

**FINAL REPORT**

**GAME FARM RING-NECKED PHEASANT (*PHASIANUS COLCHICUS*) HARVEST RATES IN PENNSYLVANIA**



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## Executive Summary

Ring-necked pheasants (*Phasianus colchicus*) have long been a popular game species in Pennsylvania. Recent surveys have revealed that about 10% of Pennsylvania hunters participated in pheasant season each year, with about 50% of current hunters having participated in the past 5 years. Pennsylvania Game Commission's pheasant propagation program is widely supported by Pennsylvania hunters, and has released over 200,000 pheasants annually in recent years.

In order to estimate harvest rates of pheasants, we banded and released 5,566 pheasants (3,567 males, and 1,999 females) throughout Pennsylvania during all releases of the 2015-16 season. We used \$100 reward bands on a subsample of pheasants to estimate reporting rate of non-reward bands. Persons recovering bands from dead pheasants (hunter-harvested, road-killed, etc.) reported band information via toll-free telephone number stamped on each band. We received reports of 2,069 banded pheasant recoveries, of which 2,026 were hunter-harvests. A total of \$47,100 in reward payments were processed. Reporting rate for non-reward bands was 67.8%.

Daily survival rates differed between male and female pheasants, between public and private properties, and among pheasants released during different stockings during the season. Male daily survival rate overall was 88.4%, and ranged from 44.4% for those released on the 4<sup>th</sup> in-season release on private properties to 96.1% for males released on private properties for the Junior hunt. Female daily survival rate was 87.9%, and ranged from 70.9% for those released on public properties during the winter hen release to 95.9% for those released on private properties during the 3<sup>rd</sup> in-season release. Overall harvest rate was 49.1%, but differed between males and females and between those released on public properties and those released on private properties. Overall, 53.8% of males and 41.1% of females were harvested. Harvest rates were similar between other public properties (50.7%) and SGLs (48.7%), but were significantly higher than harvest rates on Hunter Access properties (37.3%).

We examined correlates of harvest rates and found that most important variables were those associated with making and keeping more pheasants available to hunters. Harvest rates were relatively high on public properties that received 5 releases of pheasants from preseason through 4<sup>th</sup> in-season release. The week following a release, hunters may flush pheasants from off a property; thus releasing pheasants each week leads to more pheasants available on properties open to hunters. Releasing more pheasants over the course of the season on a property made a slight improvement in harvest rates, but pheasants released at locations more centrally located within the property, i.e., farther from adjacent properties where they may escape hunter pressure, resulted in higher harvest rates. Harvest rates were higher for pheasants released later in the week, i.e., closer to Saturday. On public properties, vegetative cover types had little if any effect on harvest rates, though harvest rates increased with an increase in shrub cover within ½ mile of release location.

In the 2015-16 season, 231,316 pheasants were released, including breeders, at a cost of \$4,378,799.40, which accounts for chick sales. On average, the cost to raise and release a pheasant was \$18.93. The cost of a hunter-harvested pheasant overall was \$38.55; \$35.19 for males, and \$46.06 for females. Costs of hunter-harvested males ranged from \$34.84 on public properties to \$44.30 on private properties. Costs of hunter-harvested females ranged from \$45.38 on public properties to \$74.94 on private properties.

Results of this study suggest the following management considerations.

(\*) Continue to release pheasants later in the week to reduce non-hunting mortality and increase harvest rates, as more hunter effort is concentrated later in the week and on Saturdays. Harvest rates of pheasants released during preseason could be improved by stocking Wednesday through Friday, i.e., eliminate releases on Tuesday. Consider a regulation to prohibit dog training on state game lands the week before the regular season opener. (This regulation was adopted by the Board of Commissioners at their March 2017 meeting)

(\*) Increase proportion of pheasants released on public properties, as the best pheasant hunting habitat and hunter access are found there, resulting in more pheasant hunter pressure and highest harvest rates.

(\*) Public properties that are not stocked regularly through the season, presumably because of some pheasant hunting habitat quality or quantity deficiencies should be considered for elimination from stocking schedules until those deficiencies are corrected. Release pheasants on a consistent basis throughout the season (preseason through 4<sup>th</sup> in-season release) rather than skipping some in-season releases.

(\*) Release pheasants in good pheasant hunting habitat as far as possible from property boundaries.

(\*) Increase shrub cover where possible to retain pheasants within property boundaries. Tree cutting or old field succession can be used to accomplish this goal, but an additional alternative is to plant fields with warm season grass stands such as switch grass.

(\*) Eliminate release of females during Junior releases in WMUs under cocks-only regulations. In 2015, female pheasants were released in either-sex WMUs during Junior release for education purposes (this practice was discontinued on 2016).

(\*) Increase hunter awareness of stocking locations through publicly available mapping application that would be updated every year with the previous year's stocking data. Stocking locations remain relatively unchanged between years. Efforts are underway to develop and make available to the public a mapping program that shows all public lands stocked with Pennsylvania Game Commission farm pheasants.

## **Introduction**

Ring-necked pheasants (*Phasianus colchicus*) have long been a popular game species in Pennsylvania, dating back to the early 1890s when they were introduced into Pennsylvania. Through the mid-1900s, wild reproducing pheasants increased in number and range, and were supplemented with Pennsylvania Game Commission raised pheasants released into the wild. Wild pheasant numbers increased greatly from the 1950s to the early 1970s, when more than 800,000 Pennsylvania hunters pursued this species (Pennsylvania Game Commission, unpublished data). Pheasant populations declined beginning in the early 1970s, and are virtually non-existent today. From 1929 when Game Commission began raising pheasants on game farms, through the most recent hunting season, millions of pheasants have been released. Today, pheasant hunting in Pennsylvania is dependent upon propagated birds from the Game Commission's game farms and from private sources.

From the 2012-13 hunting season through the 2015-16 hunting season, over 200,000 pheasants have been released annually, with about 10% of Pennsylvania hunters in pursuit (Johnson and Boyd 2016). A hunter survey on pheasant management in 2013 indicated that 12% of Pennsylvania's hunters

participated in hunting Game Commission released pheasants in 2012; 3% hunted on shooting preserves for pheasants, but not Game Commission released pheasants; 52% hunted pheasants in the past, but not in 2012; and 31% never hunted pheasants in Pennsylvania. A 2017 hunter survey indicated 39% of Pennsylvania hunters have hunted pheasants at least once in the past 5 years (C. Jagnow, Pennsylvania Game Commission, unpublished data). Indeed, Game Commission's pheasant propagation program is widely supported by Pennsylvania hunters, with 77.1% of all hunters in support, and 64.8% of hunters who have never hunted pheasants in support according to the 2013 survey of Pennsylvania hunters (Johnson et al. 2014).

Pennsylvania Game Commission guiding documents, including the 2015 Strategic Plan and Pennsylvania Game Commission ring-necked pheasant management plan, recognize the importance of game farm pheasant stocking in enhancing hunter opportunity, and call for increasing the percent of game farm pheasants harvested by hunters. An objective in the Pennsylvania Game Commission 2015 Strategic Plan is to "by 2020, increase harvest rate of Pennsylvania Game Commission-released pheasants by 10% to increase hunter opportunity". The Pennsylvania Game Commission ring-necked pheasant management plan indicates the agency should "review and revise as needed Game Commission stocking protocols and standards to maximize hunting opportunity for game farm releases and increase game farm pheasant harvest rates to 60% or greater" (Klinger and Reigner 2008).

Several studies have examined harvest rates of game farm pheasants in Pennsylvania (Gerstell 1938, Hartman 1968, Kriz 1968, Kriz et al. 1974, Diefenbach et al. 1999, 2000). However, only one estimated harvest rates statewide and accounted for reporting rates of non-reward banded pheasants (Diefenbach et al. 1999, 2000). Their study estimated hunters harvested 42.8% of game farm pheasants, including those released in September for dog training (Diefenbach 1999). Non-reward bands in their study were reported at a rate of 71.0%.

One of the challenges of a study that uses banded animals is that not all bands that are recovered are reported, resulting in a negative bias in harvest estimates. For example, if 1,500 of 2,000 banded pheasants were harvested by hunters, and 100% of those harvests were reported, the harvest rate estimate would be 75%. If only 50% of bands were reported (750 pheasants), our harvest rate estimate would be 37.5%. The most efficient method of assessing reporting rate is to band a subset of pheasants with reward bands. Reward amount has a positive effect on reporting rate (higher reward amounts result in higher reporting rates), but consensus is that a \$100 reward results in nearly 100% reporting rate (Nichols et al. 1991, Diefenbach et al. 2000). Further, reward amount must be stamped on bands to provide incentive to report, as opposed to stamping bands with "reward"; an unclear incentive would provide unclear results (Dillman et al. 2009).

Reporting rates of ~100% for reward bands allow for calculation of reporting rate of non-reward bands. Harvest rate ( $H$ ) is estimated by  $H = m'/R'$ , where  $m'$  is the number of reward bands reported, and  $R'$  is the number of reward bands released. Estimate of reporting rate is calculated as:  $\lambda = (m/R)/H$ , where  $m$  is the number of non-reward bands reported, and  $R$  is the number of non-reward bands released (Williams et al. 2002). For example, if we released 1,000 pheasants with non-reward bands ( $R$ ), and 500 pheasants with reward bands ( $R'$ ), and 300 non-reward bands were reported ( $m$ ) and 250 reward bands were reported ( $m'$ ), then:  $\lambda = (300/1000)/(250/500)$ ; reporting rate is 60%.

## **Pheasant stocking and hunting season structure**

The game farm pheasant harvest rate study conducted in Pennsylvania in 1998 recommended that percentage of pheasants harvested by hunters could be increased by allocating releases to times and locations where harvest rates were greater (Diefenbach et al. 1999, 2000). Consequent to the study, hens were no longer released in September for dog training, as only 15.3% of hens were harvested. Also, in 1998, pheasant management in Pennsylvania was administered in two zones, an either-sex zone (basically north of Interstate 80) and a male-only zone. Hens were not allowed to be harvested in the south zone, but 10-20% of the birds stocked there were hens. Since 1998, Pennsylvania was split into 23 ecologically based Wildlife Management Units (WMUs), with pheasant hunting allowed in all WMUs; however, by the 2015-16 hunting season, only males were allowed to be harvested in WMUs 2A, 2C, 4C, 4E, 5A, or 5B, and essentially no hens were stocked there (Figure 1). In 1998, State Game Lands (SGL) and other public lands were found to have higher harvest rates than private lands in the hunter access program. An effort was made to have a higher percentage of pheasants released on public lands. In 1998, 49.3% of pheasants were stocked on public lands and by 2015 this number had increased to 87.7%.

The 2015-16 Pennsylvania pheasant hunting season consisted of a one-week Junior hunt (October 10–17) open only to Junior hunting license holders (newly established in 2002), a five-week season (October 24 – November 28) open to all hunters prior to white-tailed deer rifle season, followed by an 11-week season open to all hunters after close of white-tailed deer rifle season (December 14, 2015 – February 29, 2016). Hunting was not allowed on Sundays, or on Christmas Day. Daily bag limit was 2 pheasants.

Pheasants were raised on four Game Commission-operated game farms and stocked in 22 of 23 WMUs (Figure 2). Numbers of pheasants released were allocated according to pheasant hunting habitat acreage, and hunter pressure as determined from Game Take Survey (Johnson and Boyd 2016). Stocking crews received crates of pheasants at game farms on mornings of day of release. For Junior hunt, pheasants were released Friday, October 9. Pheasants were released preseason (Tuesday – Friday, October 20–23), during the first week of the season (Tuesday – Friday, October 27–30), second week of the season (Wednesday – Friday, November 4–6), third week of the season (Thursday – Friday, November 12–13), and fourth week of the season (Thursday – Friday, November 19–20). A release of females was conducted on Friday, December 18 (i.e., winter release) in either-sex WMUs. Compared to the 1998 pheasant releases, the Junior release was new, as was the added release during the 4th week of the season.

Pheasants were stocked on Game Commission SGLs, on other public lands (e.g., State Parks, county parks, etc.), and on private properties enrolled in Game Commission Hunter Access program.

