FACTORS AFFECTING POPULATION INDICES OF RING-NECKED PHEASANTS

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SUMMARY OF FINDINGS

The purpose of this study was to assess the validity of using replicated roadside surveys to estimate abundance of ring-necked pheasants (*Phasianus colchicus*) on 18, 23-km^2 (9-mi^2) study areas in southern Minnesota by comparing roadside indices to crowing indices adjusted for detection probability. For the crowing index, we used an auditory mark-recapture method to estimate mean detection probability. Crowing indices ranged from 1.2-6.4 males/stop. Roadside indices ranged from 0.9-11.9 males/route and were correlated to unadjusted crowing indices (r^2 = 0.42, P = 0.003). For crowing surveys, mean conditional probability of detection (conditional on males that crowed at least once during 3, 2-minute listening intervals) varied among study areas, was positively correlated with the total crows detected during the first 2-minute listening period, negatively correlated with the amount of disturbance/stop, and was slightly lower during the first listening period than during the second and third period.

INTRODUCTION

To make knowledgeable decisions, wildlife managers often need to estimate species population parameters (e.g., Hicks et al. 1941, Efford et al. 2005). Population size monitoring allows managers to make inferences on how a population is responding to environmental or regulatory changes and plan appropriate management alternatives (Ruff 1939, Eberhardt and Simmons 1987, Thomas 1996, Gibbs et al. 1998).

Populations of ring-necked pheasants are difficult to estimate because pheasants do not have the flocking habits of other birds, are relatively secretive, and difficult to capture (Brown 1947, Thomas 1996, Lancia et al. 2005). Therefore, pheasant populations are typically monitored using population indices. Although carefully designed population indices may provide unbiased estimates of population trends (Bart et al. 2004), they also suffer from high amounts of variability (Fisher et al. 1947).

The 2 most common types of population indices used for pheasants are roadside surveys and crowing surveys (Brown 1947, Rice 2003, Haroldson et al. 2006). Advantages of roadside surveys are that roads are easy to access and surveys require fewer personnel than other survey methods, which make roadside surveys relatively inexpensive. Roadside surveys are a type of convenience sampling, and the accuracy of roadside population indices may be affected by factors such as weather, road-related disturbance, distribution of roads and habitats, and variation in detection probability (Kimball 1949, Kozicky 1952, Anderson 2003, Hutto and Young 2003). Although weather may be controlled through carefully designed survey protocol, roads are non-randomly distributed and may not be representative of the habitats on the study area. In addition, detection probability is unknown.

We postulated that crowing surveys may not be affected by as many variables as roadside surveys. We hypothesized that factors such as road-related disturbance and the non-random distribution of roadside survey routes within the study area may affect the ability to detect pheasants during roadside surveys, but careful selection of crowing survey stops may yield representative coverage of a survey area and reduce the effect of road-related disturbance. In addition, we postulated that detection probability may be estimated with an auditory mark-recapture technique.

In this study, we used replicated surveys to compare crowing and roadside indices of male pheasants on 18 study areas in southern Minnesota. For the crowing index, we used

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closed mark-recapture methods to estimate mean detection probability and evaluate the assumption that the expected value of mean detection probability was similar among study areas. Our objectives were to: (1) evaluate use of an auditory mark-recapture technique to estimate mean detection probability of crowing male pheasants; (2) assess the validity of using replicated roadside surveys by comparing roadside indices to crowing indices (adjusted for detection probability) across the 18 study areas; and (3) evaluate factors that may influence the accuracy of roadside and crowing indices.

STUDY AREA

This study was conducted on 18 study areas in southern Minnesota. To facilitate pheasant surveys, 9 study areas were selected in each of 2 regions located near Windom and Faribault, Minnesota (Figure 1). Study areas averaged 23 km^2 (9 mi^2) in size and varied in the amount and distribution of grassland habitat, winter habitat, roads, and relative pheasant density (Haroldson et al. 2007).

METHODS

We conducted 10 crowing and 10 roadside surveys on each study area between 20 April and 31 May 2007. Crowing surveys and roadside surveys were scheduled independently (not necessarily on the same days). Trained observers conducted surveys on mornings meeting standardized weather conditions; however, surveys were completed even if weather conditions worsened during the survey. Observers rotated systematically among study areas to reduce the effect of observer bias.

