Management and Conservation Note

Evidence for Black Duck Winter Distribution Change

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ABSTRACT The Mississippi Flyway midwinter population survey (MWS) indicates that American black ducks (*Anas rubripes*) have been rapidly declining for the last 10 years. We found a negative relationship between MWS and Ontario (Canada) midwinter counts for black ducks. Thus, as number of black ducks in the MWS decreased, Ontario midwinter counts increased. A shift in midwinter distribution of black ducks may be partly responsible for the decreasing trend in MWS counts. We recommend that midwinter black duck surveys be expanded to more sites in southern Canada and northeastern United States that currently are not sampled to better assess winter habitat use and improve the midwinter black-duck population index. (JOURNAL OF WILDLIFE MANAGEMENT 73(1):98–103; 2009)

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The Mississippi Flyway Midwinter Waterfowl Survey (MWS) is part of an effort to quantify wintering waterfowl in the United States (Conroy et al. 1988, Smith et al. 1989). For American black ducks (*Anas rubripes*), this survey is used primarily to monitor population status and make decisions on management. The MWS indicates that black duck abundance has declined since the 1950s with a dramatic decline more recently (Rusch et al. 1989, Nudds et al. 1996). The MWS survey results have been the basis for black duck adaptive-harvest models that guide decisions regarding harvest management (Conroy et al. 2002). Although several explanations for black duck declines have been proposed (e.g., Ankney et al. 1987, Rusch et al. 1989, Merendino et al. 1993), there has been little attention directed toward the possibility of a change in winter distribution (but see Link et al. 2006). If changes in migration distribution or phenology of the black duck have occurred, population estimates based on MWS counts may be biased. Northward shifts in range margins and changes in migration phenology have been reported recently for several bird species in the northern hemisphere (Price and Root 2000, 2002; Hitch and Leberg 2006) and Europe (Thomas and Lennon 1999, Sparks and Mason 2001, Brommer 2004), typically citing a warming global climate as the primary mechanism (e.g., Crick 2004).

We performed annual midwinter waterfowl surveys along the Canadian shores of Lake Ontario and the St. Lawrence River at the same time as the MWS. Over the past 10 years, we observed increasing numbers of black ducks in our survey area and related annual black duck estimates from our midwinter surveys with the MWS counts from 1986 to 2005. Historically, most black ducks in our midwinter survey region are produced in Ontario and western Quebec, Canada; thus, we also inspected breeding black duck abundance in Ontario and western Quebec for trends from 1991 to 2005. Further, we related midwinter black duck counts in Ontario to the number of thaw-degree days (total no. of degree days above freezing) in December and early January to test for a possible mechanism for an increase in black duck numbers in southern Ontario. As a comparison, we also include analyses of similar data for mallards (*A. platyrhynchos*).

STUDY AREA

We conducted our midwinter survey (hereafter the Ontario midwinter survey) over the north shore of the St. Lawrence River and eastern Lake Ontario extending from Lake St. Francis to Presqu'ile Provincial Park, Ontario (Fig. 1). For breeding black ducks, we used data collected in central and northeast Ontario and western Quebec, which was dominated by forested wetlands, lakes, and riverine systems known to be important breeding sites for black ducks (Bordage et al. 2003, Collins 2005). The MWS was conducted in all states of the Mississippi Flyway (Fig. 2) and included the United States shoreline of the Great Lakes and sites known to be important wintering and migration areas for waterfowl.

METHODS

We conducted the Ontario midwinter survey at the same time as the MWS (i.e., 3–5-day interval in early Jan) each year. We performed the survey using 2 observers and a pilot flying in Cessna high-winged aircraft (Model 172 or 182; Wichita, KS). We flew 75 m aboveground on a fixed route approximately 200 m offshore and parallel to the northern shoreline of the St. Lawrence River and eastern Lake Ontario along the survey route (Fig. 1; Ross 1989). Every year we flew the same route at the same elevation. All observers were experienced biologists and included R. K.