Given changes made to pheasant season structure and stocking strategies since 1998, our objectives were to reevaluate harvest rates for male and female pheasants on public and private properties for each release of the season throughout Pennsylvania. Further, we examined harvest rates at WMU scale, and relations to harvest rates of cover types at and surrounding release locations.

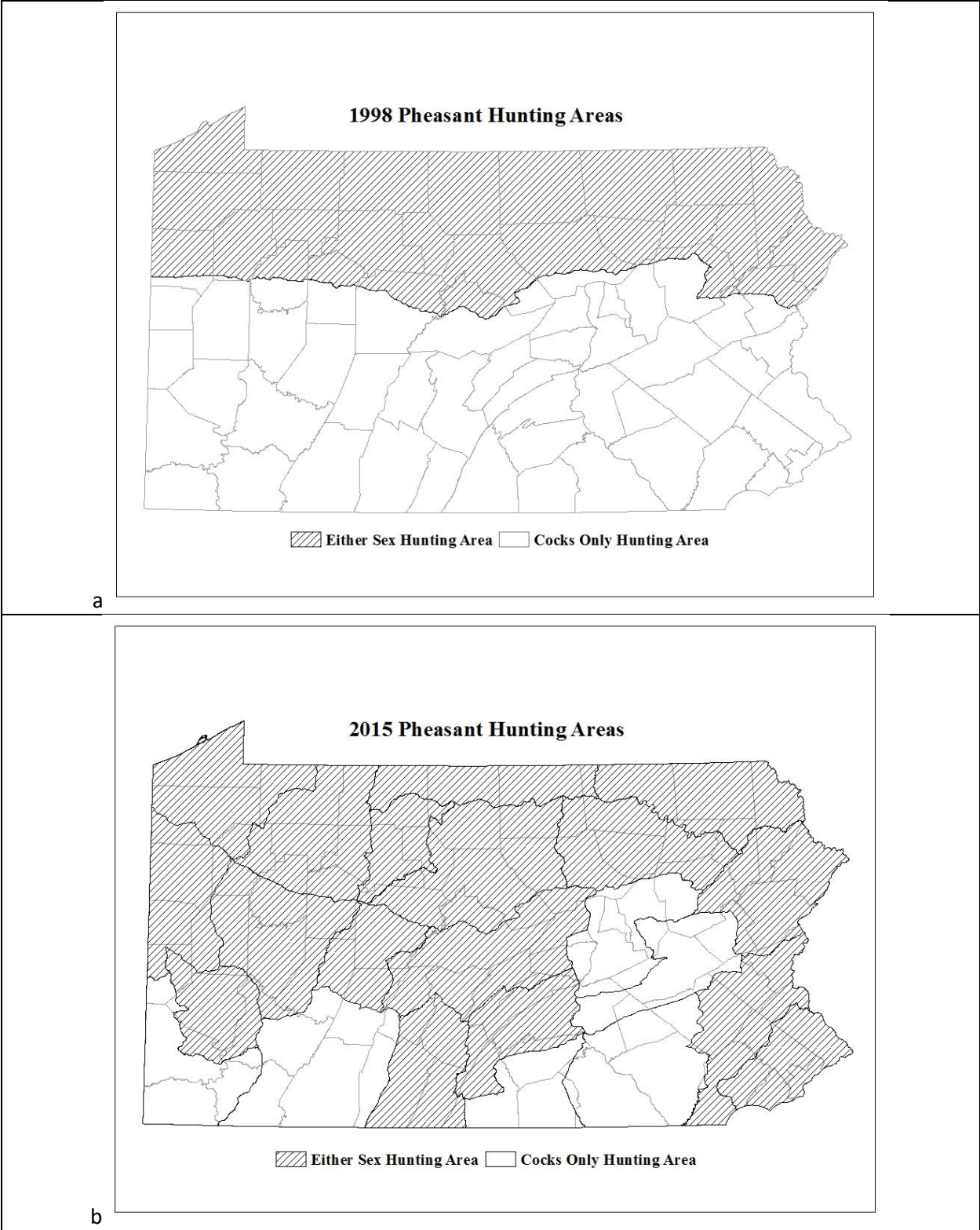


Figure 1. Either-sex and cocks only pheasant hunting zone in Pennsylvania, a) 1998, and b) 2015.

# 2015 Pheasant Stocking

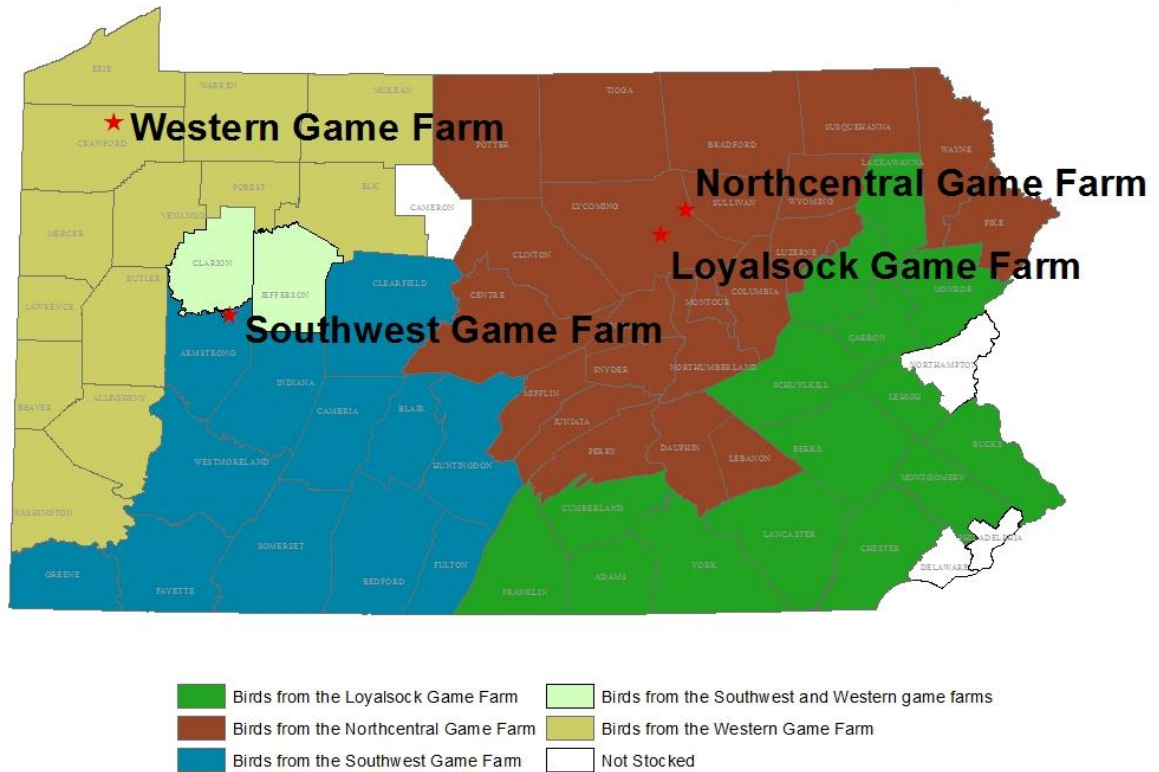


Figure 2. Distribution of ring-necked pheasants from four Pennsylvania Game Commission game farms in Pennsylvania, 2015.

## Methods

We conducted a band-recovery study to determine harvest rates of game farm pheasants released in Pennsylvania during the 2015-16 hunting season. Methodology closely resembled that of the pheasant harvest rate study conducted in 1998 (Dieffenbach 1999, 2000).

## Sample size determination

To determine sample sizes of banded pheasants, we used Proc Simulate in Program SURVIV (White 1992). Model simulation constraints (i.e., harvest, survival, and reporting rates) were specified to approximate ranges encountered in 1998 (Dieffenbach et al. 1999, 2000). Sample sizes of all strata (males, females, and releases) were adjusted to satisfy goodness-of-fit tests (White 1992). Sample sizes among releases were consistent (with exception of winter release), but male and female sample sizes were in approximate proportion to the ratio in which they were stocked overall. Further, geographic distribution of banded pheasants was in approximate proportion in which they were stocked.

## **Pheasant banding**

Bureau of Wildlife Management personnel provided training to staff that participated in banding pheasants to ensure bands would be applied correctly, and data recorded accurately. Pheasants were banded at all four Game Commission game farms to achieve statewide distribution of banded birds; each game farm provides pheasants for separate areas of Pennsylvania. Pheasants were banded as they were being crated (10 pheasants per crate). Females were banded and crated the afternoon prior to the day of release. Males were banded and crated the morning of day of release.

## **Pheasant bands**

Non-reward bands were aluminum butt-end leg bands that were anodized green for males and gold for females (National Band and Tag Company, Newport, KY). Males were fitted with size 14 bands, and females were fitted with size 12 bands. Non-reward bands were stamped with "PA GAME COMMISSION", toll-free number, identification number with prefix "F" for females and "M" for males, and expiration date (EXP 3/16). Reward bands were aluminum lock-on bands; all were silver in color, and same sizes as non-reward bands. Reward bands were stamped with "REWARD \$100", toll-free number, identification number, and expiration date (EXP 3/16). We used lock-on bands to assess band loss, as all pheasants fitted with a reward band also were fitted with a non-reward band on the opposite leg. Reward and non-reward band identification numbers were randomized and then paired (Proc Surveyselect, SAS Institute, Inc., 2011). Each band identification number was randomly assigned a crate number (5 or 10 banded pheasants per crate). Bands were then organized and placed in plastic storage bags, each bag being associated with one crate. Paired reward and non-reward bands were twist-tied together to ensure personnel conducted banding would place paired bands on the same pheasant. Each crate of banded pheasants contained 0–3 reward-banded pheasants.

A data form was placed in each plastic storage bag with the bands; data form listed all band numbers in the bag, crate number, game farm, and stocking crew to receive the crate (Appendix A). When completed, the top half of the data form was separated from the bottom half, and later scanned into pdf format and emailed to the wildlife biometrician. The bottom half of the form remained in the storage bag and was stapled to the crate of banded pheasants. Upon stocking banded pheasants, stocking crews completed the bottom half of the form, which listed crate number, date released, WMU, County, Township, location of release (e.g., SGL 333), and description of release location. Forms were scanned into pdf format and emailed to the wildlife biometrician. Because band numbers were matched to crate numbers, and location where each crate was stocked was provided, we knew when and where each banded pheasant was stocked based on the band identification number.

Stocking crews were instructed to release all banded pheasants within any one crate at the same time. Further, banded pheasants were to be released on public and private lands in approximately the same proportion as non-banded pheasants.

## **Toll-free band reporting number**

A toll-free telephone number was established for this study, and was in operation 24 hours a day, 7 days a week from 9 October 2015 (one day prior to opening of Junior pheasant hunt) through 31 March 2016 (one month following the close of pheasant season). A single voicemail box had a 75 message storage



capacity, less than our anticipated number of calls per day. Therefore, we secured 7 voicemail boxes, one representing each Game Commission region (6 total), and one additional box for callers who did not know in which region they recovered their band(s). After selecting in which region they recovered their band in an auto-attendant menu, callers received a greeting prompting them to leave their name, mailing address, phone number, and best time for us to call them back. We retrieved voicemail messages daily, and returned calls in approximately the order in which they were received.

### **Data collection**

When we contacted callers, we asked them to provide the band color and identification number, if the band was recovered from a pheasant that was harvested, road-killed, or other cause, date and location of band recovery, and verification of their contact information (Appendix B). If the band was for reward, we confirmed that the caller was not a Pennsylvania Game Commission employee, Deputy WCO, Commissioner, or immediate family thereof, as they were not eligible for reward. If we were unable to contact a caller after multiple tries, we mailed them a questionnaire with postage-paid envelope asking them the same questions as in our telephone interviews (Appendix C). Data were entered into a computer application developed by Bureau of Automated Technology Services for the pheasant harvest rate study.