Crowing Surveys

We located and conducted surveys at 9 stops on each study area. Stops were evenly distributed across each study area, based on an estimated 0.8 km (0.5 mile) auditory radius, to achieve maximum possible coverage of the study area and minimize overlap among stops (Figure 2). Where possible, we located stops on roads to facilitate convenient access. Where roads were not available, we located stops up to 0.4 km (0.25 mile) from roads. Due to road coverage and landscape obstacles (e.g., lakes), 2 study areas had only 8 stops.

Crowing surveys began 45 minutes before sunrise and were completed by sunrise on mornings with <16 km/hour (10 mile/hour) winds and no precipitation (Kimball 1949, Kozicky 1952, Luukkonen et al. 1997). Two observers performed surveys on each study area, dividing the 9 stops between them (4-5 stops/observer). The starting location for each survey route was selected randomly, and direction of travel was selected to minimize travel time and observer overlap. At the beginning and end of each survey route, observers recorded temperature, wind speed, and amount of dew. The percent of sky covered by clouds was recorded at the end of the survey route.

At each stop, observers counted the number of crowing males and the number of times each male crowed for 2 minutes. Sightings of pheasants and vocalizations other than crows were not recorded. At the end of each listening period, observers recorded which males they were certain were unique and which were potentially confused with adjacent males. Observers classified disturbance affecting their ability to hear crowing pheasants into 4 categories: none, low (e.g., distant tractor noise), medium (e.g., intermittent traffic), or high (e.g., constant background noise). For each study area, we calculated a population index (male pheasants counted/stop) from the mean number of crowing males counted/stop over all 10 repeated surveys.

We used extended listening periods at 4 of the 9 stops on each study area and day to evaluate whether a closed population capture-recapture approach (Huggins 1989) could be used to estimate the mean detection probability of male pheasants. Observers at mark-recapture stops continued to survey for 2 additional 2-minute listening periods immediately following the first listening period. The second and third listening periods identified which birds heard during the first period were heard again, and also birds that had not previously been heard.

Roadside Surveys

Roadside surveys were conducted at sunrise on mornings with <60% cloud cover, <16 km/hour (10 mile/hour) winds, temperatures >0°C, and dew present. Roadside survey routes ranged from 16-19 km (10-12 miles) in length and were conducted mainly on gravel roads. Starting location and direction of travel were randomly selected for each survey and observers rotated among study areas to reduce effects of observer bias. Observers drove approximately 24 km/hour (15 miles/hour) along survey routes and recorded the sex and number of pheasants observed. Observers used Global Positioning System receivers to record the location and time of each pheasant observation (Haroldson et al. 2007). For each study area, we calculated a population index (male pheasants counted/route) from the total number of male pheasants counted/total survey distance driven over all 10 repetitions. We standardized the index to males/16.1 km (males/10 miles) to adjust for variation in survey distance among study areas.

Habitat Evaluation

We estimated the amount and distribution of grass habitat available to pheasants by cover mapping to a Geographic Information System from recent aerial photographs. Cover types were verified by ground-truthing all habitat patches visible from roads.

RESULTS AND DISCUSSION

Observers completed 177 of 180 crowing surveys and all 180 of 180 roadside surveys. Pheasants were heard crowing on all study areas, with indices ranging from 1.2-6.4 males/stop (Table 1). Crowing frequencies ranged from 0.0-10.5 crows/male/stop with a mean of 1.7 crows/male. Pheasants were observed on all study areas during roadside surveys. Roadside indices ranged from 0.9-11.9 males/route (Table 1). Roadside indices were correlated with unadjusted crowing indices ($r^2 = 0.42$, $P = 0.003$). We observed more pheasants along gravel roads than paved roads ($t = -2.63$, $P = 0.013$, Figure 3) during roadside surveys, but not during crowing surveys ($t = -1.74$, $P = 0.09$, Figure 4).