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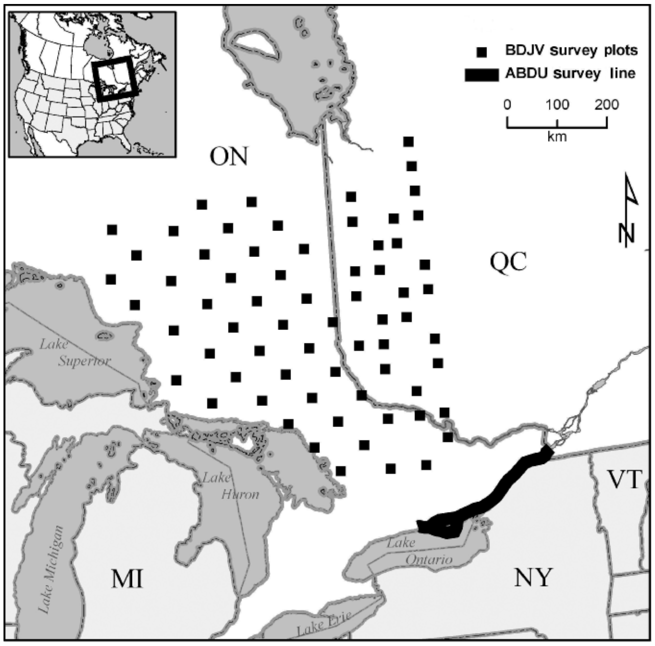

Figure 1. Lake Ontario and St. Lawrence River January waterfowl survey, 1986–2005 and the Black Duck Joint Venture breeding black duck aerial survey (stratum 4 of the eastern North America survey).

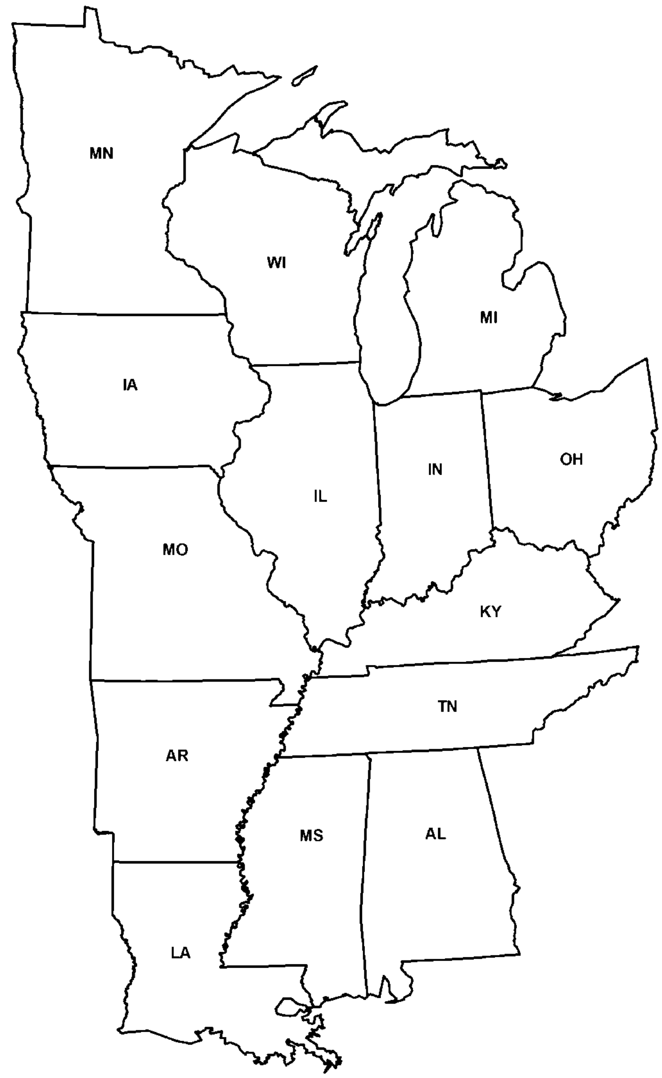

Figure 2. States that participated in the Mississippi Flyway midwinter waterfowl survey, 1986–2005.

Ross as well as 3 others. We counted all observed waterfowl and identified them to species when possible. In some cases, we classified mallards and black ducks as unidentifiable large dabbling ducks if we could not discern species. For these birds, we corrected estimates post hoc by using the species ratio successfully identified each year during the survey.

The MWS is a coordinated effort conducted mostly by ground counts and uses fixed-wing aircraft for remote and difficult-to-reach locations. Survey design and field procedures are determined by individual states but typically are consistent within states among years (Eggeman and Johnson 1989). The survey is conducted annually during the first full week of January for a predetermined 3–5-day interval to minimize potential bias associated with migration events and double-counting. Additional details on the midwinter surveys are provided in Conroy et al. (1988). For comparison of Ontario midwinter survey and MWS counts, we used survey data from 1986 to 2005.

