Pilot effort to develop 2-season banding protocols to monitor black duck vital rates.

Proposed by:
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Introduction:

The goals of American black duck management are to ensure the future sustainability of the population and provide recreational opportunities, including sport harvest. To meet these goals managers and researchers require information about the abundance and distribution of populations, and vital rates (i.e., survival and mortality rates). Researchers and managers have principally relied on large-scale banding programs to obtain this information. Over the past 2-3 decades researchers and managers have been most interested in obtaining information on annual survival and harvest rates. Given these objectives researchers and managers have typically relied on banding programs consisting of a single banding period just prior to the hunting season (i.e., preseason; July-September) because it is the most efficient design (Brownie 1985, Nichols and Hines 1987). However, single-season banding operations have a variety of constraints. First, preseason banding is not the most logistically or financially efficient season to trap black ducks. Second, single-season banding programs do not provide information about seasonal survival rates thus limit our ability to model and contrast alternative hypotheses of population regulation (e.g., additive harvest mortality vs. post-season density dependence through changes in survival). This second limitation is particularly important because previous research and experience suggest management agencies cannot attain population goals through harvest management alone. Further, predictions of large-scale landscape and system changes (e.g., climate change) may influence the black duck population in ways not experienced or anticipated in harvest management programs. To address current management needs and address the impact of anticipated landscape and system changes on black ducks we need estimates of seasonal survival rates.

Goals and objectives:

The BDJV proposes to implement a 5-year pilot project to assess the potential of a 2-period (pre- and post-hunting season) banding program to estimate seasonal survival and harvest rates. A 2-period banding program will provide data to estimate survival during the summer/fall (August–January) and winter/spring (February–July). It will also provide data to estimate harvest rate analogous to estimates currently obtain from pre-season banding alone. The overall goal of this effort is to improve our ability to model black duck population dynamics and identify limiting factors that can be mitigated through habitat and harvest management. Our objectives are:

1. Use historic banding data to design protocols (i.e., season specific sample sizes and spatial allocation) that will provide point estimates of seasonal survival and harvest rates with annual coefficient of variation ≤10% and 5-year mean coefficient of ≤5%.
2. Implement 5-year pilot effort to test field and data analysis protocols. Resulting banding data will be used to evaluate success of field operations (i.e., meeting banding quotas), assumptions, data quality and applicability.
3. Use data from pilot effort to estimate required post-season banding sample needed to measure density dependent changes in post-season survival.
4. Revise protocols and make recommendations for operational implementation of 2-season banding program for American black ducks.

The BDJV is requesting support, specifically personnel time and equipment from its Federal, Provincial and State agencies to conduct the pilot effort.

Methods:

Designing the Pilot Study

Estimating sample size requirements.– We will use historic black duck banding data (1970–2007) and a simulation analysis to estimate required sample sizes need to estimate seasonal survival rates with annual and 5-year mean coefficient of variation (CV) $\leq$10% and $\leq$5%, respectively. First we will use Model H_7 (Brownie et al. 1985) and historical banding records to estimate the mean, standard error, and CV for survival during the summer/fall (August–January) and winter/spring (February–July) seasons. The input data will consist of all normal, wild-caught black ducks in the Mississippi and Atlantic Flyways captured in the pre-season (August and September) and post-season (January and February). Next we will use the results from Model H_7 in a simulation analysis to estimate the number of pre- and post-season bandings (Table 1, Fig. 1) needed to obtain the desired precision in point estimates. We will generate recovery matrices based on expected values, with simulated sample sizes of 500 to 6000 (250 band increments both pre and post season allocations). Next we will estimate recovery rate (*f*) and season-specific survival rates (*S*) in Program R and calculate corresponding CV's. The assumptions of the simulation analysis are 1) quotas are met each year (i.e., bandings are consistent over time), and 2) the same population is banded during the pre- and post-season. The third, and ultimately most important step, will be to use the results of Model H_7 to estimate the number of pre- and post-season bandings needed to test the hypothesis that black ducks exhibit density dependent post-season survival. This last step will be completed with contemporary banding data obtained during the 5-year pilot effort.

Spatial allocation of banding effort.– A key assumption of 2-period banding programs is the same population is banded during each period. To meet this assumption we will use estimates of pre-season banding distributions across the 3 Canadian reference (1990–2008; Table 2, Fig. 2) areas and published estimates of movement probabilities (Zimpfer and Conroy 2006; Table 30) among breeding and wintering areas to determine the appropriate spatial allocation of winter banding quotas. In the pre-season we will allocate banding effort equal to the mean proportion of pre-season bandings across Canadian reference areas (Table 2, Fig. 2) between 1990 and 2008. In other words, pre-season banding will continue under the status quo.

