

**PENNSYLVANIA GAME COMMISSION
BUREAU OF WILDLIFE MANAGEMENT
RESEARCH DIVISION
PROJECT ANNUAL JOB REPORT**

PROJECT CODE NO.: 06210

TITLE: White-tailed Deer Research/Management

PROJECT JOB NO.: 21008

TITLE: Fawn Survival Study

PERIOD COVERED: 1 July 2000 to 30 June 2001

COOPERATING AGENCIES: Pennsylvania Cooperative Fish and Wildlife Research Unit, The Pennsylvania State University

WORK LOCATION(S): Quehanna Wild Area (QWA) in Elk, Cameron, and Clearfield Counties and Penns Valley (PV) in Centre County

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DATE: 20 March 2002

Abstract: We selected 2 study areas, 1 forested and 1 agricultural, in which to capture and monitor fawns. Fawns were located by foot searches in suitable fawning habitat or vehicular searches for does exhibiting maternal behavior. Fawns were captured by hand or with dipnets. Captured fawns were outfitted with expandable radio collars, ear-tagged, measured, sexed, weighed, and released. Fawns were located by triangulation and monitored for survival. When mortality occurred, the collar was located and physical and photographic evidence was collected at the site. Cause of death was determined from the evidence, and survival rates were estimated. Ninety-eight fawns were captured, 52 in Penns Valley (PV) and 46 in Quehanna Wild Area (QWA). Fifty-six known deaths of radio-tagged fawns occurred during the monitoring period. Predation by coyotes and black bears was the leading cause of mortality in QWA. Natural causes other than predation (e.g., starvation, malnutrition, disease) were the leading cause of mortality in PV. Fawn survival to 34 weeks was similar in the 2 study areas. However, an initial greater predation rate in QWA led to lower overall survival by the end of the 34-week monitoring period.

OBJECTIVES

To quantify proportions of white-tailed deer fawns dying from specific causes and to estimate survival rates of fawns.

PROCEDURES

Study Areas

One forested and 1 agricultural landscape were selected in which to capture and monitor fawns. Comprising approximately 200 km², the Quehanna Wild Area (QWA) is located in Moshannon and Elk State Forests within portions of Elk, Cameron, and Clearfield counties in the Allegheny Plateau region. QWA is characterized by nearly flat to gently rolling terrain, terminating at abrupt ridges and canyons that descend approximately 350 m to Susquehanna River

drainages. Forest cover is primarily second- and third-growth mature hardwood forest and regenerating cuts with few, small, and scattered permanent openings. Common tree species include red maple (*Acer rubrum*), American beech (*Fagus grandifolia*), and red, black, and white oaks (*Quercus* spp.). Conifers are scarce. Regeneration is sparse and the understory, when present, is dominated by laurel (*Rhododendron maximum*), sweet fern (*Comptonia peregrina*), blueberry and huckleberry (*Vaccinium* spp.), and ferns. Ground cover is comprised of mosses and leaf litter. A distinct browse line is evident throughout much of QWA. QWA is public land and the area is bisected by dirt roads; hiking, skiing, and snowmobile trails; and utility (gas and electric) corridors. A large swath of currently regenerating hardwood forest was created by a tornado in 1985. Hunting is permitted, and QWA receives substantial pressure, especially during the antlered deer season. QWA likely supports a diverse assemblage of potential fawn predators including black bears, coyotes, red foxes, and bobcats, but densities are known only for black bears.

Penns Valley (PV) in Centre County is a typical agricultural valley located approximately 30 km east of State College in Pennsylvania's "ridge and valley" province. The PV study site extends to portions of Brush Valley to the north and George's Valley to the southwest and encompasses approximately 280 km². Most of the valley land is devoted to corn, soybean, and hay and alfalfa crops, and dairy agriculture. Development primarily is limited to low-density residential housing and small hamlets and villages. Small hardwood woodlots are found in agriculturally unproductive areas, around farmsteads and housing developments, and along riparian corridors. Slopes and ridges surrounding PV are contiguous eastern oak-hickory (*Carya* spp.)-maple (*Acer* spp.) forests. Bald Eagle and Poe Paddy State Forests are located on forested ridges to the east, north, and south of PV. Because of limited access to private land, hunting pressure might be less in PV than in the QWA. Black bears, bobcats, coyotes, and foxes are present in and around PV, but in unknown numbers.

