MINNESOTA'S RING-NECKED DUCK BREEDING PAIR SURVEY

David P. Rave, Michael C. Zicus, John R. Fieberg, John H. Giudice, and Robert G. Wright

SUMMARY OF FINDINGS

A pilot study was conducted in 2004-2006 to develop a survey for Minnesota's ring-necked duck (*Aythya collaris*) breeding population because little was known about its distribution and relative abundance. We employed the survey design and methods developed during the pilot study (Zicus et al. 2006) to estimate the size of the population in 2007. The helicopter-based counts (5–13 June 2007) entailed 11 flight days between 2 crews, and included the portion of Minnesota considered primary breeding range. The combined population was estimated to be ~14,500 indicated breeding pairs (~30,300 birds) which is similar to the estimates during the pilot years of the study.

INTRODUCTION

Staff members in the Minnesota Department of Natural Resources (MNDNR) Wetland Wildlife Populations and Research Group have been developing a forest wetlands and waterfowl initiative. The status of ring-necked ducks has been among the topics considered because the species has been identified as an indicator species for the Forest Province (Minnesota Department of Natural Resources. 2003. A Vision for Wildlife and its Use – Goals and Outcomes 2003 – 2013 (draft). Minnesota Department of Natural Resources, unpublished report, St. Paul). However, little is known about the current distribution and abundance of breeding ring-necked ducks in Minnesota. A 3-year pilot study was used to develop a breeding pair survey (Zicus et al. 2006), and 2007 represented the first year of an operational ring-necked duck breeding pair survey.

METHODS

Two separate surveys, identical to those used in 2006 (Zicus et al. 2006), were conducted in 2007. We used a stratified random sampling design with 2 stratification variables: (1) Ecological Classification System (ECS) sections; and (2) presumed nesting-cover availability (i.e., a surrogate for predicted breeding ring-necked duck density) to estimate population size in the best ring-necked duck habitat. We used a 2-stage simple random sampling design to estimate population size in the remainder of the survey area. We used a helicopter for the survey because visibility of ring-necked ducks from a fixed-wing airplane is poor in most ring-neck breeding habitats. We considered pairs, lone males, and males in flocks of 2 – 5 to indicate breeding pairs (IBP; J. Lawrence, Minnesota Department of Natural Resources, personal communication). The total breeding population in the survey area was considered to be twice the IBP plus the number of birds in mixed sex groups and lone or flocked females.

Statistical Population, Sampling Frame, and Sample Allocation

The surveys were restricted to an area believed to be primary breeding range of ring-necked ducks for logistical efficiency (Zicus et al. 2005). We used the same habitat class definitions that were used for stratification in the last pilot year (i.e., 2006) (Table 1). Habitat class 1 and 2 plots were presumed to represent the best habitat whereas habitat class 3 and 4 plots represented the remainder of the survey area. Public Land Survey (PLS) sections at the periphery of the survey area that were <121 ha in size were removed from the sampling frame to reduce the probability of selecting these small plots.

A stratified sampling design was used to estimate breeding ducks in habitat class 1 and 2 plots, and the sampling frame consisted of 12 strata (i.e., 6 ECS sections x 2 habitat classes). We proportionally allocated 200 plots to the 12 strata (Zicus et al. 2005). We used a 2-phase

sampling process to sample 50 plots in habitat classes 3 and 4. The phase-1 sample consisted of 1,000 habitat class 3 and 4 plots, disregarding ECS sections. These plots were visually inspected using 2003 Farm Services Agency (FSA) true color aerial photography and classified as to their ring-necked duck potential (i.e., possible breeding pairs vs. no pairs). PLS sections containing open water except for small streams were considered potential ring-necked duck plots. The proportion of plots classified as potentially having pairs was used as an estimate of the proportion of all class 3 and 4 plots that had potential for breeding pairs. We then randomly selected 50 plots (phase-2 sample) from those having the potential for ring-necked duck pairs in order to estimate the mean number of breeding pairs in these plots.

Data Analyses

Estimated population size

We used SAS PROC SURVEYMEANS (SAS 1999) to estimate population totals for habitat class 1 and 2 plots in each ECS section and the entire survey area. In this analysis, PLS sections were the primary sampling unit in a stratified random sampling design. For the second survey, we estimated population size (τ) for habitat class 3 and 4 plots in the entire survey area as follows:

$$\hat{\tau} = \hat{P} * \bar{x} * N ,$$

where $\hat{P}$ = proportion of phase-1 plots classified as habitat-class 3,
$\bar{x}$ = mean breeding ducks detected on phase-2 sample plots, and
N = total habitat-class 3 and 4 plots in sampling frame.

