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# WINTERING BALD EAGLE COUNT TRENDS IN THE CONTERMINOUS UNITED STATES, 1986–2010

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ABSTRACT.—We analyzed counts from the annual Midwinter Bald Eagle Survey to examine state, regional, and national trends in counts of wintering Bald Eagles (*Haliaeetus leucocephalus*) within the conterminous 48 United States from 1986 to 2010. Using hierarchical mixed model methods, we report trends in counts from 11 729 surveys along 844 routes in 44 states. Nationwide Bald Eagle counts increased 0.6% per yr over the 25-yr period, compared to an estimate of 1.9% per yr from 1986 to 2000. Trend estimates for Bald Eagles were significant ($P \leq 0.05$) and positive in the northeastern and northwestern U.S. (3.9% and 1.1%, respectively), while trend estimates for Bald Eagles were negative ($P \leq 0.05$) in the southwestern U.S. (−2.2%). After accounting for potential biases resulting from temporal and regional differences in surveys, we believe trends reflect post-DDT recovery and subsequent early effects of density-dependent population regulation.

KEY WORDS: *Bald Eagle*; Haliaeetus leucocephalus; *climate change*; *conterminous 48 states*; *population trends*; *survey*; *U.S.A.*; *wintering.*

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TENDENCIAS EN EL CONTEO DE INDIVIDUOS INVERNANTES DE *HALIAEETUS LEUCOCEPHALUS* EN LOS ESTADOS UNIDOS COLINDANTES ENTRE 1986–2010

RESUMEN.—Analizamos los conteos del Censo Anual de Mediados de Invierno de *Haliaeetus leucocephalus* para examinar las tendencias estatales, regionales y nacionales en los conteos de individuos invernantes dentro de los 48 estados colindantes de Estados Unidos desde 1986 hasta 2010. Utilizamos métodos de modelado jerárquicos mixtos y mostramos las tendencias en los conteos de 11 729 censos a lo largo de 844 rutas en 44 estados. Los conteos de *H. leucocephalus* a lo ancho de la nación se incrementaron un 0.6% por año a lo largo de un periodo de 25 años, comparado con una estima del 1.9% por año desde 1986 hasta el año 2000. Los estimadores de tendencia para *H. leucocephalus* fueron significativos ($P \leq 0.05$) y positivos en el noreste y noroeste de los Estados Unidos (3.9% y 1.1%, respectivamente), mientras que los estimadores de tendencia para *H. leucocephalus* fueron negativos ($P \leq 0.05$) en el suroeste de los Estados Unidos (−2.2%). Considerando los sesgos potenciales en los censos que resultan de las diferencias temporales y regionales, creemos que las tendencias reflejan la recuperación post-DDT y los efectos tempranos subsecuentes de una regulación de la población denso-dependiente.

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Monitoring Bald Eagles (*Haliaeetus leucocephalus*) during winter is important because the distribution and size of the population in the conterminous United States changes after the breeding season, in part because birds from more northern latitudes migrate into the contiguous 48 United States (Hansen et al. 1984, Grubb et al. 1994, McClelland et al. 1994, Harmata 2002, Mandernack et al. 2012). The winter population of Bald Eagles in the contiguous 48 states includes migrants from Canada and Alaska, as well as migratory and nonmigratory breeding eagles at midlatitudes (e.g., the Pacific Northwest, the Midwest, and the mid-Atlantic) and resident eagles at southern latitudes (e.g., Florida), and is therefore larger than during the nesting period (Buehler 2000).

In 1979, when Bald Eagle populations were beginning to recover after the ban on use of DDT in 1972 (Grier 1982), the National Wildlife Federation (NWF) initiated nationwide coordinated counts in an effort to document their population changes. Initial NWF survey objectives were to establish an index to the total wintering Bald Eagle population in the conterminous 48 states, to determine eagle distribution during a standardized survey period, and to identify previously unrecognized areas of important winter habitat (Pramstaller 1981). Since that time, every January, several hundred individuals have counted eagles as part of a nationwide Midwinter Bald Eagle Survey. The surveys have continued under the oversight of several federal agencies including the Bureau of Land Management (1992), National Biological Survey (1993–1996), U.S. Geological Survey (U.S.G.S.; 1997–2007), and most recently U.S. Army Corps of Engineers (U.S.A.C.E.; 2008 to present). U.S.A.C.E. assumed responsibility for coordinating the national survey, organizing results, maintaining the long-term database, and jointly compiling, analyzing, and reporting survey data with U.S.G.S., following methods described by Steenhof et al. (2002).

During this period of Bald Eagle monitoring, the eagles' conservation status changed dramatically from Endangered to Threatened throughout the conterminous 48 states in 1995, and then the species was proposed for removal (''delisting'' under the Endangered Species Act [E.S.A.] of 1973, as amended) from the list of Threatened and Endangered Species in 1999 and 2006. The Bald Eagle was removed from the E.S.A. list in 2007. However, the Bald Eagle in the Sonoran Desert area of central Arizona was returned to the E.S.A. list from 2008 to 2010, and then removed in 2011. The E.S.A. requires the U.S. Fish and Wildlife Service (U.S.F.W.S.) to develop a post-delisting monitoring plan for each recovered species to assess that species' status for a minimum of 5 yr in the absence of E.S.A. protection. The goal of post-delisting monitoring for the Bald Eagle is to detect a 25% change in the number of occupied eagle nests on a national scale at 5-yr intervals, with an 80% chance of detecting a 25% or greater difference between 5-yr intervals (U.S.F.W.S. 2009). Continuing other established eagle monitoring efforts is also encouraged to document progress toward post-delisting goals for the Bald Eagle (U.S.F.W.S. 2009).

Millsap (1986) reported results of the Midwinter Bald Eagle Survey from 1979–1982. In this report, we evaluate national trends in wintering Bald Eagle counts from 1986–2010 by interpreting data collected in key regions during the period of eagle recovery. We evaluated reliability of data sets through careful data screening and modeling relevance of survey covariates on trends.

## METHODS

Beginning in 1984, NWF officials asked participants in each state to count eagles only along standard, nonoverlapping routes to establish a basis for monitoring count trends. Standard survey routes were defined as clearly described areas where eagles had been previously observed. NWF guidelines stipulated that standard surveys be conducted by the same number of experienced observers using the same method (e.g., fixed-wing, helicopter, boat, or vehicle) at approximately the same time of day each year. Steenhof et al. (2002) reported the first 15 yr of count data, and Steenhof et al. (2015) summarized 20 yr of count data from 1986–2005.

Methods used during winter Bald Eagle surveys from 1986 to 2000 and years thereafter were described by Steenhof et al. (2002). Methods included observers conducting surveys on standard routes during the first 2 wk of January each year, usually on one of two target days. Most survey participants were employees of federal or state conservation agencies, but many private volunteer ''citizen scientists'' also participated in the survey. Coordinators from each state organized local counts, enlisted survey participants, and compiled data to eliminate duplicate sightings and overlapping routes. The size of areas surveyed range from single fixed points to 242-km survey routes. Steenhof et al. (2002) reported that 60% of surveys were conducted from the ground, 10% by boats, and 30% by aircraft, both fixed-wing and helicopter. Survey methods from 1986–2010 differed from those reported by Steenhof et al. (2002) with 69% of surveys conducted from the ground, 10% by boats, and 21% by aircraft.

Due to weather and staffing limitations, not all standard routes were surveyed every year. Twenty-five states identified and began surveying standard routes in 1986; other states did not begin standard surveys until the mid-1990s. Some states stopped participating in the count in the late 1990s and early 2000s (Michigan and Virginia, respectively) and some states started counting eagles annually after 1995 (Mississippi, Ohio, West Virginia, and Wyoming). The number of states participating each year has ranged from 25–42, and the number of standard survey routes per state ranged from 1–86.

**Trend Estimation.** Data screening, classification, and evaluation closely followed Steenhof et al. (2002). Surveys were used in the analysis only if they were conducted after 1 January and before 25 January, if they were consistently based on the same survey route and method, and were conducted for at least 4 yr and had $\geq$ 4 eagles observed in at least one yr. At least 4 yr of data were needed for estimating trends (Steenhof et al. 2002). We considered routes with $<$ 4 eagles to be marginal or unsuitable habitat. Routes were assigned to the Northeast, Southeast, Northwest, and Southwest regions based on location relative to 100°W and 40°N. Analyses also were conducted on a state-level basis, and by cardinal regions (North, South, East, and West, based on boundaries at 100°W and 40°N) to facilitate comparison with earlier analyses. We identified length of each survey and classified each as one of four size categories, based on the length of river or shoreline surveyed: 0–17 km ($n$ = 167), 18–56 km ($n$ = 287), 57–120 km ($n$ = 227), and >120 km ($n$ = 163). To test whether trends varied depending on whether surveys were conducted in eagle concentration areas or less suitable habitats, we identified eagle concentration areas as those with more than approximately one eagle sighting per km: i.e., having counts >15, 50, 80, or 100 eagles in each of the four route size classifications, respectively ($n$ = 60, 43, 40, and 29).

Because counts were conducted only once annually, we assumed that detectability on each route remained consistent over time, depending on the survey mode. Ground surveys were modeled separately from water surveys as separate and distinct routes to account for potential differences in detectability. We did not consider weather conditions (e.g., fog and precipitation) because ''the variability introduced by fog and precipitation was not a systematic or important component of the variability already inherent in the eagle counts'' (Steenhof et al. 2002).

We fit a hierarchical mixed model to estimate trends using the logged counts (Steenhof et al. 2002, Littell et al. 2006, Stroup 2013). Route sizes, regions, concentration area, and year were modeled as fixed effects, with route modeled as the random effect. To facilitate comparison with the prior analyses (Steenhof et al. 2002; Steenhof et al. 2015), we used the same model, which included a three-way interaction of route size, region, and year, and all two-way interactions of these terms, and a main effect of concentration area. Also known as a random coefficients regression model, the structure allows covariance between random slope and intercept terms to account for within-route variation. We assumed this within-route variation was the same for all routes, and that routes were independent of each other. We examined residual plots to ensure the appropriateness of this model. We assessed the sensitivity to changes in routes used between the 1986–2005 analysis and the current analysis (1986–2010) using influence diagnostics (Cook's Distance on fixed effects and covariance parameters, and restricted likelihood distance; West et al. 2014), and by running the analysis without any new routes and looking for material changes in regional and national estimates. We used the final model to estimate total, regional (Northeast, Northwest, Southeast, Southwest), and state-level trends in midwinter eagle counts over the 25 yr of the survey. We adjusted the $P$-values for each estimate using a Bonferroni step-down procedure (Holm 1979). All analyses were conducted in SAS version 9.3 (SAS Institute Inc. 2011).

## Results

Our analysis of data from 1986–2010 was based on 237 259 observations of wintering eagles during 11 729 surveys along 844 routes in 44 states (Table 1). Our analysis incorporated 94 routes new since 2005 (70 in the Northwest, 8 in the Southeast, and 16 in the Southwest) but surveys were apparently not conducted on 113 routes used in the 1986–2005 analysis (13 in the Northeast, 14 in the Northwest, 32 in the Southeast, and 54 in the Southwest). Notably, Wyoming began participating in the survey in 2006 (64 routes), and Michigan (3 routes) and Virginia (4 routes) did not provide counts after 2005. New Mexico only provided

Table 1. Number of survey routes and surveys used in the analysis, with estimated trends in the eagles counted, midwinter, by state. Asterisk (*) indicates that trend is significantly different from 0 at $P \leq 0.05$. $P$-value adjusted for multiple testing (44 states, 44 tests) using Bonferroni step-down procedure.

| STATE | ROUTES | SURVEYS | YEARS | TREND |
|---|---|---|---|---|
| Alabama | 3 | 72 | 1986–2010 | −1.7% |
| Arizona | 65 | 986 | 1992–2010 | −2.2%* |
| Arkansas | 21 | 218 | 1986–2010 | −1.7% |
| California | 30 | 211 | 1986–2010 | 0.0% |
| Colorado | 34 | 565 | 1986–2010 | −3.1%* |
| Connecticut | 10 | 180 | 1986–2010 | +2.3% |
| Delaware | 1 | 17 | 1989–2010 | +5.9% |
| Georgia | 9 | 66 | 1989–2010 | +0.7% |
| Idaho | 78 | 1476 | 1986–2010 | +1.2%* |
| Illinois | 43 | 488 | 1988–2010 | +1.0% |
| Indiana | 25 | 415 | 1986–2010 | +2.8%* |
| Iowa | 48 | 698 | 1987–2010 | +4.2%* |
| Kansas | 15 | 276 | 1986–2010 | +1.3% |
| Kentucky | 19 | 255 | 1986–2010 | +0.4% |
| Louisiana | 6 | 70 | 1986–2010 | −0.9% |
| Maryland | 3 | 66 | 1986–2010 | +4.0%* |
| Massachusetts | 4 | 82 | 1986–2010 | +0.8% |
| Michigan | 3 | 31 | 1987–1998 | +7.3%* |
| Minnesota | 4 | 75 | 1986–2010 | +4.8%* |
| Mississippi | 2 | 22 | 1997–2010 | −0.1% |
| Montana | 37 | 408 | 1986–2010 | −0.3% |
| Nebraska | 6 | 101 | 1986–2010 | −3.4%* |
| Nevada | 10 | 107 | 1992–2010 | −1.4% |
| New Hampshire | 6 | 88 | 1991–2010 | +6.5%* |
| New Jersey | 21 | 385 | 1988–2010 | +5.0%* |
| New Mexico | 41 | 289 | 1990–2010 | −1.7% |
| New York | 2 | 50 | 1986–2010 | +7.0%* |
| North Carolina | 4 | 51 | 1987–2010 | +2.7% |
| North Dakota | 1 | 24 | 1986–2010 | +1.9% |
| Ohio | 1 | 15 | 1996–2010 | +6.2% |
| Oklahoma | 33 | 449 | 1986–2010 | −1.2% |
| Oregon | 86 | 1610 | 1988–2010 | +2.0%* |
| Pennsylvania | 8 | 115 | 1986–2010 | +0.5% |
| South Carolina | 24 | 319 | 1993–2010 | +1.3% |
| South Dakota | 4 | 90 | 1986–2010 | −0.4% |
| Tennessee | 13 | 177 | 1986–2010 | −1.4% |
| Texas | 20 | 308 | 1986–2010 | −3.5%* |
| Utah | 19 | 302 | 1986–2010 | −1.4% |
| Vermont | 3 | 54 | 1989–2010 | +8.1%* |
| Virginia | 4 | 27 | 1997–2005 | +1.3% |
| Washington | 6 | 87 | 1986–2010 | +2.7% |
| West Virginia | 3 | 23 | 1995–2010 | +0.2% |
| Wisconsin | 8 | 87 | 1991–2010 | +4.2%* |
| Wyoming | 61 | 294 | 2006–2010 | +1.4% |
| TOTAL | 844 | 11 729 | | |

information on 1 route (down from 54 routes last analysis period). When the model was re-run omitting all newly included routes, there was no material change and by visual inspection we concluded there was no meaningful difference in regional or national estimates. The final model retained the three-way interaction of region, route size, and year, but concentration area did not interact with any other model terms (Table 2).

Table 2. Significance of fixed effects and estimated covariance in the hierarchical mixed model used to estimate trends in midwinter counts of Bald Eagles, 1986–2010[a].

| EFFECTS AND VARIABLES | NUMERATOR DF | DENOMINATOR DF | F-VALUE | $P^b$ | ESTIMATE | S.E. |
|---|---|---|---|---|---|---|
| Fixed effects | | | | | | |
| Year | 1 | 682 | 5.99 | 0.015 | | |
| Route size category | 3 | 679 | 44.90 | <0.0001 | | |
| Route size category by year | 3 | 686 | 1.64 | 0.178 | | |
| Region | 3 | 667 | 5.89 | 0.001 | | |
| Region by year | 3 | 669 | 17.22 | <0.0001 | | |
| Region by route size category | 9 | 666 | 0.37 | 0.947 | | |
| Region by route size category by year | 9 | 674 | 0.90 | 0.527 | | |
| Concentration area | 1 | 802 | 583.01 | <0.0001 | | |
| Random effects | | | | | | |
| Route slope increments | | | | | 1.146 | 0.081 |
| Route intercept increments | | | | | 0.003 | 0.004 |
| Covariance | | | | | −0.037 | 0.0002 |
| Model residual | | | | | 0.577 | 0.008 |

[a] Based on 844 routes and 11 729 surveys.

[b] Model estimated by restricted maximum likelihood estimation; the defining contrast for the effect is tested with an approximate *F*-test (Littell et al. 2006).

Counts of wintering Bald Eagles increased nationwide at an estimated rate of 0.6% per yr from 1986–2010. Regional trends were highest in the Northeast (3.9%), with most parts of the country showing increasing trends (Table 3). Twelve northern and eastern states had significant increasing trends in number of eagles counted; Idaho, Indiana, Iowa, Maryland, Michigan, Minnesota, New Hampshire, New Jersey, New York, Oregon, Vermont, and Wisconsin (Table 1). Counts in the Southwest decreased significantly by −2.2% per yr over 25-yr (Table 3). Model-based trend estimates revealed statistically significant declining trends in Arizona, Colorado, Nebraska, and Texas (Table 1). We did not detect trends in counts (increasing or decreasing) for the remaining 28 states during 1986–2010 (Fig. 1).

Counts of adult Bald Eagles increased nationwide, at an estimated rate of 0.6% per yr from 1986–2010, and counts of eagles in immature plumage (juvenal and basic I–IV; Buehler 2000) increased most in the Northeast (4.0% per yr) over the 25-yr period. Counts of adult and immature Bald Eagles, respectively, increased significantly in

Table 3. Estimates of trends in the midwinter Bald Eagle count by region, 1986–2010. Asterisk (*) indicates that trend is significantly different from 0 at $P < 0.05$. *P*-value adjusted for multiple testing using the Bonferroni step-down procedure.

| REGION[a] | NO. ROUTES | TREND ESTIMATE[b] | STANDARD ERROR | CHANGE PER YEAR[c] | 95% C.I. |
|---|---|---|---|---|---|
| Nationwide | 844 | 0.006 | 0.002 | 0.6%* | 0.1, 1.0 |
| North | 432 | 0.019 | 0.002 | 1.9%* | 1.5, 2.4 |
| South | 412 | −0.008 | 0.002 | −0.8%* | −1.3, −0.4 |
| East | 365 | 0.015 | 0.002 | 1.5%* | 1.1, 2.0 |
| West | 479 | −0.001 | 0.002 | −0.1% | −0.6, 0.3 |
| Northeast | 131 | 0.038 | 0.006 | 3.9%* | 2.7, 5.1 |
| Southeast | 234 | 0.002 | 0.004 | 0.2% | −0.7, 1.1 |
| Northwest | 301 | 0.011 | 0.004 | 1.1%* | 0.3, 1.9 |
| Southwest | 178 | −0.023 | 0.006 | −2.2%* | −3.3, −1.2 |

[a] Regions defined in relation to 40°N and 100°W.

[b] Calculated from logged counts.

[c] Annual percentage change estimated from actual counts (back-transformed).

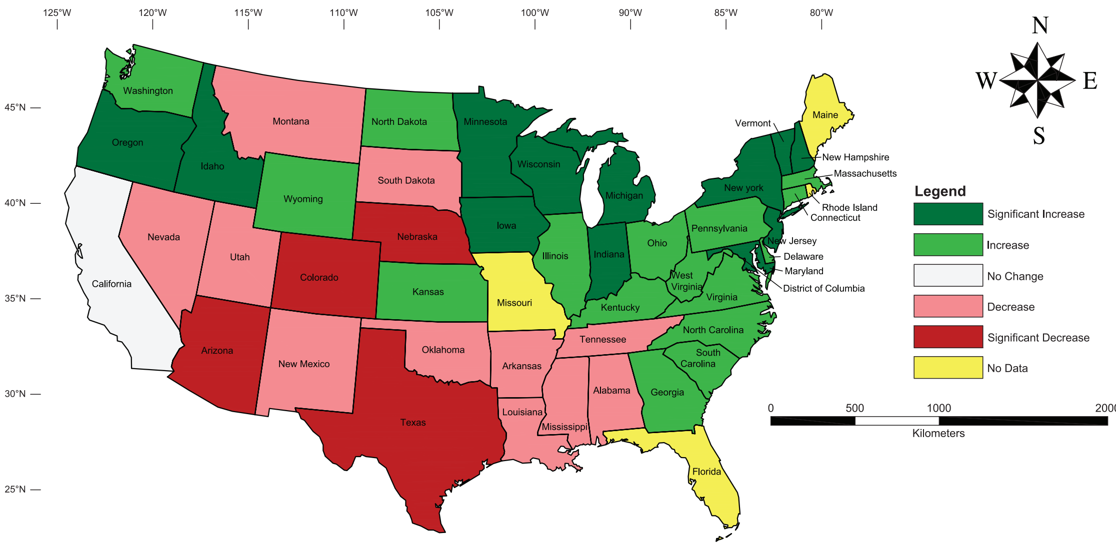


Figure 1. Map of the conterminous United States with midwinter Bald Eagle count trends by state, 1986–2010. Dark green and dark red represent states with significant positive and significant negative count trends, respectively. Light green, light red, and white represent states with non-significant positive, non-significant negative, and no change count trends, respectively (e.g., stable counts). