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Do Resident and Non-Resident Northern Bobwhite Hunters Self-Regulate Harvest Based on Population Size?

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DO RESIDENT AND NON-RESIDENT NORTHERN BOBWHITE HUNTERS SELF-REGULATE HARVEST BASED ON POPULATION SIZE?

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ABSTRACT

A variety of factors influence the relative strength of additive and compensatory mortality of harvest on northern bobwhite (*Colinus virginianus*) including covey dynamics, habitat fragmentation, and timing of harvest. State wildlife agencies have long believed regulations could be liberal because hunters will self-regulate effort when populations decrease. A confounding observation is that with lower population abundances, hunter skill and harvest rate increases because the more novice hunters do not participate. This raises the question whether non-resident small game hunters could have a larger impact at lower population levels if they have (1) more money to dedicate to out of state licenses and travel/lodging, and (2) time to dedicate to the hunting experience? We examined long-term bobwhite population and harvest data from Kansas (1966–1999) to learn if self-regulation differed between resident and non-resident small game hunters. The number of resident and non-resident small game hunters was related to their respective harvest of northern bobwhites. Decreasing October population index was associated with a decline in the number of resident bobwhite hunter days and harvest. Conversely, increasing numbers of non-resident hunters participated in the hunting season with higher hunter efficiency and a larger harvest at lower October population index levels. Total relative harvest decreased overwinter (Oct–Jan) survival. The Kansas resident bobwhite harvest is probably self-regulatory but non-resident harvest is not. Future harvest regulations should consider the impact of non-resident harvest.

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Key words: *Colinus virginianus*, hunting, nonresident, northern bobwhite, resident, self-regulation

INTRODUCTION

The effect of harvest on northern bobwhite populations has been of interest to wildlife professionals because of their economic, recreational, and ecological values (Burger et al. 1994). Thus, state wildlife agencies have long had interest in designing harvest regulations to maximize recreational potential while remaining consistent with sustaining bobwhite populations. The relationship between harvest and natural mortality has been described between 2 opposing models: additive and compensatory (Anderson and Burnham 1976, Caughley 1983). We define compensatory mortality as occurring when harvest is ameliorated by reduced natural mortality or increased density-dependent reproduction. Additive mortality occurs when natural mortality or reproductive responses are unaffected by increased harvest pressure. Early empirical evidence supported a compensation hypothesis where natural mortality decreases and reproduction increases to compensate for increased hunting mortality for multiple quail species (Baumgartner 1944, Glading and Saarni 1944, Parmalee 1953, Swank and Gallizioli 1954, Campbell et al. 1973). However, reanalysis of older (Guthery 2002:101) and recent research indicates harvest mortality tends to be additive to winter natural mortality (discounting for a reproductive response) for bobwhites during the fall–winter (Roseberry and Klimstra 1984:142, Pollock et al. 1989, Robinette and Doerr 1993, Dixon et al. 1996, Williams et al. 2004a, Rolland et al. 2011). A variety of factors influence the relative strength of additive and compensatory mortality including covey dynamics (Williams et al. 2003b), habitat fragmentation (Roseberry and Klimstra 1984:147–148, Ellison 1991, Guthery et al. 2000), and late season harvest (Roseberry 1982, Kokko 2001).

A common observation is that hunter numbers tend to fluctuate with quail abundance and state wildlife agencies have additionally believed self-regulation occurs in bobwhite harvest (i.e., hunting effort and resulting harvest will decrease with decreasing population; Peterson and Perez 2000). For example, when bobwhite numbers are low, hunter effort is low and fewer quail are harvested than when quail numbers are high (Latham and Studholme 1952, Gallizioli 1965, Guthery 1986, Peterson and Perez 2000, Guthery et al. 2004). Agencies often do not have robust and cost-effective quail population indices to guide season decisions that are made months or a year in advance. Therefore, agencies rely on faith in self-

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regulation to set socially acceptable regulations on a standard opening date with standard bag limits, possession limits, and season lengths (Peterson and Perez 2000).

Hunter effort and total harvest decline with lower population abundance, and Guthery et al. (2004) found hunter skill and resulting harvest rate increase as populations decline. Self-regulation is brought into question because hunters that continue to hunt when populations are low are more avid than those that quit. Peterson and Perez (2000) and Guthery et al. (2004) made strong inroads into understanding self regulation, but neither addressed the impact of non-resident hunters in these relationships.

Kansas is a popular destination for quail hunters from throughout the United States with an estimated 20,000 non-resident small game hunters (of a total 72,900 hunters) during the 2009–2010 season. Thus, understanding self-regulation for this group has implications for establishing regulations. We tested the hypothesis that as bobwhite populations decline, the number of hunters and harvest would decline (as predicted by Guthery et al. 2004) using long-term bobwhite population and harvest data from Kansas (1966–1999). We extend the hypothesis that self-regulation patterns do not differ between resident and non-resident hunters.