To allocate winter banding quotes, we will first distribute the total winter banding sample (N_n) across the 3 Canadian (i.e., breeding) areas according to the pre-season banding proportions (Table 1).

$$N_e = N_n * e$$

$$N_c = N_n * c$$

$$N_w = N_n * w$$

Where:

N_{n} = the required winter banding sample size;
N_e = the required winter banding sample originating in the Eastern Reference Area;
e = the estimated proportion of the pre-season breeding sample from the Eastern Reference Area;
N_c = the required winter banding sample originating in the Central Reference Area;
c = estimated proportion of the pre-season banding sample from the Central Reference Area;
N_w = the required winter banding sample originating in the Western Reference Area;
w = estimated proportion of the pre-season banding sample from the Western Reference Area;

Next, we will allocate the post-season banding sample in Canada. We assume 20% the black duck population overwinters in Canada (in the same spatial proportion as the pre-season population).

$$N^c_n = N_n*0.20$$

$$N'_e = N_e *0.20$$

$$N'_c = N_c *0.20$$

$$N'_w = N_w *0.20$$

Where:
N^c_{n} = the required winter banding sample size in Canada;
N′e = the winter banding quota in the Eastern Reference Area;
N′c = the winter banding quota in the Central Reference Area;
N′w = the winter banding quota in the Western Reference Area;

Next we will calculate post-season banding quotas for the Mississippi Flyway, North Atlantic Flyway and South Atlantic Flyway reference areas (Fig. 2) by applying movement probabilities from each Canadian Reference Area (Zimpfer and Conroy 2006).

$$N_m = \Sigma((1-N'_e)*0.01)((1- N'_c)*0.042)((1- N'_w)*0.306))$$

$$N_n = \Sigma((1-N'_e)*0.794)((1- N'_c)*0.569)((1- N'_w)*0.190))$$

$$N_s = \Sigma((1-N'_e)*0.205)((1- N'_c)*0.389)((1- N'_w)*0.504))$$

Where:
N_m = Mississippi Flyway post-season banding quota
N_n = Northern Atlantic Flyway post-season banding quota
N_s = South Atlantic Flyway post-season banding quota

The BDJV will work with our Federal, State, and Provincial partners to identify specific banding areas within each Reference Area that maximize the probability of meeting the specified post-season banding quotas.

Field Protocols.–Pre-season banding operations will adhere to current protocols. Black ducks will be captured between July and September using a combination of swim-in bait traps, rocket-netting, and spot-lighting. Each bird will be fitted with a standard U.S. Fish and Wildlife Service leg band and the sex and age recorded. Each bird will be released at the trap site following banding. Banding data are to be submitted to the U.S. Geological Survey Bird Banding Laboratory (BBL) using standard procedures.

Post-season banding operations will occur between January and February and will adhere to the same protocols as the preseason. If the waterfowl hunting season extends into January banding operations are to be initiated following the last day of the waterfowl hunting season within the appropriate jurisdiction (i.e., by state and province). Black ducks will be aged and sex using methods described by Ashley et al. 2006. Banding records are to be submitted to the BBL using standard procedures. The focus of the 5-year pilot effort is to design and test field protocols that will allow the estimation of seasonal survival. Therefore additional data regarding bird condition (e.g., wing length, mass, etc.), though useful to test hypotheses, will not be collected as part of the pilot study. Future protocols may include instructions for collecting and submitting these types of data.

Data Analysis.– We will use Model H_7 (Brownie et al. 1985) to obtain estimates of seasonal survival and harvest rates starting in the winter of 2012/2013 (after 3-years of winter banding) through 2017. We will compare seasonal survival rate estimates to published results to assess quality and accuracy. We will evaluate estimates of annual and mean CVs to determine if realized sample sizes provide the desired level of precision. These results will be used to revise sample size and spatial allocation estimates and make final recommendations regarding the design and implementation of an operational 2-period banding program to monitor trends and changes in American black duck vital rates.