The variance of $\hat{\tau}$ was estimated using the delta method as:

$$\text{var}(\hat{\tau}) = N^2 ((\hat{P}^2 * \text{var}[\bar{x}]) + (\bar{x}^2 * \text{var}(\hat{P})).$$

Estimates from the 2 surveys were combined to produce an overall population estimate for the survey area.

Data acquisition

The 2005 and 2006 survey utilized an ArcView 3.x extension (DNRSurvey) in conjunction with a GPS receiver and MNDNR Garmin program (real time survey technique) to collect the survey data. This approach allowed us to display the aircraft's flight path over a background of aerial photography and the survey plots. The flight path and ring-necked duck observations were recorded directly to ArcView shapefiles, all in real time (R. Wright, Minnesota Department of Natural Resources, personal communication). We planned to use an updated version of DNRSurvey for the 2007 survey, however, the updated version was not ready, thus DNRSurvey was not used this year. In 2007, location, date, and time was recorded on data sheets for all ring-necked ducks seen on study plots from the helicopter. Locations of these birds were also plotted on aerial photos.

RESULTS

In 2007, plots were well distributed throughout the study area (Figure 1). Most plots (77) were located in the Northern Minnesota Drift and Lake Plains section, while the fewest plots (8) were located in the Lake Agassiz, Aspen Parklands section (Table 2). The highest and lowest sampling rate again occurred in the Lake Agassiz, Aspen Parklands section and Northern Superior Uplands section, respectively. The survey was conducted 5–13 June and entailed 11 survey-crew days. Observed pairs represented 56% of the indicated pairs tallied during the 2007 survey compared to 44% in 2006, 36% in 2005, and 57% in 2004 (Table 3).

Estimated Pair Density

Mean pair density on habitat class 1 and 2 plots ranged from a high of 2.65 pairs/plot in the Lake Agassiz, Aspen Parklands section to a low of 0.30 pairs/plot in the Western and Southern Superior Uplands section (Table 4). Indicated pair densities were greatest in the Lake Agassiz, Aspen Parklands section with lowest pair densities in the Western and Southern Superior Uplands and the Northern Minnesota and Ontario Peatlands sections. Estimated indicated breeding pairs on habitat class 1 and 2 plots ranged from a high of 5,686 in the Northern Minnesota Drift and Lake Plains section to a low of 671 in the Western and Southern Superior Uplands section (Table 5).

Estimated Population Size

The estimated population of ring-necked ducks on habitat class 1 and 2 plots ranged from a high of 11,651 in the Northern Minnesota Drift and Lake Plains section to a low of 1,342 in the Western and Southern Superior Uplands section (Table 6). The number of estimated indicated breeding pairs on habitat class 3 and 4 plots was 1,721 (90% confidence interval = 267 – 3,176), while the estimated breeding population on class 3 and 4 plots was 4,304 (90% confidence interval = 1,117 – 7,491, Table 7).The estimated number of indicated breeding pairs for the entire survey area in 2007 was 14,508 (90% confidence interval = 10,514 – 18,503), and the estimated ring-necked duck population was 30,330 (90% confidence interval = 22,203 – 38,457, Table 7).

Observed Distribution

The survey was not designed explicitly to describe the distribution of breeding ring-necked ducks, but observations accumulated thus far have improved our knowledge of ring-necked duck distribution in the survey area. Indicated pair observations in 2005–2007 shifted somewhat to the east compared to 2004 (Figure 1). Estimates from 2004–2007 suggest that some ECS subsections or portions of a section might have substantial numbers of breeding ring-necked ducks even though few birds were observed in the ECS section (Figure 2). For example, pairs/plot and total estimated pairs were relatively high in the Northern Superior Uplands, yet few plots in the section had indicated breeding pairs (Tables 5 and 6).

DISCUSSION

Survey dates in 2007 appeared appropriate because 56% of the indicated pairs were counted as paired birds, and survey timing is considered optimal when most birds are counted as pairs and not in flocks (Smith 1995). The stratified random sampling design that we employed was adequate for plots in habitat classes 1 and 2, while the second survey based on a simple random sample of plots in habitat classes 3 and 4 again provided an estimate for the survey area that was unbiased (i.e., included all potential breeding habitat). Detection rates appeared to be relatively high in all habitats, suggesting that any bias probably would be minor.