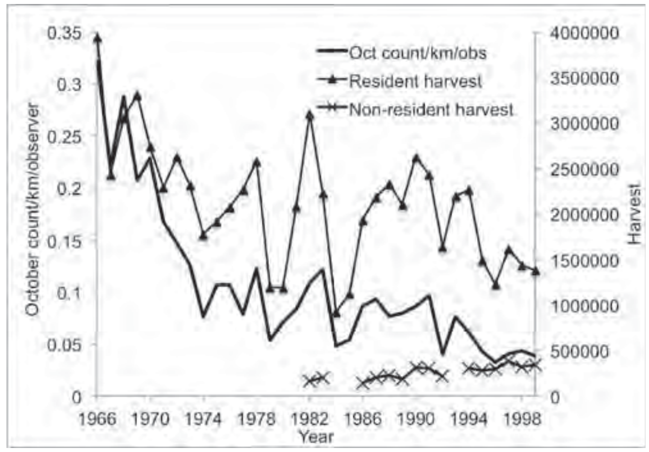

Fig. 1. Trends in the October northern bobwhite population index and estimated resident and non-resident harvest in Kansas, 1966–1999.

METHODS

Population indices for northern bobwhite (quail/km/observer) were obtained from annual roadside surveys conducted by rural mail carriers (RMCS) during the second week of October and January throughout all counties in the state of Kansas (Robinson et al. 2000, Williams et al. 2003a). Wells and Sexson (1982) found the October survey gave the best predictor of subsequent bobwhite hunter harvest. Counts were taken by carriers while making deliveries on their regular mail routes. This survey involves 550 mail carriers that drive 400,000 km during the 2 weeks (Wells and Sexson 1982). Data were recorded on prepaid postage cards supplied by the Kansas Department of Wildlife, Parks, and Tourism (KDWPT).

KDWPT obtained annual northern bobwhite resident harvest numbers from a mail questionnaire sent to a random sample of 5–10% (yearly mean ± SE = 8,689 ± 1,867) of the previous year's resident small game license holders between 1966 and 1999 (following Turner 1970). We sent an introductory mailing to each selected cooperator before opening of the small game season. The introductory mailing consisted of a letter explaining the survey and a report card to record hunting activity and harvests. We mailed the questionnaire to the selected group after the close of the small game season. We also mailed a follow-up questionnaire to account for non-respondents (Turner 1970, Yu and Cooper 1983). This resulted in an average return rate of 27.8 ± 2.5% of usable questionnaires. We acknowledge potential non-response bias, which might have yielded overestimates of hunter-days and harvest (Peterson 2001). We expanded questionnaire results (Sondrini 1950, Landwehr 1982) to estimate annual northern bobwhite harvest.

Non-resident harvest was estimated by mailing a questionnaire, identical to that mailed to the resident sample, to all non-residents purchasing licenses from KDWPT Licensing Section in Pratt. This sampling frame was used because all non-resident license applications sent to the Licensing Section were computerized whereas all licenses sold through other KDWPT offices or vendors were not. We mailed an average of 974 ± 512 questionnaires annually and obtained a 45 ± 8% response rate. We expanded questionnaire results in an identical fashion to that of resident questionnaire results. We used all available non-resident data collected in 1982–83, 1986–92, 1994–1999 ($n = 15$ years).

We modeled the relationship of both resident and non-resident harvest with bobwhite abundance; our assumption was that October population index (I) was an approximately linear, zero-intercept function of population abundance. This relationship is reasonable because harvest is linear to both local and regional population abundance indices (Brown et al. 1978, Guthery 1986:149, Peterson and Perez 2000, DeMaso et al. 2002, Palmer et al. 2002, Guthery et al. 2004) indicating a linear correlation between population indices and true abundance. We predicted that resident and non-resident hunting pressure (P, hunter days) was a linear function of abundance (Peterson and Perez 2000):

$$P = f(I).$$

We calculated relative pressure (P_R; pressure/index bird) from that equation as:

$$P_R = \frac{P}{I}$$

and the total annual harvest (H) as:

$$H = g(P) = g\Big(f(I)\Big)$$

because harvest pressure is a function of the population

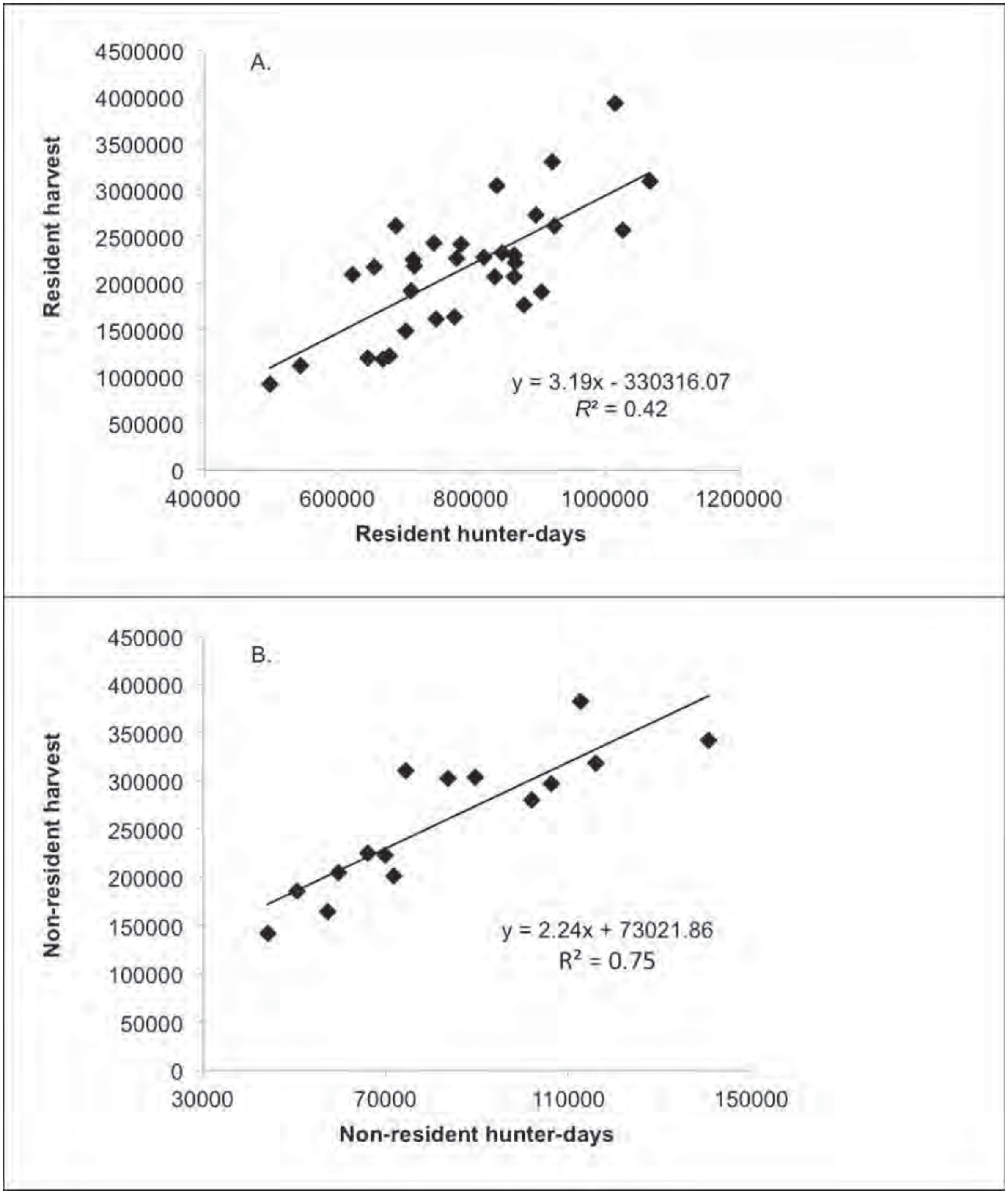

Fig. 2. Relationship between total number of resident and non-resident hunters and respective northern bobwhite harvest in Kansas, 1966–1999.

index. We defined hunter efficiency (S) as 'harvest/hunter-day/index bird' or 'harvest/index-bird exposure-day':

$$S = \frac{\frac{H}{P}}{I} = \frac{\frac{H}{I}}{P} = \frac{H}{PI}.$$

We define relative harvest rate (R; harvest/index bird) as:

$$R = \frac{H}{I}$$

where the relative harvest is a product of pressure and efficiency, and is a scaled version of the absolute harvest rate (percent of population harvested). We related the relative harvest to an index of overwinter mortality (M) defined as:

$$\hat{M} = 1 - \frac{I_{Jan}}{I_{Oct}}.$$

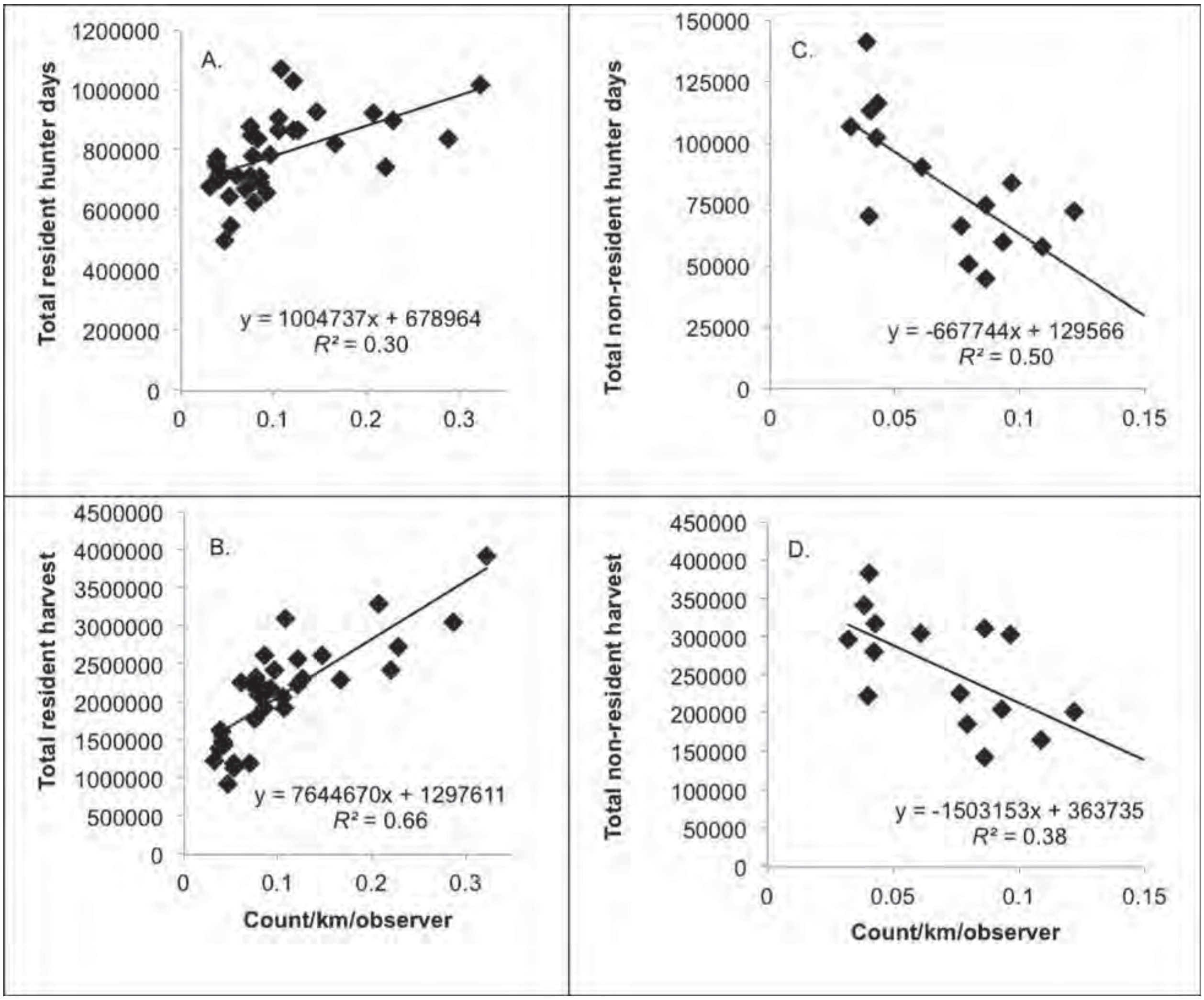

Fig. 3. Relationship between October northern bobwhite population index and resident hunters (A), resident harvest (B), non-resident hunters (C), and non-resident harvest (D) in Kansas, 1966–1999.

We used simple linear regression ($P \leq 0.05$) to examine: (1) the number of resident and non-resident hunters and harvest; (2) the relationship between October population index and the number of resident and non-resident bobwhite hunters, harvest, and hunter efficiency; and (3) the relationship between total relative harvest of both resident and non-resident hunters and estimated overwinter mortality.

RESULTS

There was a steady decline in the October population index between 1966 and 1999 (Fig. 1). Estimated resident harvest also declined and generally tracked natural increases and decreases in the population (Fig. 1). Non-resident harvest was substantially lower but generally increased despite the declining population (Fig. 1). Numbers of resident and non-resident hunters were correlated to resident and non-resident northern bobwhite harvest (respectively: $F_{1,35} = 25.49$, $P < 0.01$; $F_{1,13} = 39.71$, $P < 0.01$; Fig. 2). Decreasing October population index decreased the number of resident bobwhite hunter days and harvest ($F_{1,32} = 13.87$, $P < 0.01$; $F_{1,32} = 60.95$, $P < 0.01$; Fig. 3A, C). The existence of non-zero intercepts suggested hunting pressure and harvest declined more slowly than quail abundance indicating the ratio of hunters to quail numbers increased as the quail population declined. Conversely, numbers of non-resident hunters participating in the hunting season increased at lower October population index levels and a larger number of birds were harvested (respectively: $F_{1,13} = 12.88$, $P < 0.01$; $F_{1,13} = 7.93$, $P = 0.02$; Figs. 3B, D). Models for hunter efficiency (harvest/hunter day/index bird) were curvilinear decreasing functions of quail abundance for both resident and non-resident hunters (Fig. 4) indicating the average hunter at low quail abundance was more efficient than the average hunter at high quail abundance.

We calculated the total relative harvest examining the 15 years when both resident and non-resident harvests were known. Non-resident harvest comprised only ~5% of total harvest when populations were at moderate levels (~0.15

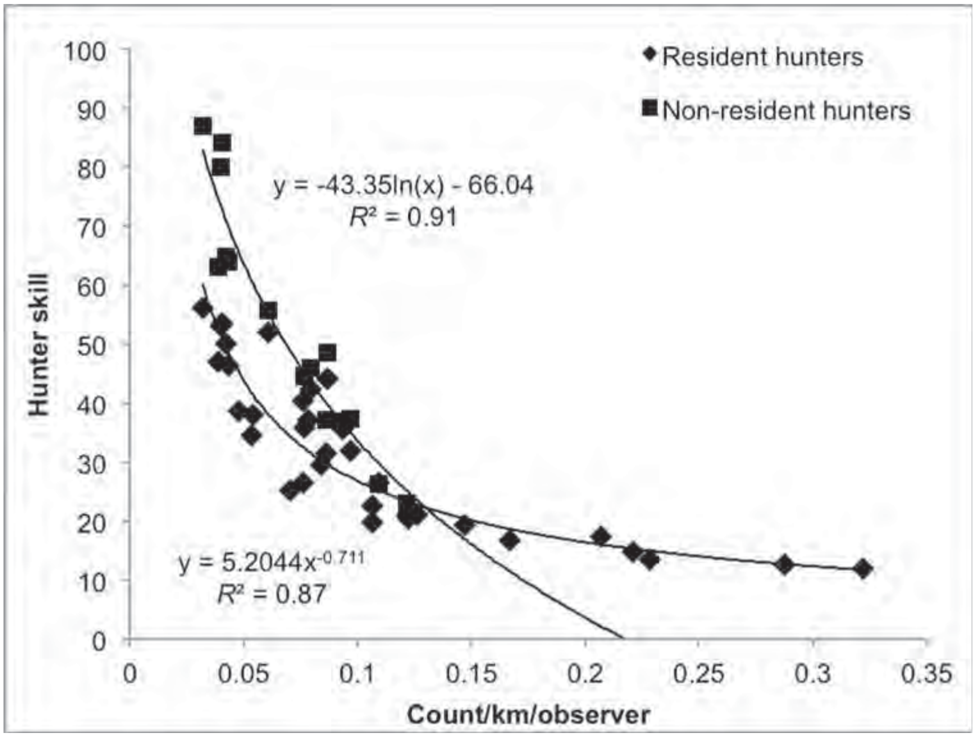

Fig. 4. Hunter efficiency as a function of northern bobwhite abundance for both resident and non-resident hunters in Kansas, 1966–1999.

index birds). However, non-resident harvest comprised ~20% of total harvest when populations were at low densities (~0.05 index birds) and harvest rates increased. We also examined how relative harvest rate during those years affected estimated mortality in the population between October and January indices. The increased relative harvest rate (when populations were moderate to low) increased overwinter mortality ($F_{1,13} = 4.80$, $P = 0.05$) indicating a more additive effect to harvest mortality (Fig. 5).

DISCUSSION

The concept of self-regulation stems from early work with ring-necked pheasants (*Phasianus colchicus*) (Allen