Preliminary Results:

Historical banding.- We report summaries of banding efforts since 1990 to provide context of potential banding success in the near term (i.e., 2009/2010–2013/2014). The mean number of black ducks banded annually was 7,105.34 (6,266.89 in pre-season and 838.45 in post-season; Table 4) for the period 1990–2007. Over this period the age ratio was 0.35 adults and 0.65 juveniles (0.21 adults and 0.73 juveniles in pre-season; 0.91 adults and 0.09 juveniles in post-season). Summaries of state/provincial and regional bandings by month and season since 1970 are provided in Appendix A (as a separate document). The spatial distribution of pre-season bandings was 0.62 in the Eastern region, 0.21 in the central region, and 0.17 in the western region.

Simulation results and sample size.-We estimated seasonal survival rates using banding data from 1970–2007. We use this period because the greatest post-season bandings occurred in the 1970s. The resulting point estimates and variances were used as input variables into a simulation program to estimate required sample size. Based on the simulation analysis the required sample size for the winter period (assuming 6,000 pre-season bandings) is ≥3,000 (≥9,000 in total; Fig. 3–4). Given the mean pre-season banded sample was 6,266 between 1990–2007 we recommend pre-season banding operations continue at current levels. This is because our simulation analysis indicates estimated CV for recovery rate is determined by the number of pre-season bands (Fig. 5). To obtain a reliable estimate of reporting rate a larger pre-season sample is needed. From these results we can allocate banding quotas temporally and spatially (Table 5). These quotas are intended as a starting point for discussion to identify the most efficient locations and distributions of bands to meet the goals of this program. However, we anticipate Tennessee, Ohio, Michigan, Illinois, Alabama, Indiana, and Wisconsin, North Carolina, Virginia, Maryland, Delaware, New Jersey, New York, Connecticut, Massachusetts, and Maine provide the greatest opportunities in the U.S. Exact locations and allocation of the banded sample will be developed in consultation with BDJV partners (USFWS, CWS, States and Provincial agencies) prior to initiation of field work. We stress the need to distribute the winter banded sample as much as possible within each region to maximize the probability of banding the same pre-season population. It is important to note these are preliminary estimates. The temporal and spatial banding quotas may change as the methodology is reviewed, tested and revised and as more data become available. However, these estimates are adequate and useful for planning the initial stages of the pilot effort.

Anticipated benefits:

The migratory game bird community is undergoing a change in management paradigms; since the inception of the North American Waterfowl Management Plan (and probably prior to) the management of migratory game birds occurred in two artificially isolated silos – population management (i.e., harvest management) and habitat management (Runge et al. 2006). The apparent future paradigm will be to address population and habitat management simultaneously through an integrated framework that places ecological theory (e.g., carrying capacity and density-dependence) as the foundation of adaptive management (Anderson et al. 2007). We believe a 2-period banding program will be an important tool in this new management paradigm because it provides traditional information on annual survival and harvest rates while simultaneously providing information on seasonal survival rates. This combination of new and traditional information will allow managers and researchers to meet contemporary information needs and build new models that link waterfowl vital rates to landscape and habitat features.

Currently, the BDJV and its partners are developing an integrated population and habitat model that will guide black duck research and help achieve coherence between harvest and habitat management. Once complete the adaptive model will allow researchers to contrast support among competing models of black duck limiting factors (e.g., density dependence in productivity vs. density dependence in post-season survival). To achieve this goal we need accurate estimates of seasonal vitals, a 2-period banding program provides the most efficient tool for obtaining this critical information.

Schedule:

Winter 2009/2010 – initiate post-season banding effort.
Winter 2013 – preliminary analysis of seasonal survival rates
Winter 2013/2014 – 5th year of winter banding effort.
Spring/Summer 2015 – Data analysis
Winter 2015/2016 – Final report to BDJV/Atlantic and Mississippi Flyway Councils/U.S. Fish and Wildlife Service/Environment Canada's Canadian Wildlife Service.

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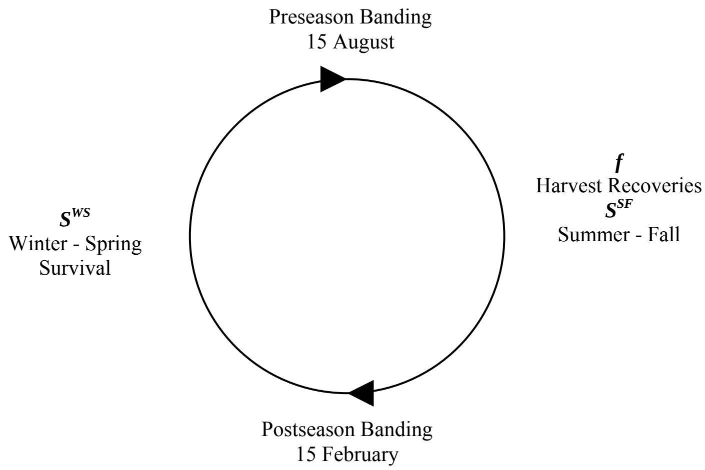

Figure 1. Chronological sequence of band recovery events (pre to post season) and corresponding parameters to be estimated based on bands recovered during the hunting season (September through January).