MN-GAP land cover data provided a convenient way to stratify the survey area, but they have shortcomings as well as strong points. They provided a consistent statewide source of land use/cover data that was available in an easy to use raster format. However, the data are derived from 1991 and 1992 satellite imagery, which makes them dated. Further, the data exist at 4 levels of resolution, and classification accuracy of cover types is diminished at the level that we used. Nearly 50% (487 of 1,000) of habitat class 3 and 4 plots were incorrectly classified when compared to conditions that existed in 2003 (based on FSA photography). Misclassifications resulted from MN-GAP data missing small wetland areas capable of supporting ring-necked duck pairs or from wetland conditions that changed between 1991 and

2003. We improved the stratification in 2006 and 2007 by eliminating emergent shoreline-vegetation associated with larger lakes containing fish from our definition of potential ring-necked duck nesting cover. Ring-necked ducks do not occupy these types of lakes during the breeding season.

Recommendations

- Identify the most important management needs to be addressed by the survey through discussions within the MNDNR Wetland Group and the Waterfowl Committee. Rationale: The current survey is a compromise allowing both population size estimation and definition of population distribution. As such, it is not optimal for either objective. If one objective is deemed more important than the other, the survey could be modified to achieve the priority objective more efficiently.

- Continue using the design and methods arrived at in the pilot study if the current survey objectives meet management needs. Rationale: MN-GAP land cover data has provided a convenient way to stratify the survey area, and population estimates based on 2 surveys using PLS-section sampling units are relatively efficient (Giudice, unpublished data). Further, beginning the survey as soon after 5 June as possible is appropriate because it allows the survey to be done while most ring-necked ducks are still paired.

- Decide whether the sampling frame needs to be modified through discussions within the MNDNR Wetland Group and the Waterfowl Committee. Rationale: Obtaining population estimates for the entire primary breeding range would be ideal. However, the information gained by surveying some areas such as the Northwest Angle and the Arrowhead region that are logistically difficult to reach, are dangerous to sample, or that have few ring-necked ducks, might not be worth the added cost.

- Update the habitat files or change the definition of nesting cover. Rationale: We defined ring-necked duck cover as: MNGAP class 10, 14, and/or 15 cover **within** 250 m of **and adjacent to** that patch of MNGAP class 12 and/or 13 cover. The habitat layer that we used in 2004 and 2005 defined nesting cover in this way. However, the habitat layer that we used in 2006 and 2007 included some MNGAP class 10, 14, and/or 15 cover that was **within** 250 m **but not** necessarily **adjacent** to that patch of MNGAP class 12 and/or 13 cover. Geographic Information System work needs to be done to correct this problem, or the definition of ring-necked duck nesting cover needs to be changed.

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Table 1. Habitat classes assigned to Public Land Survey section plots in the Minnesota ring-necked duck breeding pair survey area, June 2004 – 2007.

	Definition[a]		% [b]		
Habitat class	2004	2005 - 2007[c]	2004	2005	2006-2007
1	Plots with ≥ the median amount of MNGAP class 14 and/or 15 cover within 250 m of and adjacent to MNGAP class 12 cover (i.e., high pair potential).	Plots with ≥ the median amount of MNGAP class 10, 14, and/or 15 cover within 250 m of and adjacent to MNGAP class 12 and/or 13 cover (i.e., high pair potential).	15.3	24.5	21.5
2	Plots with < the median amount of MNGAP class 14 and/or 15 cover within 250 m of and adjacent to MNGAP class 12 cover (i.e., moderate pair potential).	Plots with < the median amount of MNGAP class 10, 14, and/or 15 cover within 250 m of and adjacent to class 12 and/or 13 cover (i.e., moderate pair potential).	15.3	24.5	21.5
3	Plots with no MNGAP class 14 and/or 15 cover that include MNGAP class 12 cover that is within 250 m of a shoreline (i.e., low pair potential).	Plots with no MNGAP class 10, 14, and/or 15 cover that include class 12 and/or 13 cover that is within 100 m of a shoreline (i.e., low pair potential).	25.2	7.7	13.5
4	Plots with no MNGAP class 14 and/or 15 cover and no MNGAP class 12 cover within 250 m of a shoreline (i.e., no pair potential).	Plots with no MNGAP class 10, 14, and/or 15 cover and no class 12 and/or 13 cover within 100 m of a shoreline (i.e., no pair potential).	44.2	43.3	43.5

[a]Plots are Public Land Survey sections. MNGAP = Minnesota GAP level 4 land cover data. Class 10 = lowlands with <10% tree crown cover and >33% cover of low-growing deciduous woody plants such as alders and willows. Class 12 = lakes, streams, and open-water wetlands. Class 13 = water bodies whose surface is covered by floating vegetation. Class 14 = wetlands with <10% tree crown cover that is dominated by emergent herbaceous vegetation such as fine-leaf sedges. Class 15 = wetlands with <10% tree crown cover that is dominated by emergent herbaceous vegetation such as broad-leaf sedges and/or cattails.