For breeding surveys, we conducted a plot-based pair count during nest initiation annually from 1990 to 2005 over the primary breeding range of the black duck as part of the Black Duck Joint Venture (BDJV) monitoring initiative. For this survey, we grouped plots into 4 geographic strata and surveyed using a helicopter (Bordage et al. 2003, Collins 2005). Our analysis was for data from BDJV stratum 4, which included 64 25-km^2 plots in central and northeastern Ontario and the western part of Quebec (Fig. 1). Based on band recovery data, this region is the origin of most black ducks we counted during our midwinter Ontario survey (L. Laurin, Canadian Bird Banding Office, unpublished data). We estimated total abundance of black duck and mallard breeding pairs using the Dzubin (1969) method of estimating indicated breeding pairs. Indicated pair estimation for black ducks differs from mallards because sexes appear alike from an aircraft (Collins 2005). An observation of one unknown-sex black duck equals an indicated pair. A group of 2 black ducks indicate 1.5 pairs because the group of 2 could be 2 males (2 indicated pairs) or a male and female (one pair; Collins 2005). We considered groups of 3 and 4 black ducks 3 and 4 pairs, respectively.

To relate potential climate effects with Ontario counts, we calculated total number of thaw-degree days from 1 December to 5 January each winter. We calculated thaw-degree days as the sum of daily mean temperatures $>0°$ C for the period (Walker et al. 1994). These data provided an index of ambient temperature preceding the Ontario midwinter survey. We used weather station data from Kingston, Ontario (44.22°N, 76.6°W), which was located on the approximate geographic center of the survey route.

We calculated Pearson correlation coefficients (PROC CORR; SAS Institute 2004) to quantify the linear trend between total numbers of ducks estimated in the Ontario midwinter survey and the MWS for black ducks and mallards. We also calculated Pearson correlation coefficients between the cumulative thaw-degree days at the Kingston, Ontario weather station and number of black ducks and mallards in the Ontario survey each winter.

For the breeding survey, we estimated trend in indicated breeding pairs from 1991 to 2005 using generalized linear modeling (PROC GENMOD; Liang and Zeger 1986, Diggle et al. 2002, SAS Institute 2004). To account for variation in survey plot locations, we included plot in the model (i.e., indicated pairs = plot + yr). We assumed the response variable had a negative binomial distribution and modeled autoregressive correlation among years using a repeated-measures analysis (generalized estimating equation). We expressed results as percent change per year and used the main-effect Z-test for year as evidence of significance. We performed all tests at $\alpha = 0.05$.

RESULTS

There was a negative relationship between the MWS and Ontario midwinter surveys in total black duck ($r = -0.50$, $P = 0.026$, $n = 20$) but not for mallard ($r = -0.16$, $P = 0.53$, $n = 19$) counts (Fig. 3a, b). Thus, as black duck numbers decreased in MWS counts they increased in Ontario surveys. Black duck ($\bar{x}$ = 591.9 birds/yr, SE = 52.8) and mallard counts ($\bar{x}$ = 442.3 birds/yr, SE = 169.3) in the Ontario survey were stable from 1986 through the mid-1990s compared with counts from 1997 to 2005, where count averages were higher and exhibited greater annual variation ($\bar{x}$ = 4,879.7 birds/yr, SE = 1,639.7; $\bar{x}$ = 5,091.1 birds/yr, SE = 925.2; respectively). From 1997 to 2005, black duck counts in the Ontario survey increased on average 20% per year, and mallards increased on average 23% per year. Annual MWS counts ranged from >60,000 black ducks in the late 1980s to <20,000 in 2005 ($\bar{x}$ = –4.2%/yr).

Number of breeding black ducks in BDJV stratum 4 during 1991 to 2005 ranged from 60,000 to >120,000 birds (Fig. 4), but there was no linear trend ($\bar{x}$ = 0.15%/yr, 95% CL = –1.05–1.36%, $P = 0.80$). During the same period, breeding mallards increased, ranging from 36,000 to >112,000 ($\bar{x}$ = 4.55%/yr, 95% CL = 2.46–6.68%, $P < 0.001$). Finally, there was a positive relationship between number of thaw-degree days and the Ontario midwinter black duck count ($r = 0.57$, $P = 0.009$, $n = 20$; Fig. 5) though not for mallards ($r = 0.33$, $P = 0.16$, $n = 19$).

