Transactions of the Illinois State Academy of Science
(1996), Volume 89, 1 and 2, pp. 63-71

Modelling Deer Harvest Alternatives in Indiana

Louis C. Bender[1]
Division of Fish and Wildlife
Indiana Department of Natural Resources
300 West First Street
Bloomington, Indiana 47403

and

Gary J. Roloff
Boise-Cascade Corporation, Timberland Resources
One Jefferson Square
P.O.Box 50
Boise, Idaho 83728

[1]Present address
Washington Department of Wildlife
5405 NE Hazel Dell Avenue
Vancouver, Washington 98663

ABSTRACT

To assess strategies for increasing trophy buck production, we used Indiana's deer population management model, which follows the dynamics of each distinct sex and age cohort, to model alternative deer population management strategies. Harvest strategies modeled included (1) aselective buck harvest, (2) limited buck harvest with emphasis on yearlings, and (3) 2-point or better buck harvests; each strategy was modeled using four different buck:doe ratios. Trophy management strategies increased the numbers of older age-class bucks, at the expense of overall harvest. Harvest strategies aimed solely at providing certain age-class harvest percentages, popular among trophy management adherents, provide little insight into the true age structure of the population being harvested.

INTRODUCTION

Trophy white-tailed deer (*Odocoileus virginianus*) management is becomingly increasingly popular among hunting groups (Fleming 1983, Weigand and Mackie 1987, Carpenter and Gill 1987, Langenau 1988). Many midwestern states utilize sex-age-kill (SAK) or other population reconstruction models, in which the annual yearling buck harvest percentage (AYBP) is used as an indicator of buck population structure (Lang and Wood 1976, Creed et al. 1978, Gladfelter 1980). In an age-stable, stationary population, the AYBP equals the overall annual buck mortality rate; thus, population managers use this value to determine how intensively the buck population is being harvested. Since the AYBP is an indicator of buck survival into older age-classes, it is popularly used to assess the trophy potential of a population as well (J. Stahl, Indiana Whitetail Lobby, pers. commun.).

In Indiana, dissatisfaction has been expressed over the age-structure of the buck white-tailed deer harvest, and the numbers of older age-class bucks in the herd. Trophy management adherents favor population management strategies which they believe increase the proportion of bucks in the population in general, and older age-class bucks in particular. In Indiana, such groups espouse a "65% rule", believing that if the AYBP exceeds 65%, too few older age-class bucks are present in the population (J. Stahl, Indiana Whitetail Lobby, pers. commun.). Most Indiana deer management units exceed this value.

Modelling allows the evaluation of differing harvest strategies on deer demographics. Deer population management requires knowledge of both herd numbers and sex and age structure to accurately predict the effects of harvests on the deer population. Indiana's deer population model allows the tracking of individual sex and age cohorts. We used Indiana's deer population model to assess total harvest and buck age structure under the current (~37 bucks per 100 does) and three alternative (50, 75, and 100 bucks per 100 does) buck:doe ratios using three buck harvest strategies. Our objective was to evaluate trophy buck production under the various harvest scenarios.

METHODS

Population Modelling

The dynamics of Indiana's deer herd are modelled using the computer simulation model Pop-II, Version 6.03 (Fossil Creek Software, Ft. Collins, CO) (Bartholow 1986). Pop-II is an accounting model which follows each sex- and age-class individually. Initial inputs of Pop-II include sex-specific initial population age-structure, age-, sex-, and season-specific mortality rates, and age-specific natality rates (Table 1). Additional information which can be added to the model include annual sex- and age-specific harvests, sex- and age-specific harvest efforts, and an environmental severity index. Pop-II models population dynamics for each individual sex- and age-class based on a biological year, beginning just after fawn drop, using the formula:

$$P_{N+1} = P_N - M_S - M_H - M_W + R,$$

where P_{N+1}=population the following June, P_N=current June population, M_S=summer mortality, M_H=harvest mortality, M_W=winter mortality, and R=recruitment. The model begins at the start of the biological year (approximately early June for Indiana deer) and proceeds with the following steps (from Bartholow 1986): (1) subtraction of age- and sex-specific pre-harvest mortality (e.g., poaching, predation, accidents, disease, and emigration. This period follows from just after fawn drop until the hunting season); (2) subtraction of harvest mortality (including a pre-selected wounding loss); (3) subtraction of age- and sex-specific post-harvest mortality (e.g., starvation, accidents, predation, poaching, disease, and emigration. The postseason period covers the time from the end of the hunting season to immediately prior to fawn drop, late May through early June); and (4) addition of recruitment based on age-specific natality rates. The final model step is to advance all surviving individuals 1 age-class and place the recruitment into the initial age-class.

Mortality and natality rates (Table 1) used in Indiana's model were derived from consultation with regional deer biologists and by iteration. Consultations were used to select a range of possible rates. Iteration was used to fine tune these rates until the model provided the best fit to observed herd parameters. Harvest check station age data were used to derive the proportion of yearling and adult deer in the harvest, and this was extrapolated to the population. Adult buck:doe ratios were derived from comparison of yearling buck and doe harvest percentages (Creed et al. 1978). Adult deer were partitioned into individual age-classes based on herd age structure data collected from Indiana Department of Natural Resources biological check stations.

Alternative Management Simulations

The relative-effort- value option of Pop-II allows the simulation of differing harvest strategies. Effort values allow the partitioning of the harvest among different age-classes. We modeled a hypothetical deer population with a constant post-harvest population of 1000 individuals under a variety of differing management scenarios. Management options modeled included (1) maintaining current herd mean sex and age parameters (post-harvest herd ratios of ~37 adult bucks per 100 adult does, and ~135 fawns per 100 adult does), (2) increasing the relative proportion of adult bucks in the population (to post-harvest levels of 50, 75, and 100 per 100 adult does, respectively), and (3) subjecting the above populations to 3 differing buck harvesting strategies: The current strategy, with harvest proportional to age-class numbers (C strategy); a "trophy only" strategy, with increased effort on age-class 2.5 and older bucks (T strategy); and a "yearling" strategy, with heavy emphasis on yearling buck harvest and decreased vulnerability to harvest among older age-class bucks (Y strategy) (Table 2). Each management scenario modeled was projected for 13 years, and compared in terms of (1) base population (post-fawning) necessary to sustain a post-harvest population of 1000 deer, (2) sustained yield, (3) harvest percentages, and (4) harvest and population age-structure.

RESULTS AND DISCUSSION

Increasing the proportion of bucks in the population resulted in declining harvests (from 6-26%) and decreased production as the relative proportions of does declined in the populations (Table 3). Concurrently, buck age-structure was shifted upward, resulting in increased numbers of older (age 4.5 and up) age-class bucks and hence greater "trophy buck" production from the population (Tables 4-5). Managing for increased proportions of adult bucks in the population can result in increased trophy buck production, but at the expense of reduced overall deer harvest and hunting opportunity.

In the above, hunter effort was assumed to be independent of deer age-class. However, as trophy animals become more common, and hunter access more limited, increased hunter selection is focused on the trophy animals in the population (Bender 1992, Langenau 1988). Simulations evaluating the effects of age-specific harvest using 3 alternative buck harvesting strategies demonstrate that trophy production from a harvested population can vary greatly with hunter selectivity (Tables 4-5). Also, as often demonstrated in the field, systems aimed at producing trophy animals by protecting younger age-classes (strategy T) usually fail to increase the numbers of trophy animals in a population (Carpenter and Gill 1987, Hernbrode 1987, Weigand and Mackie 1987). Conversely, trophy management systems aimed at harvesting a large percentage of the younger, more vulnerable animals, thereby increasing survival probabilities for mature animals (strategy Y), are often very effective in producing older age class individuals (Fleming 1983, Ueckermann 1987, Bender 1992). Strategy C, where harvest is proportional to numbers in an age-class, is seldom observed in populations with large numbers of trophy animals; exceptions include intensively managed European red deer (*Cervus elaphus*) populations (Ueckermann 1987). In these populations, harvest is apportioned by age-class via selective culling of animals with inferior inherent antler development qualities.