Figure 2. Breeding and wintering areas used for spatial allocation of pre- and post-season black duck banding quotas (from Zimpfer and Conroy 2006).

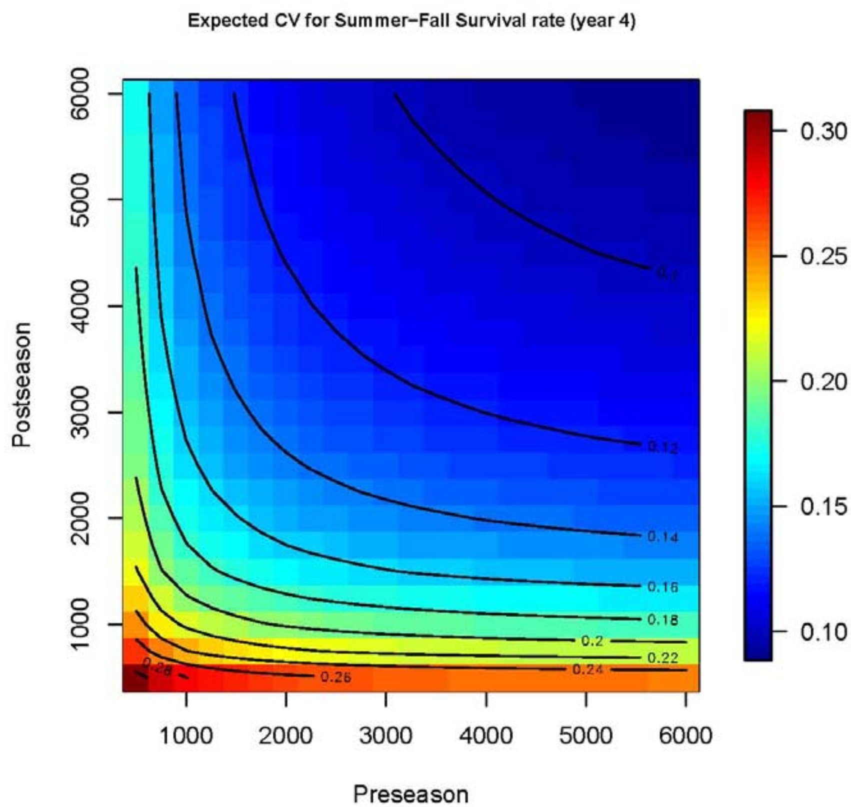

Figure 3. Expected coefficient of variation (CV) of black duck survival during the summer/fall in year 4 of a 5-year pilot as a function of pre-season and post-season banded sample size.