We considered 16 mark-recapture models (Table 2) that described possible sources of heterogeneity in detection probability for crowing surveys. The best approximating model (M13) indicated that mean conditional probability of detection (conditional on males that crowed at least once during the 3, 2-minute listening intervals) varied among study sites (Figure 5), was positively correlated with the total crows detected during the first 2-minute listening period, negatively correlated with the amount of disturbance/stop, and was slightly lower during the first listening period than during the second and third period. There was evidence that the relationship between the crows detected during the first listening period and detection probability varied among study areas, but it is unclear whether this interaction reflected measurement error while recording crows or true spatial variation in the relationship between detection probability and crowing frequency and intensity. Conversely, mean detection probability was not strongly correlated with road type, weather conditions, survey date, or contractor (observer groups). The latter was not unexpected because our survey protocols were designed to minimize these effects on both roadside and crowing surveys.

We are currently analyzing data and have few results at this time. We plan to complete data analysis by June 2008 and have a final report by September 2008.

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Table 1. Pheasant crowing and roadside indices after repeated surveys (n) on 18 study areas in southern Minnesota during spring 2007.

		Crowing index		Roadside index	
Region	Study area	N	Males/stop	N	Males/route[a]
Windom	19	10	4.6	10	11.5
	20	10	6.4	10	10.5
	21	10	3.5	10	6.3
	22	10	5.5	10	11.9
	23	9.5[b]	5.0	10	11.0
	24	9.5[b]	4.7	10	4.2
	25	10	3.9	10	3.4
	26	10	5.5	10	7.9
	27	9.5[b]	2.7	10	2.7
Faribault	28	10	3.0	10	11.0
	29	10	3.9	10	3.2
	30	10	2.7	10	4.1
	31	10	4.2	10	7.1
	32	10	3.1	10	5.5
	33	10	3.7	10	4.2
	34	10	3.7	10	3.8
	35	10	3.5	10	2.1
	36	10	1.2	10	0.9

[a] Route length standardized to 16.1 km (10 miles).

[b] For 1 survey, half of stops were not surveyed.

Table 2. Closed population capture-recapture models (Huggins 1989) used to estimate and evaluate factors affecting conditional probability of detection in pheasant crowing surveys in southern Minnesota, spring 2007.

Model	Covariates[a]	Npar	AICc	ΔAICc	Weight	Deviance
13	t2bin + site * t1crows + disturb	38	13067	0.0	1	12991
11	t2bin + site + t1crows + disturb	21	13210	142.2	0	13168
14	t2bin + sagrass + t1crows + disturb	5	13237	169.8	0	13227
16	t2bin + sagrass + contract + t1crows + disturb	10	13238	170.8	0	13218
10	site + t1crows + disturb	20	13253	186.0	0	13213
8	t1crows + disturb	3	13284	216.4	0	13278
9	t1crows + I(t1crows^2) + disturb	4	13286	218.4	0	13278
15	t2bin + site + rtype	21	13561	493.9	0	29898
6	site + disturb	19	13596	528.7	0	13558
12	contract+jdate+mbsun2+avg.dewst+avg.temp +avg.wind+avg.clds+disturb	13	13609	541.5	0	13583
3	site	18	13618	550.1	0	29960
7	rtype + disturb	4	13668	600.5	0	13660
2	contract	6	13675	607.7	0	30042
5	disturb	2	13678	610.8	0	13674
4	rtype	3	13703	635.5	0	30076
1	1	1	13723	655.4	0	30100

[a] t2bin= crows detected during the second and third listening periods
site=study area
t1crows= crows detected during the first listening period
disturb= level of disturbance encountered by observer
sagrass= percent of grass habitat located within the study area
contract= observer groups
rtype= road type (paved, gravel, or off-road)
jdate= julian date
mbsun2= minutes before sunrise
avg.dewst= average amount of dew present at start of survey
avg.temp= average temperature
avg.wind= average wind speed
avg. clouds= average amount of cloud cover