Capture and Handling

Suitable fawn habitat (dense understory growth in wooded areas, tall grasses, hayfields, alfalfa, reverting pasture and cropland, riparian corridors) was identified from orthographic photographs, informal interviews with landowners, and ground reconnaissance of the 2 study sites. In PV, permission was obtained to access property of >60 private landowners owning >3,000 hectares of potential fawn habitat.

Fawn capture commenced on 16 May 2000 and extended through late June on both study sites. Foot searches were used to locate bedded fawns in PV. Eight to 10 persons, standing 3-5 m apart, slowly and methodically canvassed suitable habitat looking for bedded fawns. Foot searches were used with little success for the first 2 weeks of fawn searching in QWA. Vehicle searches were used thereafter. Crews separated among several vehicles, each slowly (15 - 30 kph) canvassing different portions of QWA. Crews looked for fawns, or for does exhibiting characteristic maternal behaviors. Bleat calls were used to elicit behaviors suggestive of the presence of fawns from solitary does.

Fawns were captured by hand or by herding fawns into dipnets (0.9-m hoop diameter on 1.2-m handles). Fawns were handled according to approved protocol described in The Pennsylvania State University Institutional Animal

Care and Use Committee project #99R060-0. Handlers were instructed on proper capture and handling techniques. To minimize scent transferal to fawns from handlers and among fawns, handlers wore surgical gloves, weighing equipment was washed frequently, and a limited number of persons handled each fawn. Fawns were outfitted with expandable radio collars and individually numbered ear tags, blindfolded with clean socks, measured for neck circumference (nearest 0.1 cm), sexed, weighed (nearest 0.1 kg) in canvas bags or pillow cases, and released, usually within 5 minutes of capture.

Radio Collars and Ear Tags

Captured fawns were fitted with 164-165 MHz VHF radio signal-transmitting collars (Advanced Telemetry Systems, Inc., Isanti, MN). Each transmitter-collar combination weighed 97 g. Transmitters were equipped with a 1-year battery and a mortality sensor (that doubled the pulse-transmission rate from 55 to 110 pulses per minute if a collar remained motionless for 4 hours), and were affixed to elastic-cotton collars sewn with a series of 3 expansion folds stitched with cotton thread designed to rot and release with exposure to ultraviolet light and wet and dry conditions.

Each fawn was tagged in both ears with same-numbered brown plastic ear tags designed for use on livestock ("original" tags, Temple Tag Co., Temple, TX). Tags were one-piece, snap-on design, weighing only a few grams. Applicators were used to create approximately 4-mm diameter holes through fawn's ears between 2 veins running parallel in the ear. Applicators and tags were treated with a disinfectant prior to and following application. Ear tags and radio collars were imprinted with the toll-free telephone number for the Northcentral Regional Office of the Pennsylvania Game Commission.

Radio-Telemetry Monitoring

Fawns were monitored for survival and located by triangulation using ground-based telemetry as often as 3 times per day during June-August, approximately 2-4 times per week during August-November, and <1-1 time per week during November-April. When the mortality signal from the transmitter indicated a motionless collar, the collar was located as soon as possible. Physical and photographic evidence was gathered at each mortality site. When predation was suspected, evidence was compared to published accounts of predator-specific kill characteristics. When cause of death could not be determined in the field, carcasses were delivered to the Animal Diagnostics Laboratory at The Pennsylvania State University for veterinarian necropsy.

Analyses

Fawn survival rates were estimated by a nonparametric estimator (Kaplan and Meier 1958, Pollock et al. 1989). One assumption of this technique is that each animal has the same survivorship function. Because fawns were caught during 3-5 week periods of changing spring phenology and predator and deer behavior in May and June, this assumption likely was violated. Therefore, fawns were given a common entry date to reduce bias associated with the traditional staggered-entry model. Survival rates were estimated to 34 weeks post-capture. This interval encompassed any mortalities accrued during the late archery and flintlock seasons in the January following the year in which fawns were captured. Penn State graduate student Justin Vreeland collected, managed, and analyzed all data.