### **Data cleansing**

As stocking locations were received from field crews, we examined and assigned location coordinates, and property names and types as needed. After band recovery data collection period closed, we scrutinized records to ensure reported recovery locations were reasonably close (within same county or in adjacent county) to stocking locations. Further, we determined if band recovery date was on or after stocking date. Pheasants that died due to a cause other than hunting, and/or date of recovery was uncertain, were censored from harvest and survival calculations. Callers were re-contacted to confirm information in few instances.

### **Modeling**

We used program MARK to calculate survival and harvest rates for male and female pheasants, for three property types (SGL, other public lands, and Hunter Access), and for each of seven releases (White and Burnham 1999). Harvest, reporting, and survival rates were calculated using Brownie band-recovery models in program MARK (Brownie et al. 1985). Survival rates were based on probability that a pheasant survived from the day of release to the day of harvest  $i$  ( $S_1 \times S_2 \times \dots \times S_i$ ) and the probability of being harvested and reported on day  $i$  ( $f_i$ ) (Brownie et al. 1985, Diefenbach et al. 1999). Daily, weekly, and 30-day survival rates and their variances were calculated according to Brownie et al. (1985) and Powell (2007). For survival rate models, we used median  $\hat{c}$  to determine goodness-of-fit of fully parameterized models prior to creating more parsimonious models, which were assessed using Quasi-Akaike's Information Criterion for small sample sizes (QAIC<sub>c</sub>). Goodness-of-fit tests for harvest rate models could not be assessed due to presence of reporting rate covariate. Therefore, harvest models were assessed with Akaike's Information Criterion for small sample sizes (AIC<sub>c</sub>). Models separated by  $\leq 2$  QAIC<sub>c</sub> or AIC<sub>c</sub> were considered competing models.

We assessed differences in survival and harvest rates among males and females, among SGL, other public, and Hunter Access properties, and among the seven release periods. We also examined if harvest rates differed among days of the week that pheasants were released. For the preseason release, we compared harvest rates among pheasants that were released Tuesday, Wednesday, Thursday, and Friday and harvested the Saturday of that week (opening day of regular season); a separate analysis examined harvest rates of pheasants released during each day of the preseason release and harvested throughout the pheasant hunting season. Also, we combined data from the four in-season releases to compare harvest rates of pheasants released on Tuesdays, Wednesdays, Thursdays, and Fridays and harvested throughout the pheasant hunting season.

We conducted pairwise comparisons of harvest rates among all WMUs for males, females, and both sexes combined. Also, we examined Pearson's correlation coefficients between WMU harvest rates and 2015-16 Game Take Survey results at the WMU level: number of pheasant hunters, number of pheasant hunter days, and number of pheasants harvested (Johnson and Boyd 2016).

For SGLs and other public properties, we examined associations between harvest rates on each property and the number of times each property was stocked, and the total number of pheasants released on each property. We conducted a similar assessment on a subset of data, which only included data from preseason through 4<sup>th</sup> in-season release for the aforementioned properties. We used a Kruskal-Wallis test to examine differences in cover type acreages (as described below) among properties receiving different number of pheasant releases from preseason through 4<sup>th</sup> in-season (Conover 1999).

Within a Geographic Information System, we extracted variables that could be associated with pheasant harvest rates in SGLs and other public properties where data were available. Using ArcMap 10.4 (ESRI, Redlands, CA) and 30 m resolution raster land use/land cover data (Homer et al. 2015), we measured the percentage of field (herbaceous, pasture, hay, and crops), shrub (included true shrubs and young trees in early successional stage), forest (deciduous, evergreen, and mixed forest types), wetland (woody and emergent wetlands), and nonhabitat, which we defined as open water, barren ground, roads and other developed areas (shooting ranges) within ¼ mile, ½ mile, and 1 mile of release locations (Figure 3). Using land cover and property boundary polygon data collected by Game Commission, we measured distance of release locations to their respective property boundary, size of the patch of cover (i.e., pheasant hunting habitat) where the pheasants were released, and total acreage of the property. Pheasant hunting habitat was defined as field, shrub, and wetland (not including types with standing water). A patch of cover was the contiguous area of pheasant hunting habitat (within property boundaries) where pheasants were released. Within property boundaries, we measured the percent of field, shrub, forest, wetland, and nonhabitat.

### **Cost per bagged pheasant**

To calculate the cost to put a pheasant in a hunter's bag, we summarized pheasant propagation operations (cost code 05120) and maintenance (cost code 05140) expenditure data from the Game Commission's cost accounting system to account for production and distribution costs. We subtracted egg and chick sales revenue to arrive at an overall cost. This cost was divided by the total number of pheasants released during the hunting seasons and the number of breeders released the following spring to calculate the cost per stocked pheasant. We enumerated male and female pheasants released in each of the three property types (SGL, other public, and Hunter Access), and for each of seven releases. Stocking reports from the field were corrected to the extent possible; percentages of

pheasants released in various categories (e.g., males on SGLs during preseason release) were similar to previous three years of stocking data. Cost per bagged pheasant was calculated as the overall cost per stocked pheasant multiplied by the number of pheasants released in that category, divided by the estimated number of pheasants from that category that were bagged by hunters (harvest rate of pheasants in that category multiplied by the number released in that category). Value of the harvest was calculated as the overall cost per pheasant released multiplied by the number harvested in that category.

## Results

We banded and released 5,566 pheasants, including 2,997 non-reward banded males, 1,614 non-reward banded females, 570 reward banded males, and 385 reward banded females (Table 1). Originally, 5,570 banded pheasants were to be released, but four bands were not released; 1 banded male escaped at a game farm during crating, 1 banded hen died in transport, and 2 bands dropped during the banding process were not found in time to place on a bird in the appropriate crate. Banded pheasants were released all days non-banded pheasants were released, from Junior hunt through winter hen release (Table 1). Banded pheasants were released in all WMUs except 5D. State Game Lands ( $n=138$ ), other public properties ( $n=40$ ), and Hunter Access properties ( $n=21$ ) received 3,998 (71.8%), 1,318 (23.7%), and 250 (4.5%) banded pheasants, respectively.

Table 1. Reward and non-reward banded ring-necked pheasants released on State Game Lands, other public properties, and Hunter Access properties during seven release periods in Pennsylvania, 2015.

Sex	Band type	Property type	Release						
			Junior hunt	Pre-season	1 <sup>st</sup> in-season	2 <sup>nd</sup> in-season	3 <sup>rd</sup> in-season	4 <sup>th</sup> in-season	Winter
Males	Non-reward	SGL	398	360	327	375	397	383	0
		Other public	93	98	139	100	85	100	0
		Hunter Access	9	42	33	25	16	17	0
		Total	500	500	499	500	498	500	0
	Reward	SGL	77	70	58	75	77	72	0
		Other public	17	17	30	15	14	20	0
		Hunter Access	1	8	7	5	4	3	0
		Total	95	95	95	95	95	95	0
Females	Non-reward	SGL	141	166	150	134	134	174	179
		Other public	88	64	56	80	80	48	56
		Hunter Access	0	0	24	16	16	8	0
		Total	229	230	230	230	230	230	235
	Reward	SGL	33	39	35	31	31	41	41
		Other public	22	16	14	20	20	12	14
		Hunter Access	0	0	6	4	4	2	0
		Total	55	55	55	55	55	55	55

We received reports of 2,069 banded pheasant recoveries; however, 101 were censored from subsequent harvest and survival rate analyses because they died from causes other than hunting, or date of harvest was uncertain. A total of \$47,100 in reward payments were processed (three rewards

were not paid because either the person reporting the band was a Pennsylvania Game Commission employee or immediate family thereof, or refused payment). Reporting rate for non-reward bands was 67.8%.

### Band loss

Of 478 reward-banded pheasants that were reported, seven (1.5%) were missing non-reward bands. Four (0.8%) reward-banded pheasants were missing reward bands, and for data analysis purposes, were treated as non-reward banded pheasants. Band loss was considered too inconsequential to incorporate into analyses.

### Non-harvest mortality

A total of 43 pheasants were reported as non-hunting mortality, including 24 found dead of unknown causes, 14 road-kills, and 5 with evidence of predation. Though most band recoveries occurred on the same property on which they were released, there were some notable exceptions. A banded pheasant released in Delaware Water Gap National Recreation Area was recovered in New Jersey. Road-killed banded pheasants were recovered up to 10 miles from their stocking locations.

### Survival rates

There were two competing models for pheasant survival rates; both indicated that male and female pheasant survival rates were different, survival rates among the seven release periods differed, and survival rates on other public properties and SGLs were similar, but may or may not be similar to survival rates on Hunter Access properties (Table 2). For subsequent analysis, we considered survival rates for SGLs and public properties different than Hunter Access properties.

Table 2. Comparison of survival rates of male and female ring-necked pheasants released on State Game Lands (SGL), other public properties, and Hunter Access properties over seven release periods in Pennsylvania, 2015. Only five best models are shown.

Model	QAIC <sub>c</sub>	Δ QAIC <sub>c</sub>	AIC <sub>c</sub> Weights	Model Likelihood
(Male ≠ Female), (Other public = SGL ≠ Hunter Access), Releases different	8513.2885	0.0000	0.5567	1.0000
(Male ≠ Female), (Other public = SGL = Hunter Access), Releases different	8514.9662	1.6777	0.2406	0.4322
(Male = Female), (Other public = SGL = Hunter Access), Releases different	8515.9126	2.6241	0.1499	0.2693
(Male = Female), (Other public ≠ SGL ≠ Hunter Access), Releases different	8518.0017	4.7132	0.0528	0.0948
(Male ≠ Female), (Other public ≠ SGL ≠ Hunter Access), Releases different	8540.5945	27.3060	0.0000	0.0000

Daily survival rates ranged from 44.4% for males released on the 4<sup>th</sup> in-season release on Hunter Access properties to 96.1% for males released on Hunter Access properties for the Junior hunt (Table 3). Overall

daily survival rates for males (88.4%) were higher than for females (87.9%). Further, daily survival rates for males on public properties were 88.1% and on Hunter Access properties were 93.0%. Daily survival rates for females on public properties were 87.6% and on Hunter Access properties were 93.3%.

Table 3. Daily, 7-day, and 30-day survival rates (̂) of ring-necked pheasants released on public and Hunter Access properties during seven release periods in Pennsylvania, 2015.

Sex	Property type <sup>a</sup>	Release	Daily		7-day		30-day	
			̂	95% CI	̂	95% CI	̂	95% CI
Male	Public	Junior	94.2%	93.0–95.4%	65.9%	63.7–71.9%	16.8%	14.5–19.0%
		Preseason	90.2%	88.3–92.2%	48.7%	45.8–56.4%	4.6%	1.7–7.5%
		1 <sup>st</sup> in-season	83.9%	81.1–86.8%	29.3%	26.4–36.8%	0.5%	0.0–3.4%
		2 <sup>nd</sup> in-season	84.6%	82.0–87.3%	31.0%	28.2–38.5%	0.7%	0.0–3.5%
		3 <sup>rd</sup> in-season	82.5%	79.5–85.6%	25.9%	23.2–33.3%	0.3%	0.0–3.1%
		4 <sup>th</sup> in-season	84.6%	81.8–87.4%	30.9%	28.0–38.6%	0.7%	0.0–3.6%
	Hunter Access	Junior	96.1%	89.4–100.0%	75.5%	61.0–100.0%	30.0%	15.5–44.6%
		Preseason	93.8%	90.0–97.7%	63.7%	56.5–82.8%	14.5%	7.3–21.7%
		1 <sup>st</sup> in-season	90.4%	82.8–98.8%	49.5%	37.3–81.7%	4.9%	0.0–17.1%
		2 <sup>nd</sup> in-season	94.5%	87.6–100.0%	67.3%	53.3–100.0%	18.3%	4.3–32.2%
		3 <sup>rd</sup> in-season	94.1%	87.8–100.0%	65.4%	53.1–98.0%	16.2%	3.9–28.5%
		4 <sup>th</sup> in-season	44.4%	15.0–100.0%	0.3%	0.0–4.3%	0.0%	0.0–1.5%
Female	Public	Junior	95.1%	93.3–96.9%	70.4%	66.7–80.0%	22.2%	18.5–25.8%
		Preseason	91.6%	88.9–94.3%	53.9%	49.6–65.4%	7.1%	2.8–11.4%
		1 <sup>st</sup> in-season	84.1%	79.6–88.8%	29.7%	25.0–42.1%	0.5%	0.0–5.2%
		2 <sup>nd</sup> in-season	84.5%	80.4–88.8%	30.8%	26.3–42.5%	0.6%	0.0–5.1%
		3 <sup>rd</sup> in-season	84.9%	80.6–89.5%	31.9%	27.1–44.6%	0.7%	0.0–5.5%
		4 <sup>th</sup> in-season	84.2%	79.6–89.1%	30.0%	25.1–43.1%	0.6%	0.0–5.5%
	Hunter Access	Winter	70.9%	64.1–78.3%	9.0%	6.1–16.4%	0.0%	0.0–2.8%
		1 <sup>st</sup> in-season	83.9%	66.6–100.0%	29.2%	9.8–80.5%	0.5%	0.0–19.9%
		2 <sup>nd</sup> in-season	84.6%	59.9–100.0%	31.1%	0.2–100.0%	0.7%	0.0–31.5%
		3 <sup>rd</sup> in-season	95.9%	91.0–100.0%	74.6%	64.1–100.0%	28.5%	18.0–39.1%
		4 <sup>th</sup> in-season <sup>b</sup>	N/A	N/A	N/A	N/A	N/A	N/A

<sup>a</sup> Public property includes State Game Lands and other public properties (e.g., State Parks).