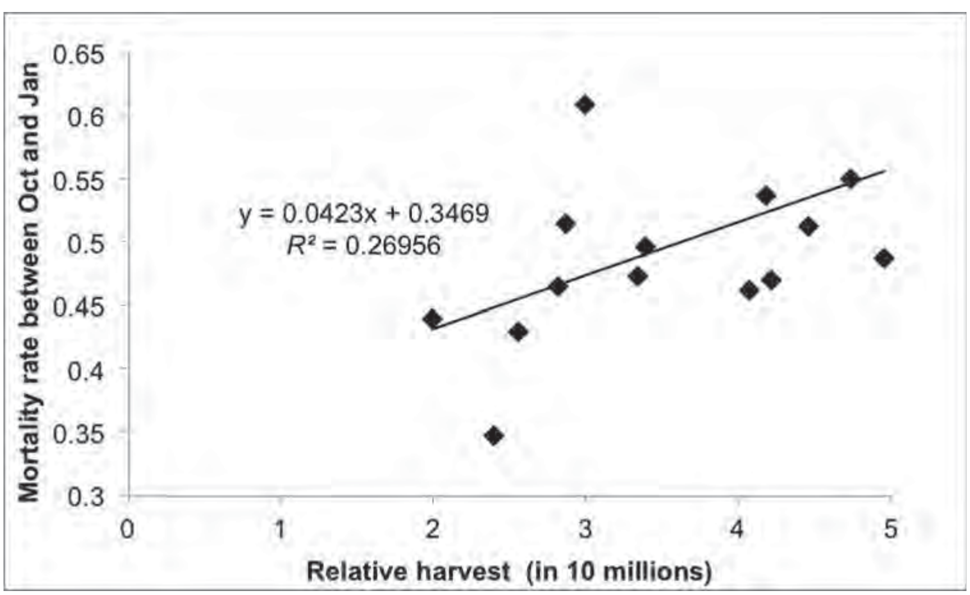

Fig. 5. Relationship between total northern bobwhite relative harvest and estimated mortality between October and January population indices during years both resident and non-resident data were collected in Kansas (1982–83, 1986–92, 1994–1999; $n = 15$ years).

1942, 1947; Lauckhart 1946; Schick 1952) and indirectly with Errington's (1945) theory of 'threshold of security'. Self-regulation can be both passive, where hunters do not go hunting because they hear it was a poor reproductive year, or active when a private landowner closes their land. Passive self-regulation of northern bobwhite harvest has been assumed, but rarely tested. Vance and Ellis (1972) suggested this relationship, but failed to demonstrate it on two wildlife management areas in Illinois. Schwartz (1974), Wells and Sexson (1982), and Peterson and Perez (2000) reported bobwhite abundance could predict harvest in Iowa, Kansas, and Texas, respectively.

Policies associated with the concept of self-regulation continue to be promoted (Kabat and Thompson 1963, MDC 1986, Madson 2000). The relative harvest rate (harvest/index bird) tended to increase with lower bobwhite abundance following Guthery et al.'s (2004) observations in 6 states (including the resident data from Kansas). This observation was attributed to increased hunter efficiency despite the lower hunting pressure. Kansas, among the 6 states, had the most profound effect and the other 5 states had a more subdued increasing trend in relative harvest rate as a function of decreasing abundance. However, the non-resident relative harvest rate in Kansas increased over 3 times that of resident harvest rate at low population levels. Thus, not only did the ratio of hunters to quail increase as the quail populations declined, but also the efficiency of the average hunter increased. However, the magnitude of this effect was substantially higher for non-resident hunters as a function of their continued and skilled hunting pressure even when bobwhites were at low densities.

Our results indicate resident northern bobwhite hunting in Kansas is self-regulatory. However, our results may indicate lack of passive self-regulation for non-resident hunters. This is likely driven by non-resident hunters increasingly coming to Kansas where populations were more robust than in their home states in recent years, as bobwhite populations have decreased throughout the region,. Non-residents (1) have a greater investment in transportation, lodging, food, and license costs, (2) must plan in advance to make trips to hunt, and (3) likely are avid hunters with high hunting skill (Hurst and Warren 1982, Guthery et al. 2004). This suggests harvest rate is higher and passive regulation will be lower even under low population levels (Guthery et al. 2004). This trend cannot biologically continue despite the linearly increasing participation and harvest by non-resident hunters and eventually would become curvilinear and drop to zero as the bobwhite population declines to zero. Informal surveys conducted by KDWPT (Jim Pitman, personal communication) have found in recent years that 92% of non-resident bobwhite hunters consider themselves to be 'mixed bag' hunters and exhibit more passive self-regulation by switching to pheasants. However, we cannot predict at what threshold this might occur. Future researchers may wish to examine the relationships documented in this paper between Central/Western counties (where bobwhites are scarce and pheasants are more abundant; Williams et al. 2003a) and Eastern counties in Kansas (where bobwhites are more common and pheasants are more scarce) to identify the spatial dynamics of non-resident passive self-regulation.