DISCUSSION

We detected a negative relationship between MWS and Ontario midwinter counts for black ducks. We conducted our Ontario count along the Lake Ontario shoreline only; thus, we did not include other potential midwinter staging and wintering areas in Ontario. Nonetheless, the negative relationship we observed could be a consequence of black ducks that were once counted in the MWS wintering farther east and north. Conroy et al. (2002) speculated on a similar scenario based on the inconsistency of results between the breeding survey and MWS counts. Higher number of black ducks in Ontario in early January may be a function of warmer climate conditions, as suggested by the positive relationship between Ontario counts and number of thaw-degree days in December and early January. The black duck is described as a short-distance facultative migrant (Palmer 1976, Bellrose 1980, Longcore et al. 2000); thus, warmer atmospheric conditions may encourage delayed migration and wintering in more northern regions. Greater numbers of black ducks in winter due to higher breeding production in the region is unlikely because number of breeding black ducks remained stable. Mallard counts also increased in the Ontario midwinter survey, but there was no relationship between Ontario and MWS counts. Number of breeding mallards increased in Ontario, which may have positively influenced their midwinter numbers. We caution against strict interpretation of these relationships because they are based on correlation analyses, which does not imply a causative mechanism.

Link et al. (2006) provided evidence to support a winter range-shift hypothesis for black ducks based on analyses of Christmas Bird Counts (CBC). Based on CBC data from the United States portion of the wintering range, Link et al. (2006) reported a significant continental decline (–1.21%/yr) in number of black ducks, similar to our MWS results. However, there was no significant negative trend when southern Canada and northern United States regions were included (Link et al. 2006). Moreover, Link et al. (2006) reported significant positive trends for the most northerly regions analyzed. In particular, black duck numbers increased 1.9% per year in the Lower Great Lakes–St. Lawrence Plain Bird Conservation Region (Link et al. 2006), which was where our study area was located. The Boreal Hardwood Transition Bird Conservation Region, which is north of our study area, also had a positive trend in midwinter black duck numbers (4.30%/yr; Link et al. 2006).

Confirmation of a distribution change, as opposed to a change in population abundance, is difficult. Our results are based on one survey period each year in Ontario so they do not provide insight into the temporal pattern of migration before or after the midwinter survey. Indeed, black ducks may still migrate to their traditional winter range, but on average later, which would affect the MWS because it is conducted in early January. Thus, adjustments in either timing or location of the MWS and Ontario surveys may be necessary to accurately estimate black duck populations. Others have criticized the midwinter survey in the Atlantic Flyway, suggesting that its index does not allow year-to-year comparisons for waterfowl due to habitat change and range shifts, a criticism that may equally apply to the MWS (Eggeman and Johnson 1989, Heusmann 1999). Conroy et al. (1988) suggested the Atlantic Flyway midwinter survey had adequate precision and compared well to more statistically rigorous surveys that they conducted. However, Conroy et al. (1998) also cautioned that midwinter surveys may be inadequate for inland wooded habitats where visibility of black ducks is impaired, which is a common