<sup>b</sup> Survival rates for females released during 4<sup>th</sup> in-season release on Hunter Access properties could not be estimated because no banded pheasants from that cohort were harvested.

### Harvest rates

Best model for harvest rates was similar to best model for survival rates, except harvest rates among release periods were similar (Table 4). However, harvest rates among releases, and SGLs and other public properties are presented to provide complete results with which to inform future management decisions. Overall harvest rate of pheasants was 49.1%; 53.8% of males were harvested, and 41.1% of females were harvested (Table 5). Harvest rates for male and female pheasants combined ranged from 40.6% for Junior hunt release to 53.2% for 2<sup>nd</sup> in-season release. Harvest rates were similar between other public properties (50.7%) and SGLs (48.7%), but were significantly higher than harvest rates on Hunter Access properties (37.3%) (Table 5). Also, percent of pheasants harvested (naïve harvest, not accounting for reporting rate) from each individual property showed that among 40 other public

properties stocked with banded pheasants, 13 (32.5%) had 50% or more banded pheasants harvested and one (2.5%) had 0% harvested; of 138 SGLs stocked with banded pheasants, 29 (21.0%) properties had 50% or more banded pheasants harvested and four (2.9%) with 0% harvested; of 21 Hunter Access properties stocked with banded pheasants, 3 (14.3%) had 50% or more harvested and four (19.0%) had 0% harvested.

Table 4. Comparison of harvest rates of male and female ring-necked pheasants released on State Game Lands (SGL), other public, and Hunter Access properties over seven release periods in Pennsylvania, 2015. Only five best models are shown.

Model	AIC <sub>c</sub>	Δ AIC <sub>c</sub>	AIC <sub>c</sub> weights	Model likelihood
(Male ≠ Female), (Other public = SGL ≠ Hunter Access), Releases same	7007.2008	0.0000	0.5826	1.0000
(Male ≠ Female), (Other public ≠ SGL ≠ Hunter Access), Releases same	7009.3990	2.1982	0.1941	0.3332
(Male ≠ Female), (Other public ≠ SGL ≠ Hunter Access), Releases different	7009.8173	2.6165	0.1575	0.2703
(Male ≠ Female), (Other public = SGL = Hunter Access), Releases different	7011.5711	4.3703	0.0655	0.1125
(Male ≠ Female), (Other public = SGL = Hunter Access), Releases same	7022.0649	14.8641	0.0003	0.0006

### Day of harvest

We received accurate day of harvest data for 1,968 pheasants. Majority of pheasant harvests were reported from Saturdays ( $n=711$ , 36.1%) and Fridays ( $n=528$ , 26.8%). Fewer were reported from harvests made on Thursdays ( $n=270$ , 13.7%), Mondays ( $n=193$ , 9.8%), Wednesdays ( $n=146$ , 7.4%), and Tuesdays ( $n=120$ , 6.1%). Harvest rates varied depending on day of week pheasants were stocked. When considering only preseason release (Tuesday – Friday), and only pheasants harvested on the season opener (i.e., Saturday immediately following release), harvest rates of pheasants released Tuesday (14.2%) were lower than those released Wednesday through Friday (22.2% combined) (Tables 6 and 7).

Considering pheasants released during preseason release, and harvested throughout the entire season, best harvest rate model indicated that harvest rate of pheasants released Tuesday and Wednesday (39.5%) were lower than for those released Thursday and Friday (52.3% combined) (Table 8). However, harvest rate of pheasants released on Thursday of preseason (49.2%) also could be considered different than Friday harvest rate (55.4%; Table 9). Results were less clear when combining data for all four in-season releases, as there were eight competing models (Table 10). Harvest rates ranged from 47.1% for pheasants released on Tuesday of the 1<sup>st</sup> in-season release and harvested throughout the season, to 53.4% for pheasants released on Fridays of the four in-season releases (Table 8).

Table 5. Harvest rates ( $\hat{H}$ ), number released, and cost of ring-necked pheasants released on public and private properties during eight releases (including release of breeders) in Pennsylvania, 2015.

Sex	Property Type	Release	Number Released	$\hat{H}$	95% CI	Number Harvested	Cost <sup>a</sup>	Cost/bagged pheasant	Value of Harvest <sup>b</sup>	
Males	SGL	All	73,986	53.6%	49.8–57.7%	39,656	\$1,400,551	\$35.32	\$750,686	
		Junior	6,220	46.3%	40.3–53.2%	2,880	\$117,744	\$40.88	\$54,518	
		PreSeason	17,404	49.7%	43.3–57.0%	8,650	\$329,457	\$38.09	\$163,744	
		1stInSeason	18,224	60.8%	53.6–68.9%	11,080	\$344,979	\$31.14	\$209,744	
		2ndInSeason	15,247	55.2%	48.7–62.5%	8,416	\$288,625	\$34.29	\$159,314	
		3rdInSeason	7,970	57.1%	50.7–64.3%	4,551	\$150,872	\$33.15	\$86,150	
		4thInSeason	8,708	53.4%	46.9–60.8%	4,650	\$164,842	\$35.45	\$88,024	
		Winter	173	–	–	–	\$3,275	–	–	
	Other public	All	15,468	58.7%	53.1–64.8%	9,080	\$292,808	\$32.25	\$171,884	
		Junior	990	48.3%	36.9–62.5%	478	\$18,741	\$39.21	\$9,049	
		PreSeason	4,180	54.7%	43.3–69.3%	2,286	\$79,127	\$34.61	\$43,274	
		1stInSeason	4,200	53.4%	44.2–64.5%	2,243	\$79,506	\$35.45	\$42,460	
		2ndInSeason	3,085	69.7%	58.8–82.8%	2,150	\$58,399	\$27.16	\$40,699	
		3rdInSeason	1,510	63.7%	50.6–80.1%	962	\$28,584	\$29.71	\$18,211	
		4thInSeason	1,430	64.3%	52.8–78.2%	919	\$27,070	\$29.46	\$17,397	
		Winter	33	–	–	–	\$625	–	–	
	Hunter Access	All	28,435	42.7%	34.1–53.5%	12,142	\$538,273	\$44.33	\$229,847	
		Junior	746	40.9%	16.0–100.0%	305	\$14,122	\$46.30	\$5,774	
		PreSeason	8,827	58.0%	42.1–79.9%	5,120	\$167,095	\$32.64	\$96,921	
		1stInSeason	8,560	39.2%	23.8–64.5%	3,356	\$162,040	\$48.28	\$63,529	
		2ndInSeason	5,990	22.7%	10.2–50.4%	1,360	\$113,390	\$83.38	\$25,745	
		3rdInSeason	1,920	51.7%	28.8–92.5%	993	\$36,345	\$36.60	\$18,797	
		4thInSeason	2,120	34.8%	16.5–73.4%	738	\$40,131	\$54.38	\$13,970	
		Winter	0	–	–	–	–	–	–	
	Breeders			1,286	–	–	–	\$23,344	–	–

Table 5, continued

Sex	Property Type	Release	Number Released	$\hat{H}$	95% CI	Number Harvested	Cost <sup>a</sup>	Cost/bagged pheasant	Value of Harvest <sup>b</sup>
Females	SGL	All	59,544	41.4%	37.6–45.7%	24,651	\$1,127,165	\$45.72	\$466,642
		Junior	5,645	30.1%	22.6–40.0%	1,699	\$106,860	\$62.90	\$32,162
		PreSeason	13,400	39.5%	31.6–49.2%	5,293	\$253,661	\$47.92	\$100,196
		1stInSeason	14,073	46.9%	38.1–57.6%	6,600	\$266,401	\$40.36	\$124,938
		2ndInSeason	9,634	50.4%	41.0–62.0%	4,856	\$182,371	\$37.56	\$91,924
		3rdInSeason	5,300	43.1%	34.3–54.1%	2,284	\$100,329	\$43.93	\$43,236
		4thInSeason	5,298	37.3%	29.8–46.6%	1,976	\$100,291	\$50.75	\$37,406
		Winter	6,184	43.7%	35.8–53.3%	2,702	\$117,063	\$43.32	\$51,149
	Other public	All	10,948	43.1%	38.0–48.8%	4,719	\$207,245	\$43.92	\$89,330
		Junior	905	28.6%	19.9–41.1%	259	\$17,132	\$66.15	\$4,903
		PreSeason	2,747	35.2%	24.4–50.7%	967	\$52,001	\$53.78	\$18,305
		1stInSeason	2,610	46.2%	33.5–63.8%	1,206	\$49,407	\$40.97	\$22,830
		2ndInSeason	1,575	49.3%	38.3–63.6%	776	\$29,815	\$38.42	\$14,690
		3rdInSeason	865	42.3%	31.7–56.6%	366	\$16,374	\$44.74	\$6,928
		4thInSeason	760	44.4%	31.2–63.3%	337	\$14,387	\$42.69	\$6,379
		Winter	1,482	61.3%	48.1–78.1%	908	\$28,054	\$30.90	\$17,188
	Hunter Access	All	21,125	25.3%	15.8–40.5%	5,345	\$399,895	\$74.82	\$101,181
		Junior	946	–	–	–	\$17,908	–	–
		PreSeason	6,182	–	–	–	\$117,025	–	–
		1stInSeason	6,443	25.5%	11.6–56.1%	1,643	\$121,966	\$74.23	\$31,102
		2ndInSeason	3,573	13.3%	3.6–49.4%	475	\$67,637	\$142.39	\$8,992
		3rdInSeason	1,225	49.3%	27.3–89.1%	604	\$23,189	\$38.39	\$11,434
		4thInSeason	1,175	0.0%	–	0	\$22,243	–	\$0
		Winter	1,309	–	–	–	\$24,779	–	–
		Breeders	16,189	–	–	–	\$306,458	–	–

<sup>a</sup> Total cost based on cost per released pheasant of \$18.93 × number released.

<sup>b</sup> Value of harvest based on cost per released pheasant of \$18.93 × number harvested.



Table 6. Harvest rates ( $\hat{H}$ ) of ring-necked pheasants released each day during preseason release in Pennsylvania, 2015. Harvest rates calculated from bands reported harvested opening Saturday of regular season.

Day of Release	Banded pheasants released	$\hat{H}$	95% CI
Tuesday	185	14.2%	9.3–21.9%
Wednesday	220	20.2%	14.7–27.8%
Thursday	240	23.7%	17.8–31.5%
Friday	235	22.7%	16.9–30.4%
Wed-Fri combined	695	22.2%	18.6–26.6%

Table 7. Comparison of harvest rates of ring-necked pheasants released each day during preseason release, and harvested opening Saturday of regular season in Pennsylvania, 2015. Only five best models are shown.