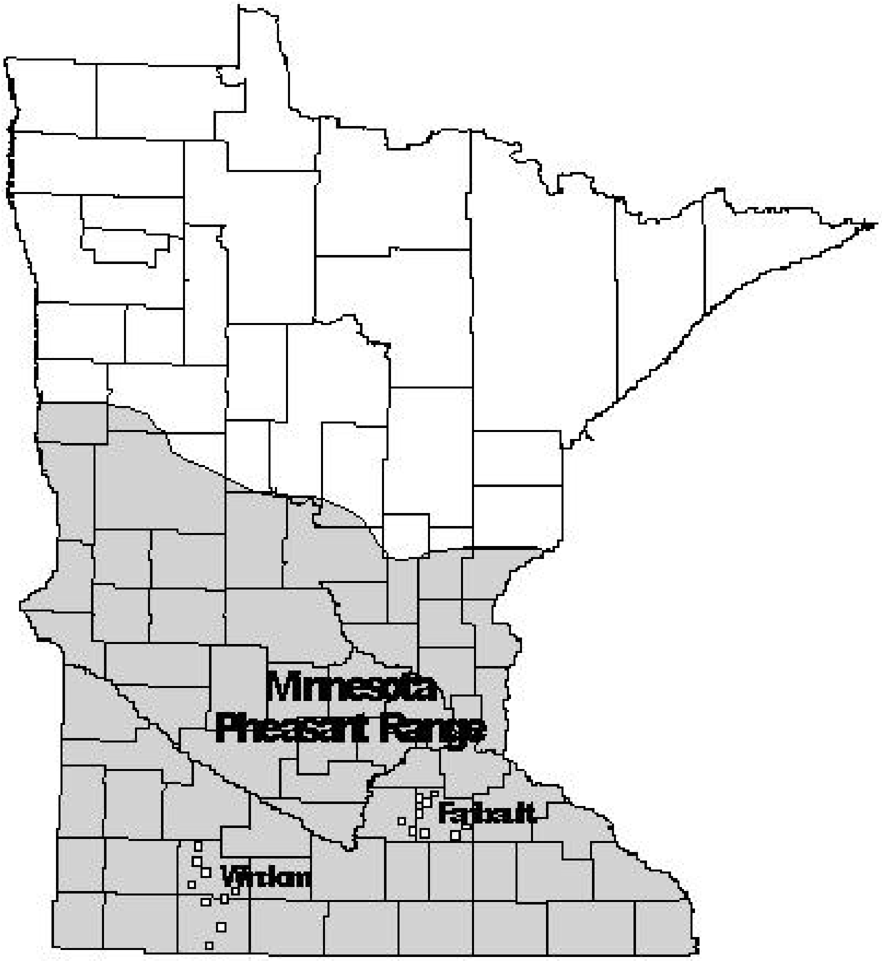

Figure 1. Locations of study areas (white squares) within Minnesota's pheasant range (shaded portion of the map), spring 2007.