Finally, a common belief among many trophy-oriented deer hunting constituents is that the AYBP in the harvest is a good indicator of the trophy quality of the herd. In Indiana, such groups espouse a "65% rule," believing that as the percentage of yearlings in the antlered buck harvest exceeds 65%, too few older age-class bucks are present in the population, while below 65%, adequate numbers are present. Several shortcomings are present in this argument. Firstly, the argument holds merit only if harvesting is proportional to herd age-structure. However, as older age-class bucks become more common in populations, harvest pressure tends to shift to these older age-classes unless otherwise regulated (i.e., a C strategy will shift to a T strategy simply by changes in hunter behavior). This change in hunter behavior actually results in fewer trophy animals being present in a population until a 1:1 adult sex ratio is approached. However, T strategies show significantly lower yearling buck harvest percentages than C strategies, despite producing fewer trophy age-class animals (T strategies do produce the greatest overall numbers of ≥2.5 year old bucks, however) (Tables 3-5). Type Y strategies, in contrast, have the highest yearling buck harvest percentages, yet produce the greatest numbers of trophy age-class deer until a 1:1 adult sex-ratio is approached. Thus, population management strategies focusing on yearling buck harvest percentages alone are simplistic, being tied to a critical assumption that is often violated as a population shifts towards increasing older-age class animals. Focus on yearling buck harvest percentage alone does not provide any confident insights into the buck age structure present in a deer population.

CONCLUSIONS

Buck harvest strategies aimed at increasing buck:doe ratios can result in increased proportions of older age-class bucks, but only at the expense of decreased population production and hunting opportunity. Despite popular belief, yearling buck harvest percentages tell little about the age structure of the buck population being harvested, especially as the proportion of bucks in the population increases. Harvest strategies aimed solely at providing certain yearling buck harvest percentages, without concurrent evaluation of hunter selectivity, have little biological basis as a legitimate white-tailed deer population management tool.

ACKNOWLEDGEMENTS

Funding for this projected was provided by the Indiana Department of Natural Resources, Division of Fish and Wildlife, through Pittman-Robertson Project W-26-R-23 (13B). We thank John Olson, Jim Mitchell, and Lou Cornicelli, IDNR, for their contributions to this project.

LITERATURE CITED

Bartholow, J. 1986. POP-II system documentation. Fossil Creek Software, Ft. Collins, CO. 59pp.

Bender, L.C. 1992. The Michigan elk: Ecology of a heavily exploited population. Ph.D. Dissertation, Michigan State Univ., East Lansing. 199pp.

Carpenter, L.H., and R.B. Gill. 1987. Antler point regulations: the good, the bad, and the ugly. Trans. West. Assoc. Game Fish Comm. 67:94-107.

Creed, W.A., B.E. Kohn, and K.R. McCaffery. 1978. Deer population measurements in management units. Wis. Dep. Nat. Res. Perf. Rep. No. 209. 25pp.

Fleming, K.M. 1983. Quality white-tailed deer management on an east Texas hunting club. Proc. Annu. Conf. Southeast. Assoc. Fish Wildl. Agencies 37:118-126.

Gladfelter, L. 1980. Deer population estimators in the midwest farmland. Pages 5-11 in R.L. Hine and S. Nehls (eds.). White-tailed deer population management in the north central states. North Central Section, The Wildl. Soc.

Hernbrode, B. 1987. Elk harvest management--meeting the challenges of quantity and quality. Trans. West. Assoc. Game Fish Comm. 67:88-93.

Lang, L.M., and G.W. Wood. 1976. Manipulation of the Pennsylvania deer herd. Wildl. Soc. Bull. 4:159-165.

Langenau, E. 1988. Managing Michigan deer herds for trophy bucks. Mich. Dep. Nat. Res. Wildl. Div. Rep. No.3080. 16pp.

Ueckermann, E. 1987. Managing German red deer (*Cervus elaphus* L.) populations. Pages 505-516 in C.M. Wemmer (ed). Biology and management of the Cervidae. Smithsonian Institute Press, Washington D.C.

Weigand, J.P., and R.J. Mackie. 1987. What's working and what's not: an overview to approaches to management for quality hunting. Trans. West. Assoc. Game and Fish Comm. 67:69-76.

Table 1. Initial inputs of Indiana's generalized Pop-II deer population model.

AGE	Population Proportions M	Population Proportions F	Preseason Mortality M	Preseason Mortality F	Postseason Mortality M	Postseason Mortality F	Young per 100 Does
0.5	0.251	0.206	0.15	0.15	0.11	0.11	68
1.5	0.135	0.118	0.07	0.07	0.11	0.11	174
2.5	0.051	0.082	0.07	0.07	0.11	0.11	195
3.5	0.006	0.044	0.07	0.07	0.11	0.11	195
4.5	0.004	0.032	0.07	0.07	0.11	0.11	195
5.5	0.002	0.014	0.07	0.07	0.12	0.12	195
6.5	0.002	0.012	0.07	0.07	0.13	0.13	195
7.5	0.001	0.010	0.07	0.07	0.14	0.13	195
8.5	0.001	0.009	0.07	0.07	0.15	0.15	195
9.5	0.001	0.007	0.07	0.07	0.17	0.17	195
10.5	0.001	0.006	0.07	0.07	1.00	1.00	---

SEX RATIO AT BIRTH: 110 MALES PER 100 FEMALES

Table 2. Relative effort values used to mimic differing hunter selectivity using Pop-II's hunter effort option.

	Harvest strategy					
	C (Aselective)		T (Trophy)		Y (Yearling)	
AGE	M	F	M	F	M	F
0.5	1	1	1	1	1	1
1.5	1	1	1	1	2	1
2.5	1	1	2	1	1	1
3.5	1	1	2	1	1	1
4.5	1	1	2	1	1	1
5.5	1	1	2	1	1	1
6.5	1	1	2	1	1	1
7.5	1	1	2	1	1	1
8.5	1	1	2	1	1	1
9.5	1	1	2	1	1	1
10.5	1	1	2	1	1	1

Table 3. Comparisons among alternative harvest simulations. Simulations were based on a post-harvest population size (after pre-season natural mortality and harvest mortality) of 1000 deer at the herd sex- and age-compositions shown. A final sex- and age-composition of 37 adult bucks per 100 adult does, and 135 fawns per 100 adult does, represents mean current conditions across Indiana.

Ratio Goal[1]	Pop Size[2]	Tot Harvest[3]	% YEAR[4]	% AB[5]
37:100:135	1639	421 (0%)	66	53
50:100:135	1603	395 (- 6%)	59	46
75:100:135	1546	350 (-17%)	49	34
100:100:135	1496	311 (-26%)	42	26

[1] Ratio Goal: Desired herd ratios immediately after harvest (# adult bucks:100 adult does: # of fawns).

[2] Pop Size: Stabilized population size immediately after fawning that produces desired herd ratio.

[3] Tot Harvest: Stabilized sustained harvest produced by simulated population. Percent difference from current strategy is shown in parentheses.

[4] % YEAR: Percent yearling bucks in simulated buck harvest.

[5] % AB: Percent adult bucks harvested.

Table 4. Population structure of a deer population with a post-harvest population level of 1000 animals and final sex- and age-structure as indicated (# bucks:100 adult does: # fawns).

	37:100:135				50:100:135			
AGE	C[1] B[2]	T B	Y B	D	C B	T B	Y B	D
0.5	393	393	393	357	375	375	375	341
1.5	231	231	231	210	221	221	221	184
2.5	79	108	56	129	91	118	68	123
3.5	27	12	30	79	38	29	38	75
4.5	9	1	16	48	16	7	22	46
5.5	3	0	9	29	6	2	12	28
6.5	1	0	5	18	3	0	7	17
7.5	0	0	2	11	1	0	4	10
8.5	0	0	1	6	0	0	2	6
9.5	0	0	1	4	0	0	1	3
10.5+	0	0	0	2	0	0	1	2

	75:100:135				100:100:135			
AGE	C B	T B	Y B	D	C B	T B	Y B	D
0.5	345	345	345	313	319	319	319	290
1.5	203	203	203	184	187	187	187	170
2.5	105	126	83	113	110	127	92	104
3.5	54	52	51	69	65	67	61	64
4.5	28	22	32	42	38	35	41	39
5.5	14	9	20	26	23	18	27	24
6.5	7	4	12	16	13	10	17	14
7.5	4	2	7	9	8	5	11	9
8.5	2	1	4	6	4	2	7	5
9.5	1	0	3	3	2	1	4	3
10.5+	0	0	1	2	1	1	3	2

[1] C=Harvest proportional to age-class (i.e. aselective); T=Harvest selective towards older age-class (trophy) bucks; Y=Harvest selective towards younger (yearling) age-class bucks.

[2] B=Numbers of bucks; D=Numbers of does.

Table 5. Harvest structure from a deer population with a post-harvest population level of 1000 animals and final sex- and age-structure as indicated (# bucks:100 adult does: # fawns).

	37:100:135				50:100:135			
AGE	C[1] B[2]	T B	Y B	D	C B	T B	Y B	D
0.5	67	67	67	61	64	64	64	58
1.5	114	85	138	46	93	66	118	44
2.5	39	80	17	28	39	71	18	27
3.5	14	9	9	17	16	17	10	17
4.5	5	1	5	11	7	4	6	10
5.5	2	0	3	6	3	1	3	6
6.5	1	0	1	4	1	0	2	4
7.5	0	0	1	2	0	0	1	2
8.5	0	0	0	1	0	0	1	1
9.5	0	0	0	1	0	0	0	1
10.5	0	0	0	0	0	0	0	0
TOTAL[3]	174	174	174	247	159	159	159	235
% YR[4]	66	49	79		59	42	74	
% TR[5]	5	0	6		7	3	8	

	75:100:135				100:100:135			
AGE	C B	T B	Y B	D	C B	T B	Y B	D
0.5	59	59	59	54	55	55	55	50
1.5	65	43	87	41	46	29	64	37
2.5	33	53	18	25	27	39	16	23
3.5	17	22	11	15	16	21	10	14
4.5	9	9	7	9	9	11	7	9
5.5	5	4	4	6	6	6	5	5
6.5	2	2	3	3	3	3	3	3
7.5	1	1	2	2	2	2	2	2
8.5	1	0	1	1	1	1	1	1
9.5	0	0	1	1	1	0	1	1
10.5+	0	0	0	0	0	0	0	0
TOTAL	133	133	133	217	111	111	111	201
% YR	49	32	66		42	26	59	
% TR	14	12	14		20	21	17	

[1] C = Harvest proportional to age-class (i.e. aselective); T=Harvest selective towards older age-class (trophy) bucks; Y=Harvest selective towards younger (yearling) age-class bucks.

[2] B = Numbers of bucks; D=Numbers of does.

[3] Total antlerless harvest (does + fawns). The other TOTAL (i.e., 133 or 111) is the number of adult bucks only.

[4] Percent yearling bucks in harvest.

[5] Percent of bucks age 4.5 or older in harvest.