Model	AIC <sub>c</sub>	$\Delta$ AIC <sub>c</sub>	AIC <sub>c</sub> weights	Model likelihood
(Tue) $\neq$ (Wed = Thu = Fri)	6705.3994	0.0000	0.2217	1.0000
(Tue = Wed) $\neq$ (Thu = Fri)	6706.5970	1.1976	0.1218	0.5495
(Tue) $\neq$ (Wed) $\neq$ (Thu = Fri)	6706.8596	1.4602	0.1068	0.4819
(Tue = Wed = Thu = Fri)	6707.5655	2.1661	0.0751	0.3385
(Thu) $\neq$ (Tue = Wed = Fri)	6708.2553	2.8559	0.0532	0.2398

Table 8. Harvest rates ( $\hat{H}$ ) of ring-necked pheasants released each day of week during preseason and four in-season releases in Pennsylvania, 2015. Harvest rates calculated from bands reported harvested over entire season.

Release	Day of Release	Banded pheasants released	$\hat{H}$	95% CI
Preseason	Tuesday	185	37.0%	29.0–47.3%
Preseason	Wednesday	220	41.4%	33.8–50.9%
Preseason	Tue-Wed combined	405	39.5%	33.6–46.4%
Preseason	Thursday	240	49.2%	41.3–58.7%
Preseason	Friday	235	55.4%	47.1–65.1%
Preseason	Thu-Fri combined	475	52.3%	46.1–59.3%
Preseason	Wed-Fri combined	695	48.8%	43.6–54.6%
All in-season	Tuesday	165	47.1%	37.9–58.4%
All in-season	Wednesday	520	51.8%	45.9–58.6%
All in-season	Thursday	1413	50.0%	45.8–54.6%
All in-season	Friday	1419	53.4%	49.1–58.1%
All in-season	Tue-Thu combined	1578	49.5%	45.1–54.4%
All in-season	Wed-Fri combined	1939	52.8%	48.4–57.5%

Table 9. Comparison of harvest rates of ring-necked pheasants released each day of week during preseason release, and harvested throughout the season in Pennsylvania, 2015. Only best five models are shown.

Model	AIC <sub>c</sub>	Δ AIC <sub>c</sub>	AIC <sub>c</sub> weights	Model likelihood
(Tue = Wed) ≠ (Thu = Fri)	7063.4636	0.0000	0.4064	1.0000
(Tue = Wed) ≠ (Thu) ≠ (Fri)	7064.4242	0.9606	0.2514	0.6186
(Tue) ≠ (Wed) ≠ (Thu) ≠ (Fri)	7065.9155	2.4519	0.1193	0.2935
(Tue = Wed = Thu) ≠ (Fri)	7065.9907	2.5271	0.1149	0.2827
(Tue) ≠ (Wed = Thu = Fri)	7067.2672	3.8036	0.0607	0.1493

Table 10. Comparison of harvest rates of ring-necked pheasants released each day of week during four in-season releases, and harvested throughout the season in Pennsylvania, 2015. Only models ≤2.1 AIC<sub>c</sub> units are shown.

Model	AIC <sub>c</sub>	Δ AIC <sub>c</sub>	AIC <sub>c</sub> weights	Model likelihood
(Tue = Thu) ≠ (Wed = Fri)	4541.1075	0.0000	0.1493	1.0000
(Tue = Wed = Thu) ≠ (Fri)	4541.2968	0.1893	0.1358	0.9097
(Tue = Wed = Thu = Fri)	4541.3068	0.1993	0.1351	0.9052
(Tue = Wed = Fri) ≠ (Thu)	4542.0255	0.9180	0.0943	0.6319
(Tue = Fri) ≠ (Wed = Thu)	4542.2412	1.1337	0.0847	0.5673
(Tue) ≠ (Wed = Thu = Fri)	4542.5513	1.4438	0.0725	0.4858
(Tue = Wed) ≠ (Thu) ≠ (Fri)	4542.8887	1.7812	0.0613	0.4104
(Tue) ≠ (Wed = Thu) ≠ (Fri)	4542.9132	1.8057	0.0605	0.4054
(Tue = Wed) ≠ (Thu = Fri)	4543.1805	2.0730	0.0529	0.3547

Among WMUs under either-sex regulations, male harvest rate was 55.2%, female harvest rate was 41.1%, and male and female combined harvest rate was 47.9%, ranging from 35.6% in 2B to 57.8% in 3B (Table 11). Harvest rates for males ranged from 40.7% in 5C to 62.7% in 3B. Female harvest rates ranged from 26.7% in 2B to 52.2% in 3B. In all WMUs, male harvest rates ranged from 40.7% in 5C to 63.1% in 4E. In WMUs under cocks-only regulations, harvest rates of males ranged from 42.3% in 5A to 63.1% in 4E, and overall was 51.8% (Table 11).

Pairwise comparisons between all combinations of WMU harvest rates indicated most WMUs had similar harvest rates, with some exceptions (Tables 12, 13, 14). For example, combined male and female harvest rate in WMU 3B was higher than in WMUs 1A, 2D, 5C, 1B, 2E, and 2B (Table 12). Female harvest rate was higher in WMU 3B than in WMUs 1B and 2E (Table 13). Male harvest rate was higher in WMU 4E than in WMUs 4C, 1B, 5A, and 5C (Table 14).

Table 11. Harvest rates ( $\hat{H}$ ) of ring-necked pheasants released in Wildlife Management Units (WMU) in Pennsylvania, 2015.

WMU	Sex	Banded pheasants released	$\hat{H}$	95% CI
1A	Male	205	51.3%	42.6–61.9%
	Female	195	40.5%	32.5–50.6%
	Combined	400	45.9%	39.5–53.3%
1B	Male	145	46.5%	36.7–58.8%
	Female	105	30.6%	21.3–44.0%
	Combined	250	39.8%	32.4–48.8%
2A	Male	325	50.5%	43.3–58.9%
	Female	0	.	.
	Combined	0	.	.
2B	Male	30	41.9%	24.4–71.9%
	Female	20	26.7%	11.1–64.0%
	Combined	50	35.6%	22.4–56.8%
2C	Male	314	55.8%	48.4–64.3%
	Female	0	.	.
	Combined	0	.	.
2D	Male	185	55.3%	46.0–66.3%
	Female	290	39.1%	32.5–47.1%
	Combined	475	45.1%	39.4–51.7%
2E	Male	75	47.8%	34.6–65.9%
	Female	100	27.0%	18.0–40.4%
	Combined	175	35.7%	27.6–46.2%
2F	Male	194	58.7%	49.5–69.6%
	Female	140	51.0%	40.9–63.6%
	Combined	334	55.4%	48.1–63.8%
2G & 2H	Male	85	61.4%	48.0–78.5%
	Female	40	32.6%	18.5–57.4%
	Combined	125	51.9%	41.1–65.6%
3A	Male	70	46.9%	33.4–65.8%
	Female	60	41.9%	28.5–61.5%
	Combined	130	44.5%	34.4–57.6%
3B	Male	90	62.7%	50.4–78.1%
	Female	80	52.2%	39.6–68.6%
	Combined	170	57.8%	48.5–68.8%
3C	Male	200	60.1%	51.2–70.4%
	Female	110	38.1%	28.2–51.5%
	Combined	310	52.3%	45.1–60.6%
3D	Male	130	56.8%	45.9–70.3%
	Female	160	49.3%	40.3–60.2%
	Combined	290	52.3%	45.0–60.8%
4A	Male	135	56.2%	45.7–69.1%
	Female	100	34.1%	24.3–47.9%
	Combined	235	46.6%	38.7–56.0%

Table 11. continued

WMU	Sex	Banded pheasants released	$\hat{H}$	95% CI
4B	Male	110	57.6%	46.1–72.0%
	Female	100	38.5%	28.1–52.8%
	Combined	210	48.4%	40.1–58.5%
4C	Male	240	46.7%	38.8–56.1%
	Female	0	.	.
	Combined	0	.	.
4D	Male	205	60.6%	51.7–70.9%
	Female	149	48.1%	38.7–59.6%
	Combined	354	55.1%	48.2–62.9%
4E	Male	130	63.1%	52.1–76.3%
	Female	0	.	.
	Combined	0	.	.
5A	Male	90	42.3%	30.9–57.9%
	Female	0	.	.
	Combined	0	.	.
5B	Male	469	51.0%	44.8–58.1%
	Female	0	.	.
	Combined	0	.	.
5C	Male	140	40.7%	31.3–52.8%
	Female	350	40.5%	34.3–47.8%
	Combined	490	40.5%	35.1–46.9%
Cocks-only	Male	1568	51.8%	47.4–56.7%
Either-sex	Male	1999	55.2%	51.2–59.6%
	Female	1999	41.1%	38.4–44.0%
	Combined	3998	47.9%	44.7–51.3%

Table 12. Pairwise comparisons of harvest rates of male and female ring-necked pheasants released in Wildlife Management Units regulated under either-sex regulations in Pennsylvania, 2015. WMU pairs that did not differ by  $\geq 2$  AIC<sub>c</sub> units are denoted “N”, whereas WMU with different harvest rates are denoted by the WMU with greater harvest rate.

		Harvest rate decreasing →														
		3B	2F	4D	3D	3C	2G/H	4B	4A	1A	2D	3A	5C	1B	2E	2B
← Harvest rate decreasing	3B	–	N	N	N	N	N	N	N	3B	3B	N	3B	3B	3B	3B
	2F		–	N	N	N	N	N	N	N	2F	N	2F	2F	2F	2F
	4D			–	N	N	N	N	N	N	4D	N	4D	4D	4D	4D
	3D				–	N	N	N	N	N	N	N	3D	3D	3D	N
	3C					–	N	N	N	N	N	N	3C	3C	3C	N
	2G/H						–	N	N	N	N	N	N	N	2G/H	N
	4B							–	N	N	N	N	N	N	N	N
	4A								–	N	N	N	N	N	N	N
	1A									–	N	N	N	N	N	N
	2D										–	N	N	N	N	N
	3A											–	N	N	N	N
	5C												–	N	N	N
	1B													–	N	N
	2E														–	N
	2B															–

Table 13. Pairwise comparisons of harvest rates of female ring-necked pheasants released in Wildlife Management Units regulated under either-sex regulations in Pennsylvania, 2015. WMU pairs that did not differ by  $\geq 2$  AIC<sub>c</sub> units are denoted “N”, whereas WMU with different harvest rates are denoted by the WMU with greater harvest rate.

		Harvest rate decreasing →														
		3B	2F	3D	4D	3A	1A	5C	2D	4B	3C	4A	2G/H	1B	2E	2B
← Harvest rate decreasing	3B	–	N	N	N	N	N	N	N	N	N	N	N	3B	3B	N
	2F		–	N	N	N	N	N	N	N	N	2F	N	2F	2F	N
	3D			–	N	N	N	N	N	N	N	N	N	3D	3D	N
	4D				–	N	N	N	N	N	N	N	N	4D	4D	N
	3A					–	N	N	N	N	N	N	N	N	N	N
	1A						–	N	N	N	N	N	N	N	N	N
	5C							–	N	N	N	N	N	N	N	N
	2D								–	N	N	N	N	N	N	N
	4B									–	N	N	N	N	N	N
	3C										–	N	N	N	N	N
	4A											–	N	N	N	N
	2G/H												–	N	N	N
	1B													–	N	N
	2E														–	N
	2B															–

Table 14. Pairwise comparisons of harvest rates of male ring-necked pheasants released in Wildlife Management Units regulated under either-sex and cocks-only regulations in Pennsylvania, 2015. WMU pairs that did not differ by  $\geq 2$  AIC<sub>c</sub> units are denoted “N”, whereas WMU with different harvest rates are denoted by the WMU with greater harvest rate.

		Harvest rate decreasing →																					
		4E	3B	2G/H	4D	3C	2F	4B	3D	4A	2C	2D	1A	5B	2A	2E	3A	4C	1B	5A	2B	5C	
← Harvest rate decreasing	4E	–	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	4E	4E	4E	N	4E	
	3B		–	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	3B	N	3B	
	2G/H			–	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	2G/H
	4D				–	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	4D	N	4D
	3C					–	N	N	N	N	N	N	N	N	N	N	N	N	N	N	3C	N	3C
	2F						–	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	2F
	4B							–	N	N	N	N	N	N	N	N	N	N	N	N	N	N	4B
	3D								–	N	N	N	N	N	N	N	N	N	N	N	N	N	3D
	4A									–	N	N	N	N	N	N	N	N	N	N	N	N	N
	2C										–	N	N	N	N	N	N	N	N	N	N	N	N
	2D											–	N	N	N	N	N	N	N	N	N	N	N
	1A												–	N	N	N	N	N	N	N	N	N	N
	5B													–	N	N	N	N	N	N	N	N	N
	2A														–	N	N	N	N	N	N	N	N
	2E															–	N	N	N	N	N	N	N
	3A																–	N	N	N	N	N	N
	4C																	–	N	N	N	N	N
	1B																		–	N	N	N	N
	5A																			–	N	N	N
	2B																				–	N	N
5C																					–	N	

There were no significant correlations between harvest rates at the WMU level and pheasant harvests ( $r=0.327$ ,  $p=0.234$ ), pheasant hunter days ( $r=0.110$ ,  $p=0.696$ ), or number of pheasant hunters ( $r=0.016$ ,  $p=0.954$ ) at the WMU level during the 2015-16 season as estimated in Game Take Survey (Johnson and Boyd 2016, Table 15).

Table 15. Numbers of pheasant harvests, pheasant hunting days, and pheasant hunters in Pennsylvania estimated from 2015-16 Game Take Survey.

WMU	Harvests	Days	Hunters
1A	8,732	20,065	4,313
1B	7,958	16,009	3,844
2A	9,727	17,183	4,688
2B	4,863	8,004	1,781
2C	13,706	27,642	6,282
2D	8,069	23,587	4,782
2E	7,737	15,262	2,438
2F	9,174	16,329	3,656
2G	4,421	6,937	1,500
2H	6,742	6,297	1,031
3A	3,205	6,510	1,781
3B	8,732	15,796	2,906
3C	5,305	14,942	3,000
3D	12,490	17,823	3,656
4A	4,311	8,111	2,906
4B	3,869	11,953	1,969
4C	8,953	17,290	4,313
4D	18,348	27,749	5,532
4E	5,969	7,578	1,969
5A	2,432	7,471	1,781
5B	20,117	37,568	8,251
5C	13,816	32,765	8,157
5D	1,326	961	281
UNKNOWN	15,364	30,310	5,532
Total	205,366	394,142	86,349

On SGLs and other public properties, the number of times pheasants were released on a property and the total number of pheasants released on a property were both positively associated with harvest rates (Tables 16–19). However, the number of times pheasants were released on a property was more strongly associated with harvest rates than total number of pheasants released; each additional release resulted in ~2.7% increase in harvest rate; each additional 1,000 pheasants released resulted in ~1.6% increase in harvest rate.

Table 16. Ring-necked pheasant harvest rates associated with number of releases and total number of ring-necked pheasants released on State Game Lands and other public properties, Pennsylvania, 2015.

Model	AIC <sub>c</sub>	Δ AIC <sub>c</sub>	AIC <sub>c</sub> weights	Model likelihood
Number of releases	5543.661	0.0000	0.4985	1.0000
Number of releases, number released	5544.265	0.6042	0.3685	0.7393
Number released	5546.303	2.6421	0.1330	0.2669

When considering only data from pheasants released from preseason through 4<sup>th</sup> in-season release on SGLs and other public properties, stocking a property on all five of those occasions resulted in a higher harvest rate (Table 17).

Table 17. Ring-necked pheasant harvest rates associated with number of releases on properties receiving ring-necked pheasants from preseason release through 4<sup>th</sup> in-season release, Pennsylvania, 2015. Only data from State Game Lands and other public properties were included.

Model	AIC <sub>c</sub>	Δ AIC <sub>c</sub>	AIC <sub>c</sub> weights	Model likelihood
3 = 4 ≠ 5	4591.489	0.0000	0.6027	1.0000
3 ≠ 4 ≠ 5	4593.196	1.7072	0.2567	0.4259
3 = 5 ≠ 4	4594.530	3.0409	0.1318	0.2186
4 = 5 ≠ 3	4600.904	9.4156	0.0054	0.0090
3 = 4 = 5	4601.840	10.3510	0.0034	0.0057

Table 18. Mean estimated harvest rates of ring-necked pheasants on public properties that received 3, 4, or 5 releases between preseason release and 4<sup>th</sup> in-season release, Pennsylvania, 2015.

Releases	$\hat{H}$
3	38.6%
4	43.1%
5	52.8%

Table 19. Estimated harvest rates for hypothetical total number of ring-necked pheasants released on public properties, Pennsylvania, 2015.

Released	$\hat{H}$
100	47.9%
500	48.6%
1,000	49.4%
2,000	50.9%
5,000	55.7%

There were some differences in cover type acreages within SGLs and public properties receiving 3, 4, and 5 releases (Table 20). Properties receiving 5 releases had more total acreage than properties receiving 3 releases, and had more field acreage and pheasant hunting habitat than properties receiving 3 and 4 releases.



Table 20. Cover type acreages within properties receiving 3, 4, or 5 releases of Pennsylvania Game Commission game farm pheasants between preseason release and 4<sup>th</sup> in-season release, 2015. Statistics represent State Game Lands and other public properties for which data were available.

Variable	Number of releases					
	3 ( <i>n</i> = 7)		4 ( <i>n</i> = 24)		5 ( <i>n</i> = 114)	
	Mean	SE	Mean	SE	Mean	SE
Total acres	1656.9 <sup>A</sup>	600.3	4034.1 <sup>AB</sup>	911.5	5368.9 <sup>B</sup>	685.8
Shrub acres	7.8 <sup>A</sup>	4.3	49.2 <sup>AB</sup>	18.8	87.1 <sup>B</sup>	14.7
Field acres	46.9 <sup>A</sup>	9.6	126.7 <sup>A</sup>	25.2	271.9 <sup>B</sup>	32.7
Forest acres	1476.1 <sup>A</sup>	592.2	3753.8 <sup>A</sup>	881.4	4800.7 <sup>A</sup>	664.7
Nonhabitat acres	48.7 <sup>AB</sup>	18.0	70.5 <sup>A</sup>	15.7	135.2 <sup>B</sup>	17.7
Wetland acres	77.4 <sup>A</sup>	48.9	33.8 <sup>A</sup>	13.8	73.8 <sup>A</sup>	23.6
Pheasant hunting habitat acres <sup>b</sup>	132.1 <sup>A</sup>	52.6	209.7 <sup>A</sup>	46.3	432.9 <sup>B</sup>	47.3
Total nonhabitat acres	1524.8 <sup>A</sup>	609.2	3824.2 <sup>A</sup>	893.2	4935.9 <sup>A</sup>	670.3

<sup>a</sup> Mean number of acres of cover types followed by different capital letters were significantly different.

<sup>b</sup> Pheasant hunting habitat was defined as field, shrub, and wetland (not including types with standing water).

Cover types within ¼ mile, ½ mile, and 1 mile of release locations were not strongly associated with pheasant harvest rates (Tables 21–23). Within ¼ mile of release locations, all cover types were competing for best model; however, for every 10% increase in shrub cover, harvest rate increase was 0.2% (Table 21). Within ½ mile of release locations, percent shrub was the best model; for every 10% increase in shrub cover, harvest rate increase was about 2.8% (Table 22). Within 1 mile of release locations, percent nonhabitat and percent shrub were competing models; for every 10% increase in nonhabitat, harvest rate decrease was about 1.6%; for every 10% increase in shrub cover, harvest rate increase was about 2.9% (Table 23).

Table 21. Ring-necked pheasant harvest rates associated with cover type percentages within 1/4 mile surrounding ring-necked pheasant release locations, Pennsylvania, 2015.

Model	AIC <sub>c</sub>	Δ AIC <sub>c</sub>	AIC <sub>c</sub> weights	Model likelihood
Percent shrub	7069.738	0.0000	0.2854	1.0000
Percent wetland	7069.782	0.0443	0.2791	0.9781
Percent forest	7070.340	0.6021	0.2112	0.7401
Percent pheasant hunting habitat	7070.665	0.9264	0.1522	0.6293
Percent nonhabitat	7071.548	1.8097	0.1155	0.4046
Percent field	7071.666	1.9274	0.1089	0.3815

Table 22. Ring-necked pheasant harvest rates associated with cover type percentages within 1/2 mile surrounding ring-necked pheasant release locations, Pennsylvania, 2015.

Model	AIC <sub>c</sub>	Δ AIC <sub>c</sub>	AIC <sub>c</sub> weights	Model likelihood
Percent shrub	7066.611	0.0000	0.6726	1.0000
Percent wetland	7070.185	3.5740	0.1126	0.1675
Percent nonhabitat	7070.399	3.7887	0.1012	0.1504
Percent pheasant hunting habitat	7070.533	3.9223	0.0865	0.1407
Percent forest	7071.447	4.8364	0.0599	0.0891
Percent field	7071.668	5.0576	0.0536	0.0797

Table 23. Ring-necked pheasant harvest rates associated with cover type percentages within 1 mile surrounding ring-necked pheasant release locations, Pennsylvania, 2015.

Model	AIC <sub>c</sub>	Δ AIC <sub>c</sub>	AIC <sub>c</sub> weights	Model likelihood
Percent nonhabitat	7068.477	0.0000	0.4193	1.0000
Percent shrub	7069.843	1.3660	0.2118	0.5051
Percent wetland	7070.684	2.2065	0.1391	0.3318
Percent forest	7070.962	2.4844	0.1211	0.2887
Percent field	7071.175	2.6981	0.1088	0.2595
Percent pheasant hunting habitat	7071.656	3.1786	0.0788	0.2041