MANAGEMENT IMPLICATIONS

Kansas resident bobwhite harvest seems to be self-regulatory but non-resident harvest does not and harvest regulations should consider the increased additivity from non-resident hunters in future regulations. We question the assumption of northern bobwhite passive self-regulation if non-resident hunters increasingly make up a larger percentage of the total hunting population. We believe, as did Errington and Hamerstrom (1936), that hunting of bobwhites should be regulated with care. Hunters and agencies, in part, have wanted liberalization (Roseberry and Klimstra 1993), but the tendency over the past 30 years to liberalize bobwhite hunting seasons despite continued habitat deterioration and loss should be questioned (Williams et al. 2004b). Managers may want to consider closing the bobwhite season on or before the closing of the season in neighboring states that provide high numbers of non-resident hunters.

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LITERATURE CITED

Allen, D. L. 1942. That season limit. Michigan Conservation 11 (2):4–5.

Allen, D. L. 1947. Hunting as a limitation to Michigan pheasants. Journal of Wildlife Management 11:232–243.

Anderson, D. R., and K. P. Burnham. 1976. Population ecology of the mallard. VI. The effect of exploitation on survival. USDI, Fish and Wildlife Service Resource Publication 128.

Baumgartner, F. M. 1944. Bobwhite quail populations on hunted vs. protected areas. Journal of Wildlife Management 8:259–260.

Brown, D. E., C. L. Cochran, and T. E. Waddell. 1978. Using call-counts to predict hunting success for scaled quail. Journal of Wildlife Management 42:281–287.

Burger, Jr., L. W., E. W. Kurzejeski, L. D. Vangilder, T. V. Dailey, and J. H. Schultz. 1994. Effects of harvest on population dynamics of upland game birds: are bobwhite the model? Transactions of the North American Wildlife and Natural Resources Conference 59:466–476.

Campbell, H., D. K. Martin, P. E. Ferkovich, and B. K. Harris. 1973. Effects of hunting and some other environmental factors on scaled quail in New Mexico. Wildlife Monographs 34.

Caughley, G. 1983. Harvesting of wildlife: past, present, and future. Pages 3–14 *in* S. L. Beasom and S. F. Roberson, eds. Game harvest management. Caesar Kleberg Wildlife Research Institute, Kingsville, Texas, USA.

DeMaso, S. J., M. J. Peterson, J. R. Purvis, N. J. Silvy, and J. L. Cooke. 2002. A comparison of two quail abundance indices and their relationship to quail harvest in Texas. Proceedings of the National Quail Symposium 5:206–212.

Dixon, K. R., M. A. Horner, S. R. Anderson, W. D. Henriques, D. Durham, and R. J. Kendall. 1996. Northern bobwhite habitat use and survival on a South Carolina plantation during winter. Wildlife Society Bulletin 24:627–635.

Ellison, L. N. 1991. Under what conditions can shooting of declining species of tetraonids be justified in France? Gibier Faune Sauvage 8:353–365.

Errington, P. L. 1945. Some contributions of a fifteen-year local study of the northern bobwhite to a knowledge of population phenomena. Ecological Monographs 15:1–34.

Errington, P. L., and F. N. Hamerstrom Jr. 1936. The northern bobwhite's winter territory. Iowa State College Agricultural Experiment Station Research Bulletin 201.

Gallizioli, S. 1965. Quail research in Arizona. Arizona Game and Fish Department, Phoenix, USA.

Glading, B., and R. W. Saarni. 1944. Effect of hunting on a valley quail population. California Fish and Game 30:71–79.

Guthery, F. S. 1986. Beef, brush, and bobwhites: quail management in cattle country. Caesar Kleberg Wildlife Research Institute Press, Kingsville, Texas, USA.

Guthery, F. S. 2002. The technology of bobwhite management: the theory behind the practice. Iowa State University Press, Ames, USA.

Guthery, F. S., M. J. Peterson, and R. R. George. 2000. Viability of northern bobwhite populations. Journal of Wildlife Management 64:646–662.

Guthery, F. S., M. J. Peterson, J. J. Lusk, M. J. Rabe, S. J. DeMaso, M. Sams, R. D, Applegate, and T. V. Dailey. 2004. Multistate analysis of fixed, liberal regulations in quail harvest management. Journal of Wildlife Management 68:1104–1113.

Hurst, G. A., and R. C. Warren. 1982. Harvest rates and efforts of avid quail hunters in east central Mississippi. Proceedings of the National Quail Symposium 2:48–50.

Kabat, C., and D. R. Thompson. 1963. Wisconsin quail 1834–1962: population dynamics and habitat management. Technical Bulletin 30. Wisconsin Department of Conservation, Madison, USA.

Kokko, H. 2001. Optimal and suboptimal use of compensatory responses to harvesting: timing of hunting as an example. Wildlife Biology 7:141–150.

Landwehr, T. J. 1982. A comparison of trapping harvest estimates determined from trapper report cards and mail surveys, 1976–79. Minnesota Wildlife Research Quarterly 42:25–47.