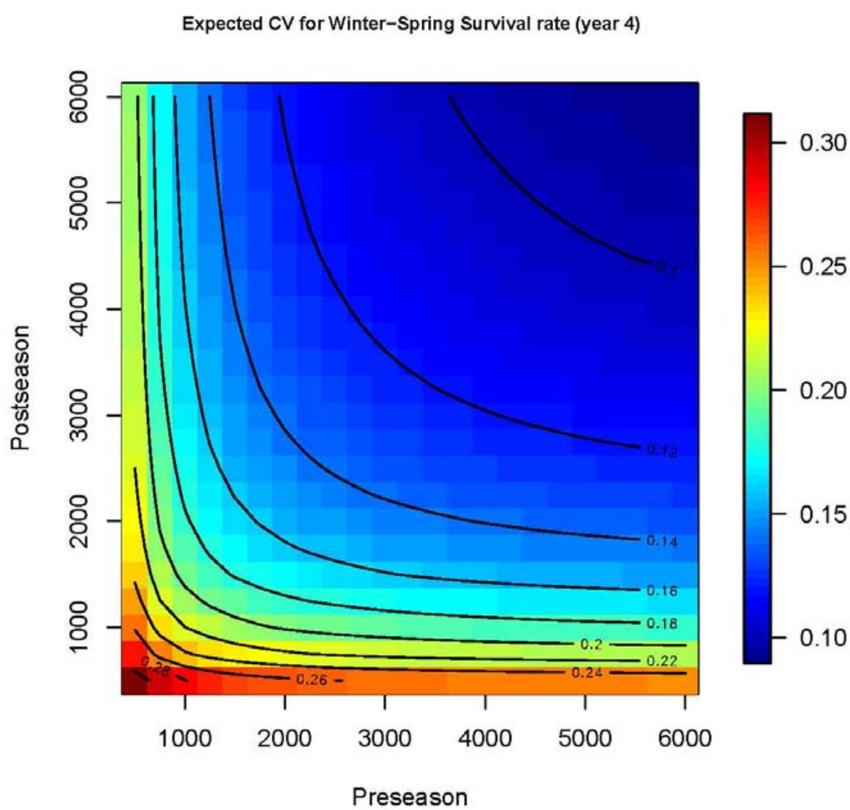

Figure 4. Expected coefficient of variation (CV) of black duck survival during the winter/spring in year 4 of a 5-year pilot as a function of pre-season and post-season banded sample size.

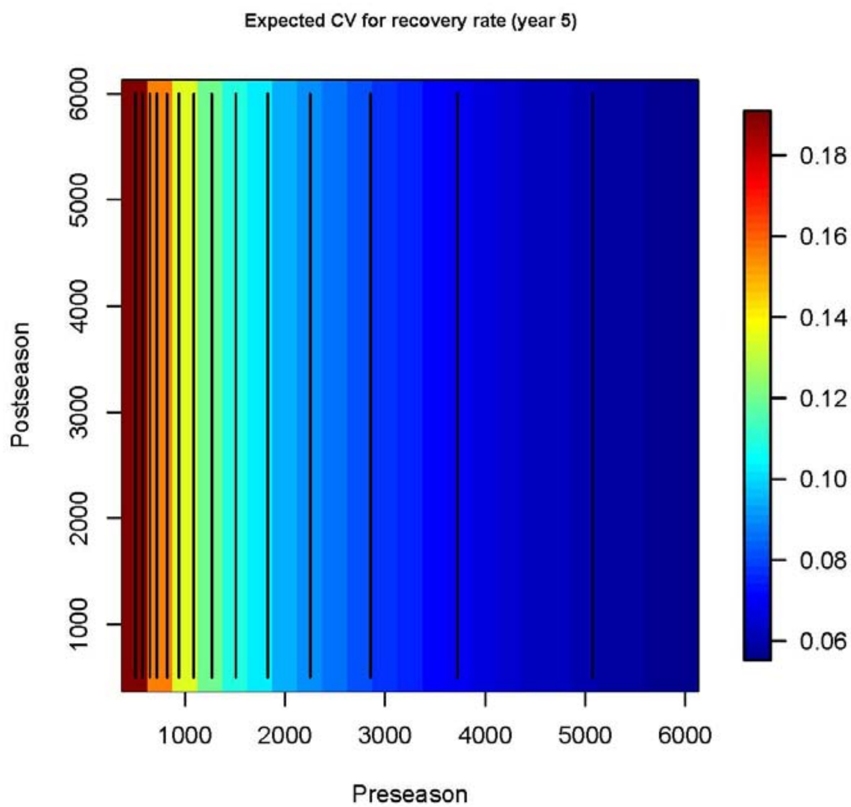

Figure 5. Expected coefficient of variation (CV) of black duck recovery rate in year 4 of a 5-year pilot as a function of pre-season and post-season banded sample size.

Table 1. The expected number of recoveries resulting from a 5 year banding program to estimate seasonal survival rates (SF = summer-fall, WS = winter-spring) with pre (N) and post season (M) releases.

