods of introducing older individuals to hunting may be beneficial for long-term hunter population growth. Recruiting and retaining hunters is a complex issue, and many of the deterrents for hunting are personal constraints (Miller and Vaske 2003). Because recruiting relies on building social bonds with fellow hunters (Applegate 1989, Ryan and Shaw 2011), developing incentives for existing hunters to act as recruiting agents may be valuable. The value of ecosystem health may be used as a draw for recruiting hunters from the younger birth cohorts (Cordell et al. 2002, Peterson 2004). Given the loss in non-game wildlife habitat with increasing deer and elk populations in some areas (Martin et al. 2011), conservation-centric personalities may be recruited into the hunter population to serve as stewards of ecosystem health (Holsman 2000).

Our analysis suggests that as license price increased retention and recruitment rates decreased in Montana. The price of a hunting license compared to the cost of the total monetary investment of hunting annually is minimal (Beucler and Servheen 2009), yet license price can affect hunter participation rates (Anderson et al. 1985, Sun et al. 2005). Manipulating license price to influence management or revenue objectives can be complicated. Anderson et al. (1985) found that increasing license price may not decrease license sales, but price increases can have detrimental effects of increased illegal hunting and decreased future recruitment. Although some believe resident license demand is not responsive to license price (Teisl et al. 1999, Mehmood et al. 2003), Sun et al. (2005) found that resident fee increases would jeopardize future sales more than increases in non-resident fees. Short-term revenue gains from resident hunting price increases could be counter-balanced by long-term loss from decreased license recruitment and retention (Sun et al. 2005, Poudyal et al. 2008).

Because our models are built using only the last 10 years of Montana hunter data, they are limited to responses specific to that time period. For example, we have no ability to compare similarly aged Baby Boomers from the 1950s to current-day Millennials to elucidate all cohort-specific characteristics. Similarly, projected population declines are only true if the hunting behaviors observed during this 10-year period (2002–2011) hold true for future generations. The projections are only valid if future cohort, age, residency, and gender proportions are similar to those populations used in the analysis (2002–2011). The digital license subscription, like ALS, and the analysis methods presented here, provide a framework for making comparisons as new cohorts emerge and older cohorts leave the population.

MANAGEMENT IMPLICATIONS

In Montana, hunter retention influenced growth of the hunting population more than recruitment during 2002–2011. Strategies that make modest increases in hunter recruitment may be the best methods of stabilizing population growth. However, because recruitment is low, any headway in motivating current hunters to hunt annually will produce the greatest stability in the hunting population. Retaining hunters may require a greater understanding of the forces that become barriers to hunting and the extent to which these can be influenced. Perceptions that too little game is available to hunt, the application process is too daunting, access is limited because of land ownership issues, or lack of knowledge of how to be a successful hunter can deter future hunting effort (Miller and Vaske 2003, Beucler and Servheen 2009). Yet, some of the biggest constraints to hunter retention are personal, such as not having enough time to prioritize hunting or not having a companion for hunting excursions (Miller and Vaske 2003). Many of these factors relate to the changing demographics and attitudes of the population as a whole (Manfredo et al. 2003), and retaining and recruiting hunters may require a larger paradigm shift in wildlife management practices (Jacobson and Decker 2006, Jacobson et al. 2010).

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