FINDINGS

Fawn Capture

Ninety-eight fawns were captured (Table 1), 52 in PV and 46 in QWA. Overall male:female sex ratio of captured fawns was 1.4:1. Fawns were captured between 16 May and 20 June in PV and between 29 May and 25 June in QWA.

Sources of Mortality

Leading sources of mortality of monitored fawns within 34 weeks of capture were natural causes (e.g., starvation, malnutrition, disease) excluding predation in PV and predation in QWA (Table 1). Predation and natural causes excluding predation were the second leading causes of death in PV and QWA, respectively. Vehicular collisions and unusual accidents were the third leading cause of death in PV. Legal hunting harvest was the third leading cause of death in QWA.

Eighty-five percent of all predation events within 34 weeks of capture occurred in QWA. Coyotes (*Canis latrans*) were implicated in 34.78 % of the predator mortalities in QWA, and they were responsible for 40.74 % of predation deaths in both areas (Table 2). Bears (*Ursus americanus*) killed the next highest number of fawns, 22.22 % of the total predator deaths. All of the bear and bobcat predation occurred in QWA. Known predation deaths beyond the 34-week reporting period include 1 death by coyote and 1 death by bobcat (*Lynx rufus*), both in QWA, in February and March 2001, respectively.

Survival Rates

Statistically, survival to 34 weeks was similar (partial to near complete overlap of 95% log-normal confidence intervals) between PV and QWA (Figure 1). However, 34-week survival rates were greater overall in PV (58.7%) than in QWA (32.4%). Survivorship in QWA declined precipitously through the first 7 weeks, primarily due to predation (Figure 1). Predation deaths in QWA continued to accrue through approximately 10 weeks, at which point survivorship began to level off. The initial greater predation rate ultimately led to lower overall survival by the end of the 34-week monitoring period.

Survivorship in PV declined sharply during the first 2 weeks after capture, but soon began to level off (Figure 1). Mortalities in PV accrued slowly for the remainder of the 34-week monitoring period.

RECOMMENDATIONS

This report summarizes the first year of a 2-year study. The second year will be a replicate of the first year. More efficient search and capture techniques developed in year one will be used to deploy larger numbers of mortality collars in the second year.

LITERATURE CITED

Kaplan, E. L., and P. Meier. 1958. Nonparametric estimation from incomplete observations. Journal of the American Statistical Association 53:457481.

Pollock, K. H., S. R. Winterstein, C. M. Bunck, and P. D. Curtis. 1989.
Survival analysis in telemetry studies: the staggered entry design.
Journal of Wildlife Management 53:715.

Table 1. Sources and proportions of fawn mortality in the Penns Valley (PV [n=52]) and Quehanna Wild Area (QWA [n=46]) study sites during the 34-week interval from May-January, 2000-01.

Source	% captured fawns		% known-fate fawns ^a
	PV	QWA	
Predation	12.12	57.50	36.99
Natural causes ^b	33.33	15.00	23.29
Vehicular collisions	6.06	5.00	5.48
Hunting harvest	9.09	3.00	5.48
Farm machinery	3.03	0.00	1.37
Poaching	0.00	2.50	1.37
Unusual accidents ^c	6.06	0.00	2.74
Total deaths	69.70	82.50	76.71

^aPercent of 73 known-fate fawns.

^bExcluding predation. Includes, but is not limited to, starvation, malnutrition, disease, organ failure, internal parasites.

^cOne fawn fell down an abandoned well and starved, dehydrated, or died from exhaustion.

Table 2. Proportion of all mortalities, and proportion of predation mortalities attributed to bears, coyotes, bobcats, and unidentified predators in the Quehanna Wild Area (QWA) and Penns Valley (PV) study sites during the 34-week interval from May-January, 2000-01.

Predator species	% of monitored fawns ^a	% of total deaths ^b	% of predation deaths ^c
Coyote	11.22	19.64	40.74
Bear	6.12	10.71	22.22
Bobcat	3.06	5.36	11.11
Unidentified	7.14	12.50	25.93
Total predation	27.55	48.21	100.00

^an=98.

^bn=56 known deaths of monitored fawns.

^cn=27 known predation events.

Figure 1. Kaplan-Meier common-entry survivorship curves (with 95% log-normal confidence intervals) to 34 weeks after capture, QWA and PV, 2000-01.