Bandings	Rec 1	Rec 2	Rec 3	Rec 4	Rec 5
Preseason N_1	$N_1 f_1$	$N_1 S_1^{SF} S_1^{WS} f_2$	$N_1 S_1^{SF} S_1^{WS} S_2^{SF} S_2^{WS} f_3$	$N_1 S_1^{SF} S_1^{WS} S_2^{SF} S_2^{WS} S_3^{SF} S_3^{WS} f_4$	$N_1 S_1^{SF} S_1^{WS} S_2^{SF} S_2^{WS} S_3^{SF} S_3^{WS} S_4^{SF} S_4^{WS} f_5$
Postseason M_1		$M_1 S_1^{WS} f_2$	$M_1 S_1^{WS} S_2^{SF} S_2^{WS} f_3$	$M_1 S_1^{WS} S_2^{SF} S_2^{WS} S_3^{SF} S_3^{WS} f_4$	$M_1 S_1^{WS} S_2^{SF} S_2^{WS} S_3^{SF} S_3^{WS} S_4^{SF} S_4^{WS} f_5$
Preseason N_2		$N_2 f_2$	$N_2 S_2^{SF} S_2^{WS} f_3$	$N_2 S_2^{SF} S_2^{WS} S_3^{SF} S_3^{WS} f_4$	$N_1 S_2^{SF} S_2^{WS} S_3^{SF} S_3^{WS} S_4^{SF} S_4^{WS} f_5$
Postseason M_2			$M_2 S_2^{WS} f_3$	$M_2 S_2^{WS} S_3^{SF} S_3^{WS} f_4$	$M_2 S_3^{WS} S_3^{SF} S_3^{WS} S_4^{SF} S_4^{WS} f_5$
Preseason N_3			$N_3 f_3$	$N_3 S_3^{SF} S_3^{WS} f_4$	$N_3 S_3^{SF} S_3^{WS} S_4^{SF} S_4^{WS} f_5$
Postseason M_3				$M_3 S_3^{WS} f_4$	$M_3 S_3^{WS} S_4^{SF} S_4^{WS} f_5$
Preseason N_4				$N_4 f_4$	$N_4 S_4^{SF} S_4^{WS} f_5$
Postseason M_4					$M_4 S_4^{WS} f_5$
Preseason N_5					$N_5 f_5$

From Brownie et al. 1985 chapter 7, pg 161

Table 2. Mean pre-season black duck banding proportions by region for the period 1990–2008. The Eastern Region consists of eastern Quebec (east of longitude 70.5) and the Maritime Provinces. The Central Region consists of central Quebec (between longitudes 70.5 and 76.5). The Western Region is western Quebec (west of longitude 76.5) and Ontario.

Region	**Proportion of pre-season bandings**
Eastern	0.62
Central	0.21
Western	0.17
Total	*1.0*

Table 3. Estimated conditional movement probabilities from breeding reference areas to wintering reference areas for males and females, based analysis by Zimpfer and Conroy (2006).

	Breeding Area		
Winter Areas	**Eastern**	**Central**	**Western**
Eastern	0.98	0.02	0.00
Central	0.02	0.95	0.02
Western	0.00	0.04	0.98
North Atlantic Flyway	0.82	0.57	0.27
South Atlantic Flyway	0.18	0.39	0.49
Mississippi Flyway	0.00	0.04	0.39

Table 4. Summary of American black duck bandings during the pre- and post-season by region, 1990–2007. The table presents data on the number of years of banding (n), mean number of banded black ducks (mean), minimum (min) and maximum (max) number of banded black ducks.

Region	**Season**	**n**	**Mean**	**Min**	**Max**
Eastern	Pre	18	3111.11	2342	4490
Central	Pre	18	992.89	496	1408
Western	Pre	18	893.00	379	1403
North Atlantic Flyway	Pre	18	679.44	291	1194
South Atlantic Flyway	Pre	18	461.28	41	1330
Mississippi Flyway	Pre	18	129.17	29	322
Eastern	Post	18	575.28	35	1402
Western	Post	3	11.667	2	30
North Atlantic Flyway	Post	18	166.33	6	755
South Atlantic Flyway	Post	17	22.53	4	71
Mississippi Flyway	Post	17	62.647	7	275
Total (post)			838.45		
Total (pre)			6266.89		
Grand Total			7105.34		

Table 5. Spatial and temporal sample size (i.e., banding quotas) estimates for American black ducks to estimate summer/fall (July-January) and winter/spring (February-July) survival rates, recovery rates, and harvest rates.

Region	**Sub-area**	**Season**	**Quota**
Eastern	Eastern Quebec	Pre	906
	New Brunswick	Pre	1483
	Newfoundland/Labrador	Pre	355
	Nova Scotia	Pre	577
	Prince Edward Island	Pre	427
Central	Quebec	Pre	1184
	Western Ontario	Pre	73
Western	Western Quebec	Pre	100
	Ontario	Pre	896
Eastern	Eastern Quebec	Post	88
	New Brunswick	Post	150
	Newfoundland/Labrador	Post	.
	Nova Scotia	Post	68
	Prince Edward Island	Post	54
Central	Quebec	Post	120
	Western Ontario	Post	7
Western	Western Quebec	Post	10
Ontario	Ontario	Post	92
Mississippi Flyway		Post	158
North Atlantic Flyway		Post	1545
South Atlantic Flyway		Post	704
Total (pre)			6000
Total (post)			3000
Grand Total			9000