[b]Percent of the survey area.

[c]Habitat class definitions in 2005, 2006 and 2007 were the same, but MNGAP class 10, 14, and 15 cover associated with lakes having a General or Recreational Development classification under the Minnesota Shoreland Zoning ordinance was not considered nesting cover in 2006 and 2007.

Table 2. Sampling rates by Ecological Classification System section for Minnesota's ring-necked duck breeding- pair survey, June 2004 – 2007.

Ecological Classification System section	Habitat classes	~Area[a]			Sampling rate (%)		
		2004	2005	2006-2007	2004	2005	2006-2007
W & S Superior Uplands[b]	1,2	1,638	2,461	2,218	1.1	0.9	0.9
Northern Superior Uplands	1,2	1,810	4,648	4,209	0.7	0.8	0.8
N Minnesota & Ontario Peatlands	1,2	1,817	2,737	2,389	1.4	1.3	1.3
N Minnesota Drift & Lake Plains	1,2	5,048	8,383	7,145	1.5	1.1	1.1
Minnesota & NE Iowa Morainal	1,2	3,510	4,033	3,561	1.4	0.9	0.9
Lake Agassiz, Aspen Parklands	1,2	316	363	340	4.7	2.2	2.4

[a]Number of Public Land Survey sections in the ECS section(s).
[b]Western and Southern Superior Uplands sections combined due to the small area of the Southern Superior Uplands occurring in the survey area.

Table 3. Social status of the indicated pairs observed in the Minnesota ring-necked duck breeding pair survey area, June 2004-2007.

Year	Habitat class	No. of plots	Total ducks	Indicated pairs			
				n	% Pairs	% Lone males	% Flocked males
2004[a]	1,2	200	278	160	57.5	18.1	24.4
2005[b]	1,2	230	147	92	35.9	28.2	35.9
2005	3,4	21	11	7	57.1	0.0	42.9
2006[c]	1,2	200	279	167	43.7	27.6	28.7
2006	3,4	50	4	3	33.3	66.7	0.0
2007[d]	1,2	200	152	137	57.7	25.5	16.8
2007	3,4	50	13	6	16.7	16.7	66.7

[a]Survey conducted 6 – 17 June.
[b]Survey conducted 12 – 24 June.
[c]Survey conducted 6 – 16 June.
[d]Survey conducted 5 – 13 June.

Table 4. Estimated indicated breeding pairs per plot in the habitat class 1 and 2 strata in the Minnesota ring-necked duck breeding pair survey area, June 2005-2007.

	2005			2006			2007		
Ecological Classification System section	Plots	Mean pairs/plot	SE	Plots	Mean pairs/plot	SE	Plots	Mean pairs/plot	SE
W & S Superior Uplands[a]	22	0.181	0.179[b]	20	0.302	0.178	20	0.302	0.301
Northern Superior Uplands	36	0.252	0.118	33	0.636	0.215	33	0.640	0.297
N Minnesota & Ontario Peatlands	35	0.087	0.045[b]	30	0.658	0.228	30	0.300	0.139
N Minnesota Drift & Lake Plains	94	0.416	0.138	77	0.887	0.279	77	0.796	0.207
Minnesota & NE Iowa Morainal	35	0.228	0.010	32	0.590	0.318	32	0.595	0.231
Lake Agassiz, Aspen Parklands	8	3.403	1.365[b]	8	4.160	1.463	8	2.652	1.086

[a]Western and Southern Superior Uplands sections combined due to the small area of the Southern Superior Uplands occurring in the survey area.
[b]Standard error estimate is biased low because no birds were observed in one of the Ecological Classification System section's strata.

Table 5. Estimated indicated breeding pairs in the habitat class 1 and 2 strata in the Minnesota ring-necked duck breeding pair survey area, June 2005-2007.