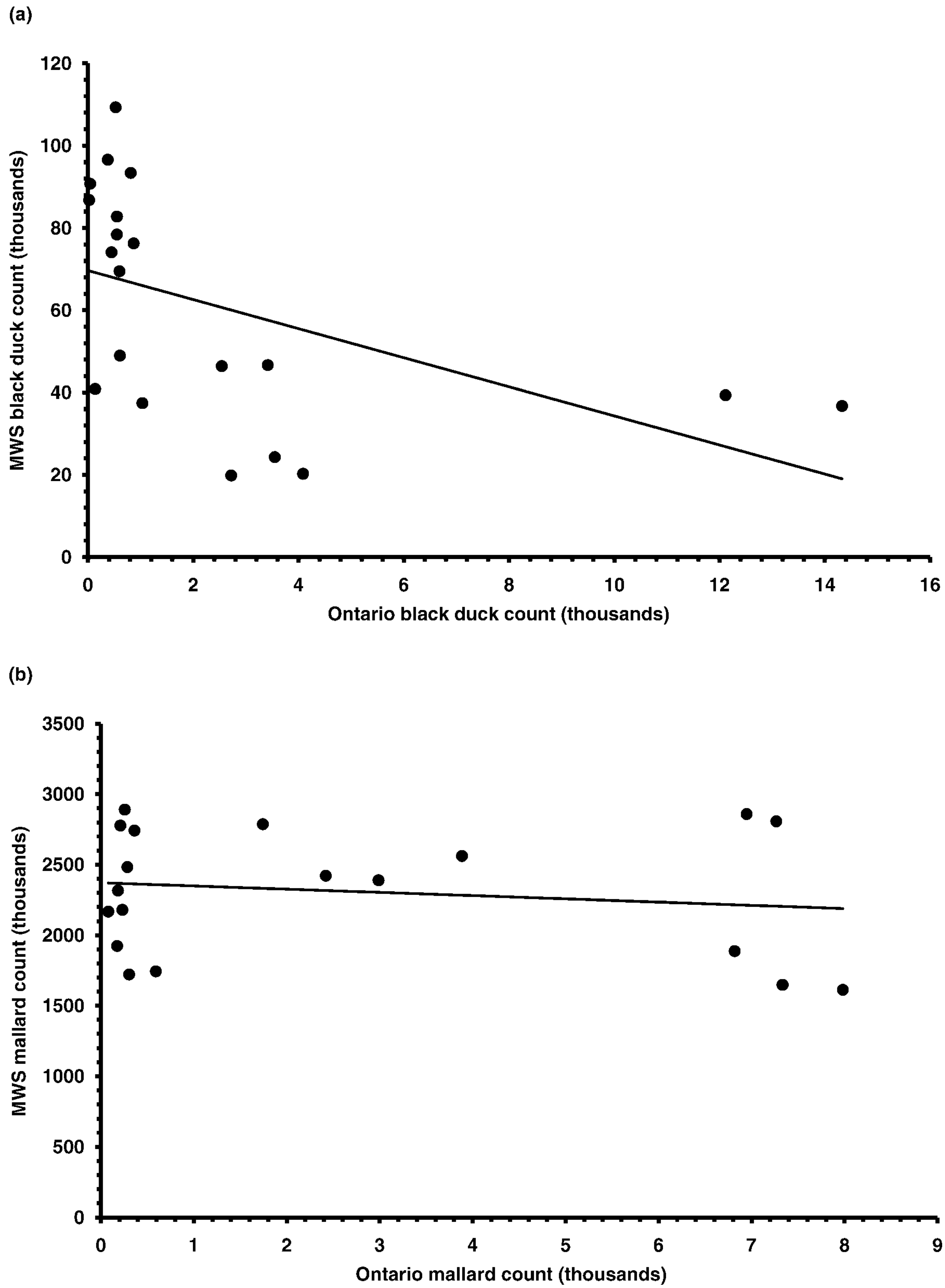

Figure 3. (a) Black duck counts from the Mississippi Flyway midwinter waterfowl survey (MWS) and the Lake Ontario–St. Lawrence River January waterfowl survey, 1986–2005. (b) The mallard count from the MWS and the Lake Ontario–St. Lawrence River January waterfowl survey, 1986–2005.

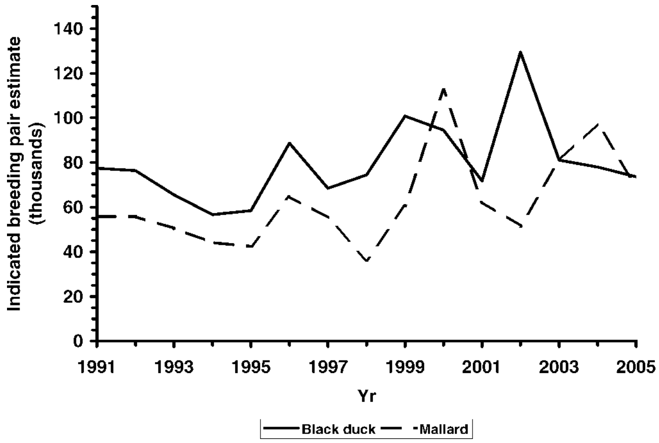

Figure 4. Annual estimate of black duck and mallard indicated pairs from stratum 4 of the Black Duck Joint Venture aerial-plot surveys (1991–2005).

habitat type used by black ducks in the Mississippi Flyway (Longcore et al. 2000).