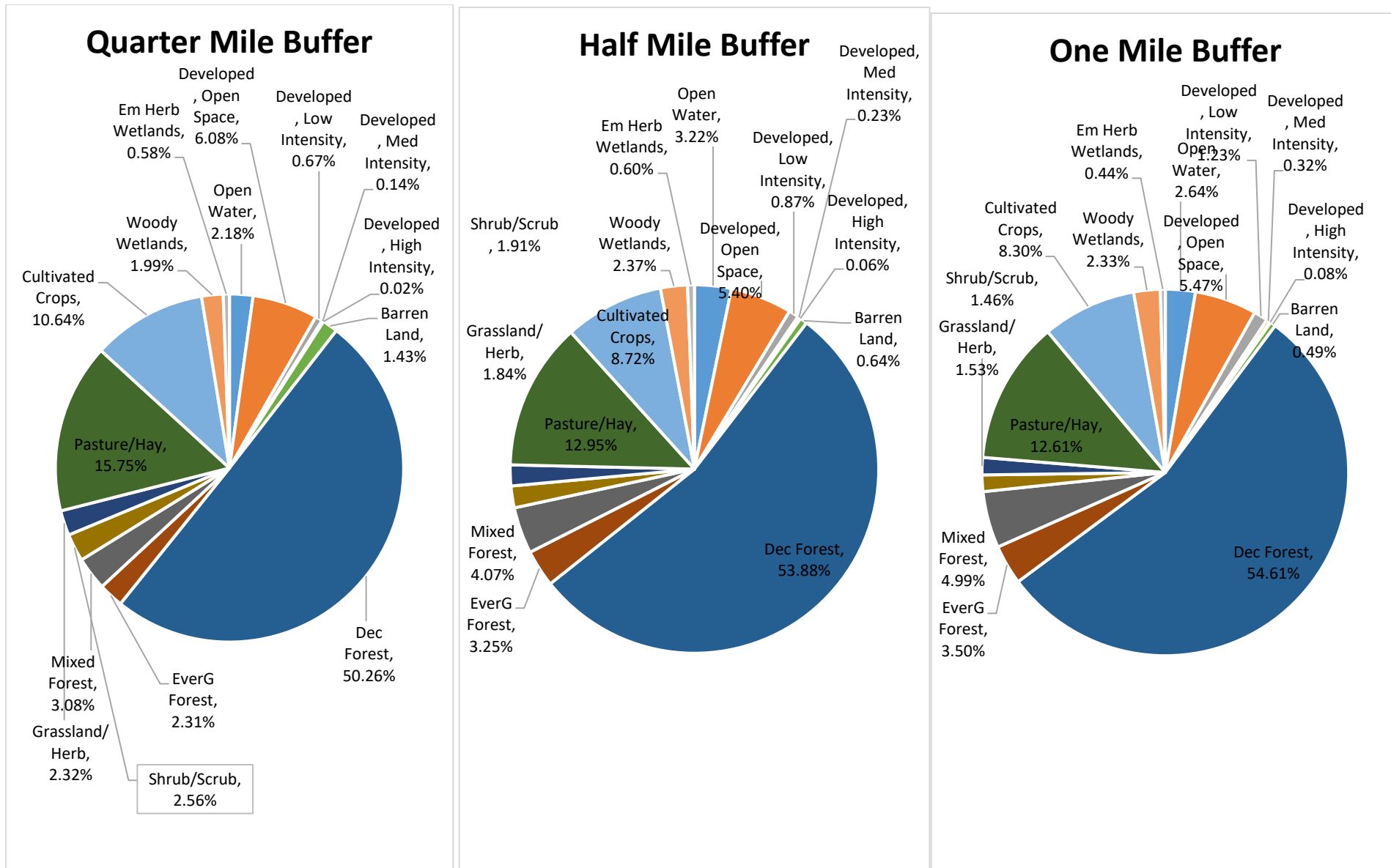


Figure 3. Cover types within 1 mile, ½ mile, and ¼ mile of ring-necked pheasant release locations in Pennsylvania, 2015.

Within SGLs and other public property boundaries, distance from release location to property boundary was the best model (Table 24). For every additional 1,000 feet from a property boundary a release site was located, harvest rate increase was about 3.1%. Mean distance from release location to property boundary was 1045.1 feet (Table 25).

Table 24. Ring-necked pheasant harvest rates associated with distances of release locations to property boundaries, size of patches where ring-necked pheasants were released, and percent of properties comprised of various cover types, Pennsylvania, 2015.

Model	AIC <sub>c</sub>	Δ AIC <sub>c</sub>	AIC <sub>c</sub> weights	Model likelihood
Distance to property boundary	4605.672	0.0000	0.7846	1.0000
Patch size	4609.835	4.1639	0.0978	0.1247
Property acreage	4611.732	6.0607	0.0379	0.0483
Percent wetland	4612.882	7.2101	0.0213	0.0272
Percent field	4613.969	8.2978	0.0124	0.0158
Percent shrub	4614.054	8.3827	0.0119	0.0151
Percent nonhabitat	4614.104	8.4328	0.0116	0.0148
Percent forest	4614.147	8.4754	0.0113	0.0144
Percent pheasant hunting habitat	4614.162	8.4900	0.0113	0.0143

Table 25. Distances of ring-necked pheasant release locations to property boundaries, size of patches where ring-necked pheasants were released, and percent of properties comprised of various cover types, Pennsylvania, 2015. Statistics represent State Game Lands and other public properties for which data were available.

Model	Mean	SE	Minimum	Maximum
Distance to property boundary (ft)	1045.1	42.1	40.0	5313.0
Patch size (ac)	66.0	5.7	1.0	1202.2
Property acreage (ac)	5210.3	678.1	96.3	45808.4
Percent wetland	2.8	0.7	0.0	42.3
Percent field	11.0	1.2	0.2	63.4
Percent shrub	3.0	0.4	0.0	23.9
Percent nonhabitat	3.7	0.4	0.0	19.5
Percent forest	79.5	1.8	23.8	98.9
Percent pheasant hunting habitat	19.7	0.9	0.8	73.6

We entered important variables from aforementioned analyses into a single logistic model to estimate a best-case scenario for pheasant harvest rates:

$$\text{Harvest rate} = \frac{\exp^{[-1.112374 + (0.371654 * \text{sex}) + (-0.000365 * \text{day}) + (0.143604 * \text{releases}) + (0.000002 * \text{pheasants}) + (0.000128 * \text{distance}) + (0.003063 * \text{shrub})]}}{1 + \exp^{[-1.112374 + (0.371654 * \text{sex}) + (-0.000365 * \text{day}) + (0.143604 * \text{releases}) + (0.000002 * \text{pheasants}) + (0.000128 * \text{distance}) + (0.003063 * \text{shrub})]}}$$

Where sex = 1 or 0 for male or female pheasants; day = 1–4 for Tuesday–Friday release; releases = 1–5 for number of pheasant releases between pre-season and 4<sup>th</sup> in-season release; pheasants = 0–4500 (4500 was the maximum released on a single property in 2015); distance = 0–5300 feet (5300 was the maximum distance from release location to property boundary in 2015); and shrub = 0–100% shrub

cover within ½ mile of release location. A maximum harvest rate of 72.5% is estimated with a model containing male pheasants, released only on Fridays, 5 releases between preseason and 4<sup>th</sup> in-season release, 4500 pheasants released, release location 5300 feet from property boundary, and 100% shrub cover within ½ mile of release location.

Total expenditures related to game farm pheasant propagation and distribution was \$4,378,799.40, including the subtraction of \$5,895.60 from egg and chick sales. A total of 213,841 pheasants were released during the hunting season, and 17,475 breeders were released in spring 2016, resulting in a cost of \$18.93 per released pheasant. Cost per bagged pheasant ranged from \$27.16 for males released on other public properties during the 2<sup>nd</sup> in-season release to \$142.39 for females released on Hunter Access properties during the 2<sup>nd</sup> in-season release (Table 5). Cost per bagged male pheasant ranged from \$27.16 for those released on other public properties during the 2<sup>nd</sup> in-season release to \$83.38 for those released on Hunter Access properties during the 2<sup>nd</sup> in-season release. Cost per bagged female pheasant ranged from \$30.90 for those released on other public properties during the winter release to \$142.39 for those released on Hunter Access properties during the 2<sup>nd</sup> in-season release (Table 5).

## **Discussion**

Overall harvest rate estimate (49.1%) of game farm pheasants released in Pennsylvania in 2015 was similar to overall harvest rate estimated in 1998 (49.8%) if September hen releases in south zone are excluded from the 1998 estimate. If harvest rates of all pheasants released in 1998 are considered, including hens released in the south zone in September that were not legal to hunt, then the harvest rate in 1998 was 42.8% (Diefenbach et al. 1999). Harvest rate patterns on public and private properties and for males and females in 2015 were consistent with the 1998 study, i.e., higher harvest rates for males than for females, and higher harvest rates on public properties than on private properties.

It is unclear if higher harvest rates for males than females were due to hunter selectivity, lower hen survival (e.g., higher non-hunting mortality), both, or some other factor (Diefenbach et al. 1999). One strategy to increase harvest rates would be to increase the percentage of males in releases. This becomes problematic in a system where chicks are hatched in a 50:50 sex ratio. In the distant past the practice of euthanizing female chicks was in play, but that was deemed to be socially unacceptable by the early 1980s and discontinued. For financial reasons, the Game Commission for 2017 and into the future will purchase day old chicks rather than maintaining in-house breeder flocks and hatchery operations. There is an added cost for purchasing a disproportionate amount of males. Under the 2017 contract with a private producer to provide day-old chicks, cost per chick can almost double from mostly straight-run (\$1.05 each) to mostly male-only (\$1.95 each). With a chick purchase of 200,000 or more birds, purchasing mostly males could cost nearly \$200,000, at a time when reducing costs and increasing efficiencies are also a major concern.

Higher harvest rates on public property than on private property (Pennsylvania Game Commission Hunter Access) may be due to a combination of factors, including more pheasants being released there, better pheasant hunting habitat to hold birds longer, easier hunter access, and greater hunter effort. A 2013 survey of Pennsylvania hunters indicated that most (79.7%) pheasant hunters used State Game Lands, whereas the fewest (18.1%) used Pennsylvania Game Commission Hunter Access properties (Johnson et al. 2014). This may be due to lack of hunter awareness of which Hunter Access properties are stocked, or that relatively few birds get stocked on those properties, and stockings may only occur once during the season without notice.

Harvest rates varied through the season, with relatively low harvest rates for pheasants released for Junior hunt (40.6%) and in preseason (46.7%), and relatively high harvest rates for pheasants released during the first three weeks of the season (52.7–53.2%). Low harvest rates for pheasants released for Junior hunt are likely due to Junior hunter inexperience with shooting pheasants and that pheasants needed to survive and remain in areas accessible to hunters the week between the closing of Junior hunt and Saturday opener of pheasant season to be harvested during the regular season. Similarly, harvest rates for pheasants released preseason were lower because they could not be harvested until the Saturday opener. Female harvest rates were relatively high on public properties during winter release in December. This is likely due to hunters knowing that only females are stocked during the winter release and therefore were willing to harvest females. This is contrary to releases earlier in the season when female harvest rates are markedly lower than for males, highlighting the possibility of hunters preferentially harvesting males. Hunters may prefer to harvest males, which are larger than females. Alternatively, some hunters may believe that by passing on harvesting a female will allow that female to survive and breed. Indeed, about 44% of surveyed Pennsylvania hunters believed that stocking game farm pheasants is an effective way to restore wild pheasant populations; 32% disagreed, and 24% neither agreed nor disagreed (Johnson et al. 2014). Moreover, in that survey, 45% of hunters who indicated harvesting females disagreed with the belief that stocking game farm pheasants is an effective way to restore wild pheasant populations; 31% agreed, and 24% neither agreed nor disagreed (Johnson et al. 2014). However, the highest hen harvest rates even in the winter season are lower than any of the male harvest rates on SGL or other public lands earlier in the season, which lends some support to the notion that there may be some inherent behavior or survival differences lowering hen harvest rates.

In 1998, pheasants released during the late season on public and private properties were harvested at rates of 33.9% and 22.3%, respectively (Diefenbach et al. 1999). That release was comprised of 25% males and 75% females, and contributed less than 2.7% to the total number of pheasants released that year. In 2015, 48.0% of females released in winter on public properties were harvested; no banded females were released on Hunter Access properties in winter. The winter release consisted of 99.6% females, 0.4% males, and contributed 4.4% to the total pheasants released in 2015.

The later in the week that pheasants were released, the higher their harvest rate, particularly for the preseason release. Our data show that most harvests were on Fridays and Saturdays, likely due to increased hunter pressure those days as well as effects of Saturday opening days for Junior and regular seasons. According to the 2013 survey of Pennsylvania hunters, 43.2% of pheasant hunters indicated that Saturdays were the only day of the week they hunted pheasants, and nearly 50% indicated hunting Saturday opening day of regular season (Johnson et al. 2014).

According to 2015-16 Game Take Survey (GTS), pheasant harvests, hunters, and hunter-days in 2015-16 were similar to recent years (since 2012-13) when Game Commission maintained over 200,000 pheasants released each season (Figure 4). Also, this indicates that releasing reward-banded pheasants did not result in appreciable increases in hunter participation and effort, which could bias harvest rate estimates. Note that total pheasant harvests in Pennsylvania in the 2015-16 season was estimated by the Game Take Survey at about 205,000. Pheasant harvests estimated in the Game Take Survey typically have exceeded the numbers of game farm pheasants released by the Game Commission. There are a few factors that likely cause the difference. Though we ask Game Take Survey recipients not to report pheasants harvested at shooting preserves, there are likely some reported anyway. There are hundreds of thousands of pheasants being released on shooting preserves that can "escape" onto adjacent

properties (and beyond) that are harvested – hunters harvesting the pheasants on those other properties may not know where the pheasants originated. Also, there are hunters who buy pheasants and release them on game lands or private lands and hunt them, and they likely are reporting these with their pheasant harvest. Lastly, there may be an unknown number of harvested “wild” pheasants or holdover pheasants from our game farm releases being reported. All of this adds up to more harvests estimated than our game farms release.