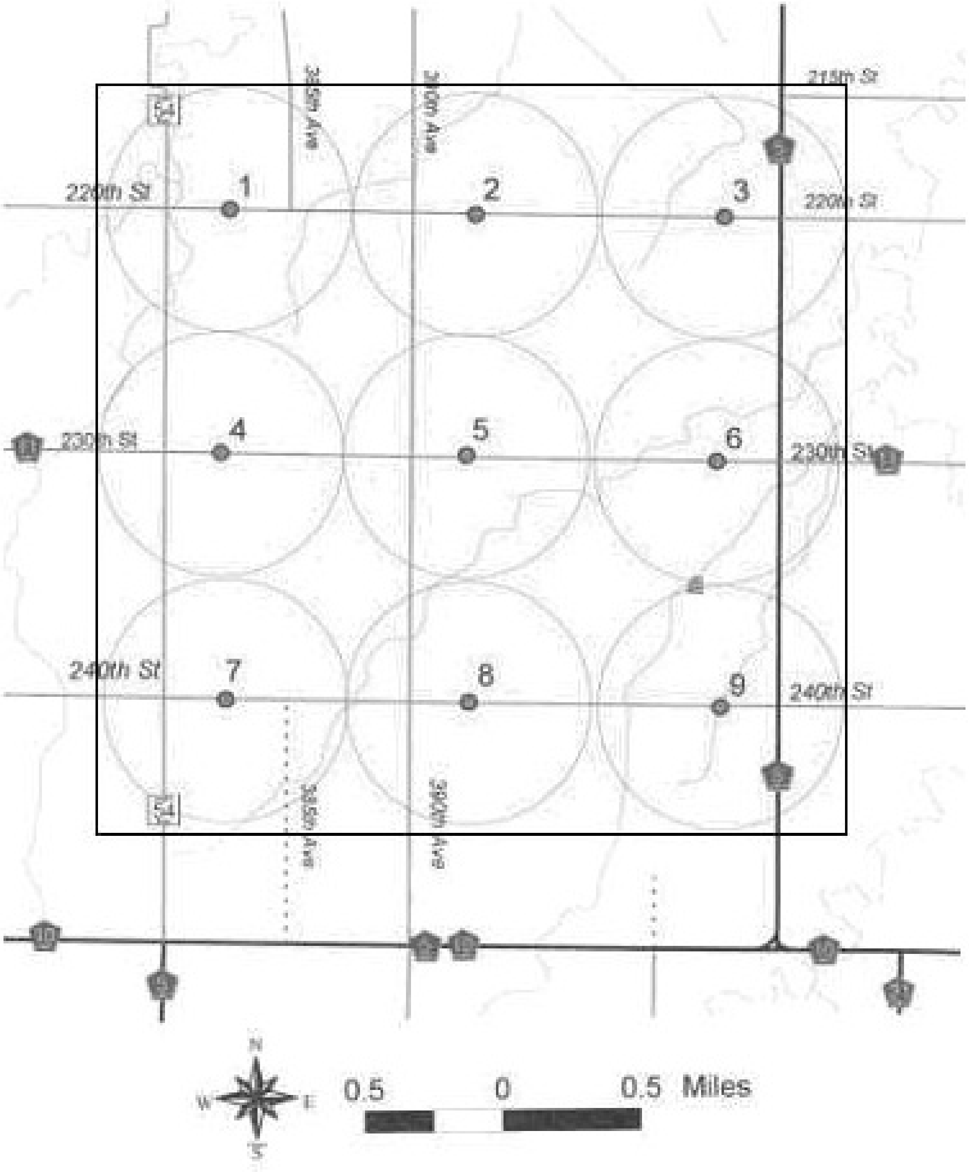

Figure 2. Typical study area showing 9 crowing survey listening stops and estimated 0.8 km (0.5 mile) auditory radii, Minnesota, spring 2007.

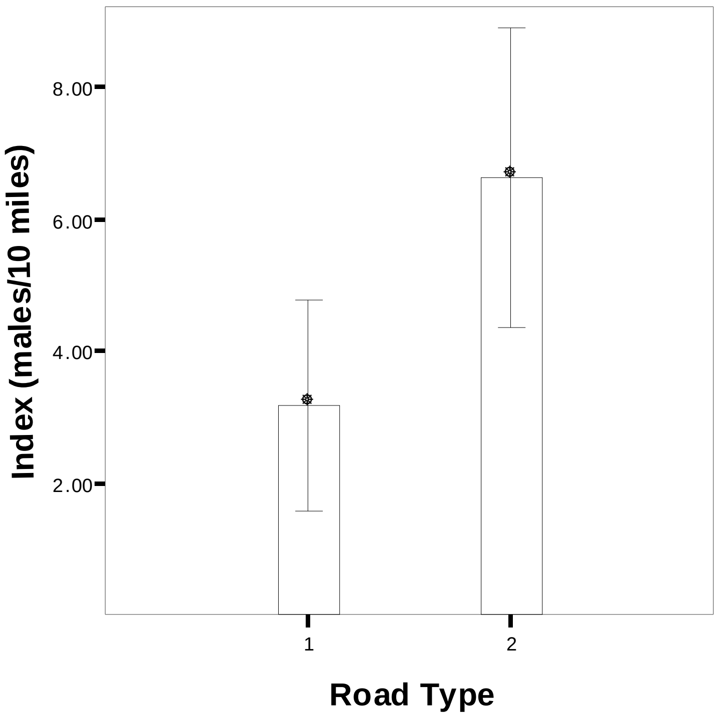

Figure 3. Effect of road type (1 = paved, 2 = gravel) on mean roadside survey indices in Minnesota, spring 2007. Error bars show 95% confidence intervals of means.

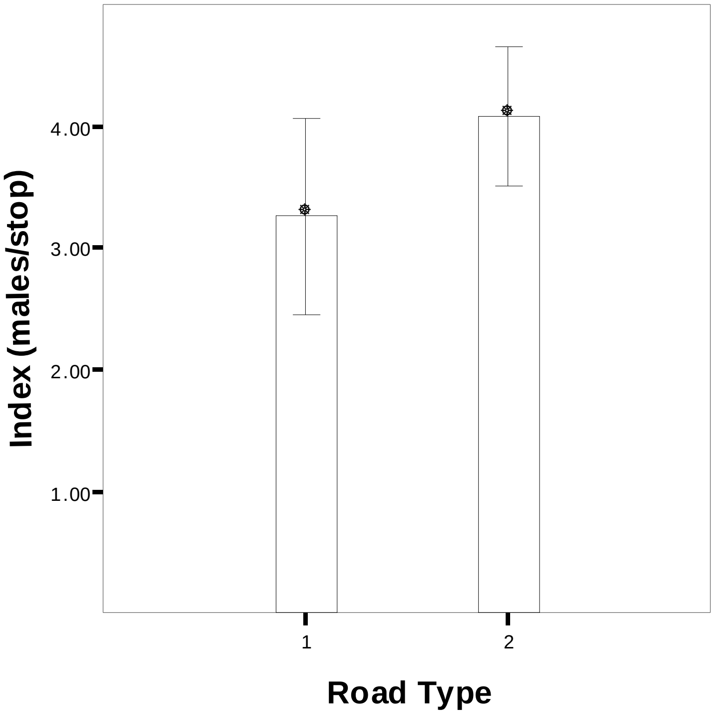

Figure 4. Effect of road type (1 = paved, 2 = gravel) on mean crowing survey indices (during the first listening period) in Minnesota, spring 2007. Error bars show 95% confidence intervals of means.

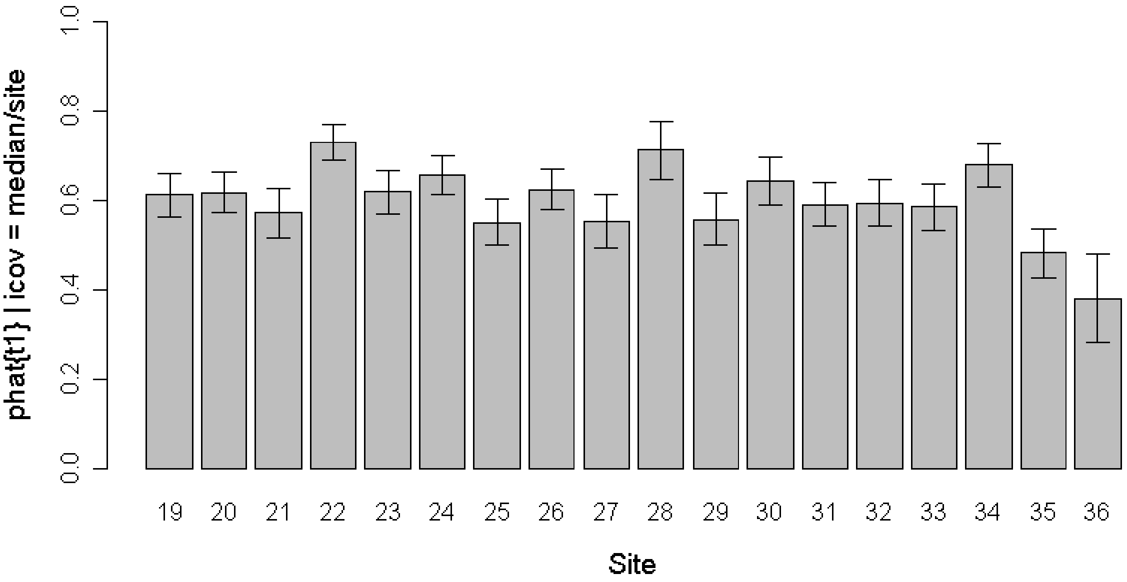

Figure 5. Mean conditional probability of detection in 10 replicated crowing surveys on 18 study areas in southern Minnesota during spring 2007. Site-specific estimates of detection are based on median covariate values for total crowing calls/stop and relative disturbance/stop.