Management Implications

Changes in distribution will impact population indices if 1) birds shift habitat use to unsurveyed areas, or 2) birds migrate during times when surveys are not being conducted. We and others (e.g., Link et al. 2006) provided evidence that American black ducks may be shifting their historical migration patterns farther north and east. Thus, the MWS may no longer provide a useful estimate of black duck population size. Our results support the current consideration by United States Fish and Wildlife Service and Canadian Wildlife Service to estimate population size of black ducks using breeding surveys. Alternatively, midwinter surveys for black ducks could be broadened in both spatial and temporal scope. We recommend that unsurveyed areas in Ontario and Quebec ≤200 km north of the Great Lakes and the St. Lawrence River be included in midwinter black duck surveys. Additional areas of known black duck use during winter in the northeastern United States and eastern Canada, where midwinter surveys are not currently conducted, might be included. Surveys also should be performed more than once a year. We recommend that the traditional midwinter survey in January be performed in addition to a second one in February, which would allow for later migrants to be included in the survey and provide information on the temporal variability of black duck migration. Surveys should include all waterfowl species if possible. Finally, our results were correlative in nature and we did not quantify migration patterns. We strongly encourage future studies to include radio and satellite telemetry to improve our understanding of spatial and temporal habitat-use patterns of migrating and wintering black ducks. We caution against the sole use of band return data to make management inferences, because results are influenced by the temporal and spatial distribution of hunting (e.g., the Ontario and Quebec hunting seasons are closed before the midwinter surveys are performed).

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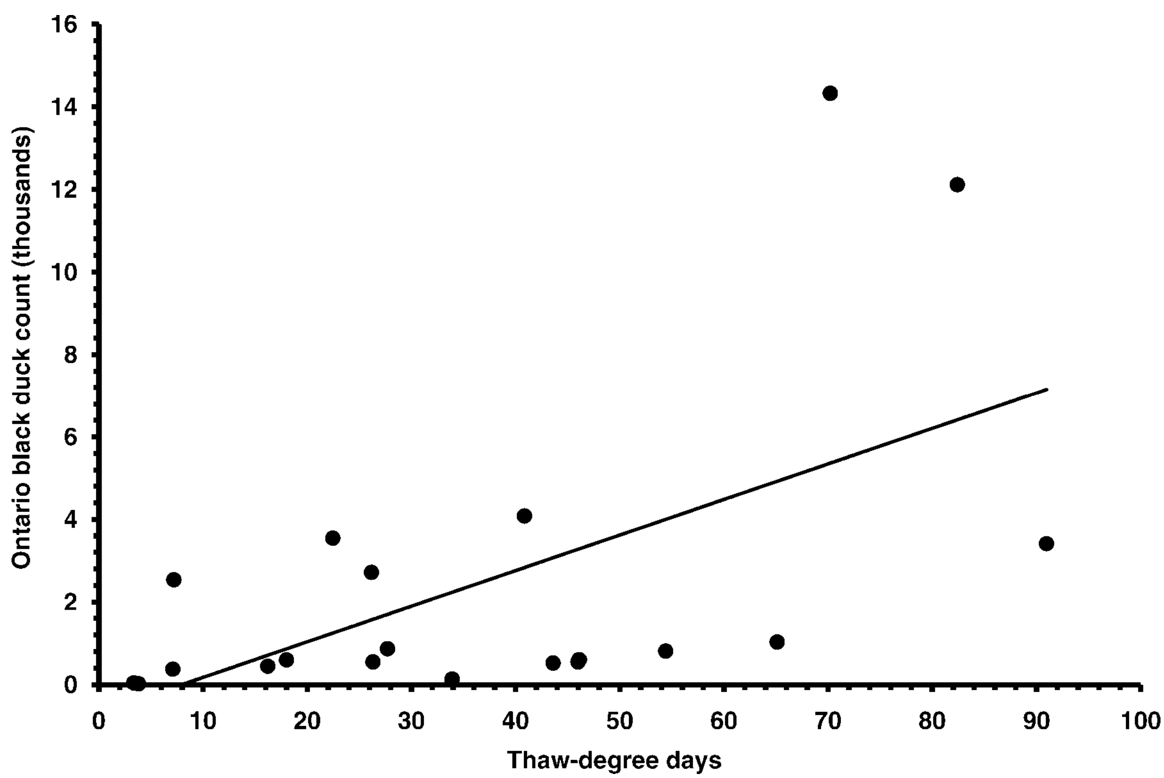

Figure 5. The Lake Ontario–St. Lawrence River waterfowl survey total degree-days >0° C from 1 December to 5 January for each year of 1986 to 2005 versus the Lake Ontario–St. Lawrence River black duck count.

participated in the midwinter and breeding surveys. We appreciate the compilation of midwinter population survey data by the United States Fish and Wildlife Service Office of Migratory Bird Management and comments by P. Devers and 2 anonymous reviewers that greatly improved the manuscript. We thank K. Middel for drafting Figure 1. Support for analysis and writing was provided by the Black Duck Joint Venture, Ontario Ministry of Natural Resources, and the Canadian Wildlife Service.

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