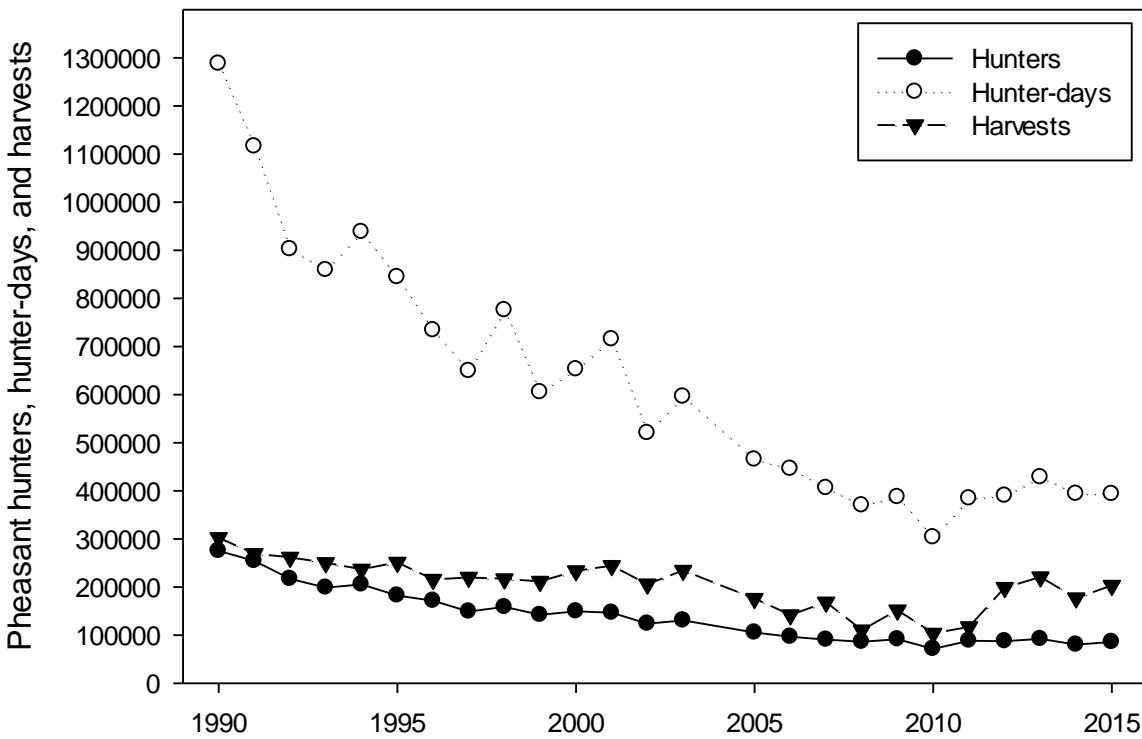


Figure 4. Number of pheasant hunters, hunter-days, and pheasant harvests in Pennsylvania according to Game Take Survey, 1990–2015.

In 1998-99 season, there were 199,613 pheasants released and 158,497 pheasant hunters (1.26 pheasants released per hunter) having a success rate (percent of hunters participating in pheasant hunting that harvested  $\geq 1$  pheasant) of 44.0%. In 2015-16, there were 215,104 pheasants stocked and 85,857 pheasant hunters (2.51 pheasants released per hunter) having a success rate of 53.5%.

Similar to harvest rates, survival rates in 2015 showed similar patterns to that in 1998, i.e., higher survival rates for males than females and higher survival rates on private than public property. Survival rates estimated for Junior and preseason releases should be interpreted with caution. If pheasants are not at risk of harvest at time of release, survival rate estimates will be positively biased (Brownie et al. 1985, Diefenbach et al. 1999). Among in-season releases, survival rates were more consistent, particularly for pheasants released on public properties where sample sizes were higher. Compared to pheasant daily survival rates in 1998, daily survival rates in 2015 were 2.1–5.2 percentage points higher, depending on sex and property type. In 1998, 1.3% of harvested pheasants released in the regular season were harvested in the late season (Diefenbach et al. 1999), whereas in 2015, that percentage was 4.7%.

In 1998, habitat variables that influenced harvest rates were habitat patchiness and percent of forest cover, though forest cover parameter estimates were inconsistent among pheasant sex and property categories (Diefenbach et al. 1999). Our results indicate that percent shrub cover, particularly within ½ and 1 mile of release sites positively influenced harvest rates. Shrub cover may benefit harvest rates by providing pheasants with cover within property boundaries where they are still available to hunters. Within property boundaries, cover type composition was not as important as distances from where pheasants were released to adjacent properties where pheasants may or may not have been available to hunters. Releasing pheasants farther from property boundaries may increase the number of times hunters are able to flush pheasants. Stocking pheasants consistently within a property also results in increased harvest rates. Pheasants may be flushed out of properties by hunters between successive releases, so releasing pheasants on a weekly basis places more pheasants where hunters can access them regularly.

### **Management considerations**

Patterns in survival and harvest rates in 2015 were similar to those discovered in 1998. Therefore, many of the recommendations remain the same. The overall purpose of the Pennsylvania Game Commission pheasant propagation program is to provide a positive hunting experience, and maximize the percent of stocked pheasants harvested by hunters. Pheasant hunting also is an effective hunter recruitment and retention tool. Pheasant hunting participation among Junior license holders is higher than any other license type. Further, while participation in other small game species has decreased dramatically in recent years, pheasant hunting participation has remained relatively stable. Since 2011, numbers of rabbit hunters, grouse hunters, and squirrel hunters are down 33%, 38%, and 29%, respectively. In that same period, pheasant hunter numbers are down just 2%.

(\*) Continue to release pheasants later in the week to reduce non-hunting mortality and increase harvest rates, as more hunter effort is concentrated later in the week and on Saturdays. Harvest rates of pheasants released during preseason could be improved by stocking Wednesday through Friday, i.e., eliminate releases on Tuesday. Consider a regulation to prohibit dog training on state game lands the week before the regular season opener. (This regulation was adopted by the Board of Commissioners at their March 2017 meeting)

(\*) Increase proportion of pheasants released on public properties, as the best pheasant hunting habitat and hunter access are found there, resulting in more pheasant hunter pressure and highest harvest rates.

(\*) Public properties that are not stocked regularly through the season, presumably because of some pheasant hunting habitat quality or quantity deficiencies should be considered for elimination from stocking schedules until those deficiencies are corrected. Release pheasants on a consistent basis throughout the season (preseason through 4<sup>th</sup> in-season release) rather than skipping some in-season releases.

(\*) Release pheasants in good pheasant hunting habitat as far as possible from property boundaries.

(\*) Increase shrub cover where possible to retain pheasants within property boundaries. Tree cutting or old field succession can be used to accomplish this goal, but an additional alternative is to plant fields with warm season grass stands such as switch grass.



(\*) Eliminate release of females during Junior releases in WMUs under cocks-only regulations. In 2015, female pheasants were released in either-sex WMUs during Junior release for education purposes (this practice was discontinued in 2016).

(\*) Increase hunter awareness of stocking locations through publicly available mapping application that would be updated every year with the previous year's stocking data. Stocking locations remain relatively unchanged between years. Efforts are underway to develop and make available to the public a mapping program that shows all public lands stocked with Game Commission game farm pheasants.

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## Appendix A

Data form to be completed by pheasant banders and releasers during pheasant harvest rate study,  
Pennsylvania 2015.

<b>Crate ID:</b>		<b>Game Farm:</b>		<b>Date Banded:</b>	
		<b>Band Numbers</b>			
<b>Bird</b>	<b>Standard</b>	<b>Reward</b>		<b>LM Group Receiving Crate:</b>	
1					
2					
3					
4					
5				<b>Comments:</b>	
6					
7					
8					
9					
10					

**Banders retain this copy and send to Harrisburg**

<b>Crate ID:</b>			
<b>LM Group Receiving Crate:</b>			
<b>Date released:</b>			
<b>WMU:</b>		<b>County:</b>	
		<b>Township:</b>	
<b>Land Ownership: (circle one)</b> <b>SGL</b> <b>State Park</b> <b>State Forest</b> <b>Public Access Land</b>			
<b>Other :</b>			
<b>Name of Location:</b> (e.g., "SGL 88" or "Farm-Game Co-op 250")			
<b>Description of Location:</b> (e.g., "food plots on north end of Game Lands" or "jct of SR2002 and T540")			
<b>Band numbers of dead pheasants:</b> Please record band numbers and band colors for each dead bird		<b>Colored band</b>	
		<b>Silver band</b>	
		<b>1<sup>st</sup> dead bird</b>	
		<b>2<sup>nd</sup> dead bird</b>	
		<b>3<sup>rd</sup> dead bird</b>	
		<b>4<sup>th</sup> dead bird</b>	
<b>5<sup>th</sup> dead bird</b>			

**Releasers submit this data to Harrisburg**

## Appendix B

Pheasant band recovery data form to be completed by Bureau of Wildlife Management staff during pheasant harvest rate study in Pennsylvania, 2015.

**PHEASANT HARVEST RATE STUDY: BAND RECOVERY DATA FORM**

Message mailbox:					
Date/time hunter called:		Date:		Time:	
First name:					
Middle initial:					
Last name:					
Name suffix:					
Address 1:					
Address 2:					
City:					
State:					
ZIP:					
Phone #:					
Best day/time to reach:					
Band details:				Band serial #	Band color
		Band 1			
		Band 2 (if applicable)			
Band recovery type (circle one):		Hunter harvest	Road-kill	Unknown	Other
		If Other:			
CID and SSN (SSN only if a band is silver)					
Date of band recovery:					
Band recovery location:		WMU:	County:		Township:
		Location details (e.g., SGL #):			
PGC employee, Deputy WCO, Commissioner, or immediate family? (Only needed if band is silver)		Yes		No	Don't know
Knowledge of banding study prior to band recovery?		Yes		No	Don't know
Needs more attention?		Yes	No		
Payment processed?		Yes	No	Date processed:	
Comments:					

## Appendix C

Pheasant band recovery data form mailed to person recovering band during pheasant banding study in Pennsylvania, 2015.



# PENNSYLVANIA GAME COMMISSION

## PHEASANT BAND RECOVERY FORM



We received a message from you on our pheasant band reporting phone number, but couldn't reach you by phone. Please complete the following form and return it in the postage-paid envelope provided. Please complete one form for each banded pheasant you harvested. If you have additional banded pheasants to report, please enter number of banded pheasants you need to report and we will mail you the appropriate number of forms to fill out:

1. How was your pheasant band recovered? (Choose one)

- a. Hunter harvest → *Go to Question 3*
- b. Hit by vehicle → *Go to Question 3*
- c. Unknown → *Go to Question 3*
- d. Other → *Go to Question 2*

2. If you answered "Other" to Question 1, please describe the circumstances surrounding the recovery of the band:

3. What was the date when the band was recovered?

Month	Day	Year

4. Please provide details about the location where you recovered the band:

Wildlife Management Unit (WMU):	
County:	
Township:	
Location details (e.g., State Game Lands name or number, State Forest name, etc.):	

5. Was the pheasant a male or female? (Choose one)

- Male
- Female
- Unknown

6. Please provide the following details from the band(s):

	Band serial number	Band color
First band		
Second band (only if your pheasant had 2 bands)		

7. Was either band silver in color?

- Yes → *Go to Question 8*
- No → *Go to Question 10*

8. Please provide your hunting license number (CID) in the space below. If you don't have a hunting license, please provide your social security number (these numbers will be kept confidential).

\_\_\_\_\_

9. Are you a Pennsylvania Game Commission employee, Deputy Wildlife Conservation Officer, PGC Commissioner, or immediate family of the aforementioned?

- Yes
- No
- Go to Question 11*

10. Please provide your hunting license number (CID) in the space below.

\_\_\_\_\_

11. Were you aware of the pheasant banding study prior to recovering your band?

- Yes
- No

**Thank you for participating in the Pennsylvania Game Commission's pheasant harvest rate study!**