Latham, R. M., and C. R. Studholme. 1952. The bobwhite quail in Pennsylvania. Pennsylvania Game News Special Issue 4.

Lauckhart, J. B. 1946. Habitat areas and their relation to pheasant management. Proceedings of the Western Association of State Game and Fish Commissioners 26:120–123.

Madson, C. 2000. To gun or not to gun? Wing and Shot 14 (6):28–29.

Missouri Department of Conservation (MDC). 1986. Small game regulations: can they save quail? Wildlife Information 2. Missouri Department of Conservation, Jefferson City, USA.

Palmer, W. E., S. D. Wellendorf, L. A. Brennan, W. R. Davidson, and F. E. Kellogg. 2002. Hunting success and northern bobwhite density on Tall Timbers Research Station: 1970–2001. Proceedings of the National Quail Symposium 5:213–216.

Parmalee, P. W. 1953. Hunting pressure and its effect on bobwhite quail populations in east-central Texas. Journal of Wildlife Management 17:341–345.

Peterson, M. J. 2001. Northern bobwhite and scaled quail abundance and hunting regulation: a Texas example. Journal of Wildlife Management 65:828–837.

Peterson, M. J., and R. M. Perez. 2000. Is quail hunting self-regulatory? Northern bobwhite and scaled quail abundance and quail hunting in Texas. Proceedings of the National Quail Symposium 4:85–91.

Pollock, K. H., C. T. Moore, W. R. Davidson, F. E. Kellogg, and G. L. Doster. 1989. Survival rates of bobwhite quail based on band recovery analysis. Journal of Wildlife Management 53:1–6.

Robinette, C. F., and P. D. Doerr. 1993. Survival of northern bobwhite on hunted and nonhunted study areas in the North Carolina Sandhills. Proceedings of the National Quail Symposium 3:74–78.

Robinson Jr., D. A., W. E. Jensen, and R. D. Applegate. 2000. Observer effect on a Rural Mail Carrier survey population index. Wildlife Society Bulletin 28:330–332.

Rolland, V., J. A. Hostetler, T. C. Hines, F. A. Johnson, H. F. Percival, and M. K. Oli. 2011. Effects of harvest and climate on population dynamics of northern bobwhites in south Florida. Wildlife Research 38:396–407.

Roseberry, J. L. 1982. Sustained harvest of bobwhite populations. Proceedings of the National Bobwhite Symposium 2:51–56.

Roseberry, J. L., and W. D. Klimstra. 1984. Population ecology of the bobwhite. Southern Illinois University Press, Carbondale, USA.

Roseberry, J. L., and W. D. Klimstra. 1993. Attitudes of a select group of Illinois quail hunters. Proceedings of the National Quail Symposium 3:34–42.

Schick, C. 1952. A study of pheasants on the 9,000 acre Prairie Farm, Saginaw County, Michigan. Michigan Department of Conservation, Lansing, USA.

Schwartz, C. C. 1974. Analysis of survey data collected on bobwhite in Iowa. Journal of Wildlife Management 38:674–678.

Sondrini, W. J. 1950. Estimating game from licensee reports. Connecticut Board of Fisheries and Game, Pittman-Robertson Bulletin 3.

Swank, W. G., and S. Gallizioli. 1954. The influence of hunting and rainfall upon Gambel's quail populations. Transactions of the North American Wildlife Conference 19:283–297.

Turner, D. W. 1970. Mail surveys of hunting-precision and sample size. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 24:292–303.

Vance, D. R., and J. A. Ellis. 1972. Bobwhite populations and hunting on Illinois public hunting areas. Proceedings of the National Quail Symposium 1:165–174.

Wells, R., and K. Sexson. 1982. Evaluation of bobwhite quail surveys in Kansas. Proceedings of the National Quail Symposium 2:19–30.

Williams, C. K., A. R. Ives, and R. D. Applegate. 2003a. Population dynamics across geographical ranges: time-series analysis of three small game species. Ecology 84:2654–2667.

Williams, C. K., R. S. Lutz, and R. D. Applegate. 2003b. Optimal group size in northern bobwhite coveys. Animal Behaviour 66:377–387.

Williams, C. K., R. S. Lutz, and R. D. Applegate. 2004a. Winter survival and additive harvest in northern bobwhite coveys in Kansas. Journal of Wildlife Management 68:94–100.

Williams, C. K., F. S. Guthery, R. D. Applegate, and M. J. Peterson. 2004b. The northern bobwhite decline: scaling our management for the twenty-first century. Wildlife Society Bulletin 32:861–869.

Yu, J., and H. Cooper. 1983. A quantitative review of research design effects on response rates to questionnaires. Journal of Marketing Research 20:36–44.