	2005				2006				2007			
Ecological Classification System section	Pairs	LCL[a]	UCL[a]	CV(%)	Pairs	LCL	UCL	CV(%)	Pairs	LCL	UCL	CV(%)
W & S Superior Uplands[b]	444	0	1,207	99.5[c]	669	0	1,355	59.1	671	0	1,829	99.6
Northern Superior Uplands	1,169	244	2,095	46.8	2,679	1,148	4,210	33.7	2,694	571	4,816	46.5
N Minnesota & Ontario Peatlands	239	20	457	54.1[c]	1,572	644	2,499	34.7	717	150	1,284	46.5
N Minnesota Drift & Lake Plains	3,490	1,577	5,404	33.0	6,334	3,011	9,657	31.5	5,686	3,227	8,144	26.0
Minnesota & NE Iowa Morainal	918	241	1,595	43.6	2,102	178	4,026	53.9	2,118	724	3,512	38.8
Lake Agassiz, Aspen Parklands	1,235	273	2,198	40.1[c]	1,414	448	2,381	35.2	902	184	1,619	40.9

[a]Estimates were based on a stratified random sample of Public Land Survey (PLS) sections in habitat classes 1 and 2 and 6 ECS sections. LCL = lower 90% confidence level. UCL = upper 90% confidence level.
[b]Western and Southern Superior Uplands sections combined due to the small area of the Southern Superior Uplands occurring in the survey area.
[c]Variance estimate for the Ecological Classification System section is biased low because no birds were observed in one of the section's strata. As a result, the confidence interval is too narrow and the CV is optimistic.

Table 6. Estimated ring-necked ducks in the habitat class 1 and 2 strata in the Minnesota ring-necked duck breeding pair survey area, June 2005-2007.

Ecological Classification System section	2005				2006				2007			
	Birds	LCL[a]	UCL[a]	CV(%)	Birds	LCL	UCL	CV(%)	Birds	LCL	UCL	CV(%)
W & S Superior Uplands[b]	889	0	2,415	99.5[c]	1,338	0	2,710	59.1	1,342	0	3,658	99.6
Northern Superior Uplands	2,339	488	4,190	46.8	5,357	2,295	8,419	33.7	5,388	1,143	9,633	46.5
N Minnesota & Ontario Peatlands	477	40	915	54.1[c]	4,076	1,141	7,012	42.3	1,434	301	2,568	46.5
N Minnesota Drift & Lake Plains	6,981	3,154	10,808	33.0	14,816	7,504	22,127	29.6	11,651	6,721	16,581	25.4
Minnesota & NE Iowa Morainal	4,122	187	8,057	56.4	4,204	375	8,052	53.9	4,236	1,448	7,024	38.8
Lake Agassiz, Aspen Parklands	2,471	545	4,396	40.1[c]	2,829	896	4,762	35.2	1,976	352	3,600	42.3

[a]Estimates were based on a stratified random sample of Public Land Survey (PLS) sections in habitat classes 1 and 2 and 6 ECS sections. LCL = lower 90% confidence level. UCL = upper 90% confidence level.
[b]Western and Southern Superior Uplands sections combined due to the small area of the Southern Superior Uplands occurring in the survey area.
[c]Variance estimate for the ECS section is biased low because no birds were observed in one of the ECS section's strata. As a result, the confidence interval is too narrow and the CV is optimistic.

Table 7. Estimated indicated breeding pairs and breeding population size in the Minnesota ring-necked duck breeding pair survey area, 2004-2007.

Year	Habitat classes	Indicated breeding pairs				Breeding population			
		Pairs	LCL[a]	UCL[a]	CV(%)	Birds	LCL[a]	UCL[a]	CV(%)
2004	1,2[b]	9,443	6,667	12,220	17.8[d]	20,321	14,248	26,395	18.1[d]
2005	1,2[b]	7,496	5,022	9,971	20.0[d]	17,279	11,156	23,402	21.5[d]
2005	3,4[c]	3,832	0	9,269	86.3	7,664	0	18,539	86.3
2005	All	11,328	5,359	17,298	32.0[d]	24,943	12,476	37,411	30.4[d]
2006	1,2[b]	14,770	10,465	19,075	17.6[d]	32,621	23,231	42,010	17.4[d]
2006	3,4[c]	861	0	1,908	74.0	1,721	0	3,816	74.0
2006	All	15,631	11,221	20,041	17.2[d]	34,342	24,766	43,918	17.0[d]
2007	1,2[b]	12,787	9,049	16,525	17.7	26,026	18,514	33,539	17.5
2007	3,4[c]	1,721	267	3,176	51.4	4,304	1,117	7,491	45.0
2007	All	14,508	10,514	18,503	16.7	30,330	22,203	38,457	16.3

[a]LCL = lower 90% confidence level. UCL = upper 90% confidence level.
[b]Population estimates were based on a stratified random sample of habitat class 1 and 2 Public Land Survey (PLS) sections in 12 strata (2 habitat classes and 6 ECS sections).
[c]Population estimates were based on a simple random sample of Public Land Survey (PLS) sections in habitat classes 3 and 4.
[d]Variance estimate is biased low because no birds were observed in one or more strata. As a result, the confidence interval is too narrow and the CV is optimistic.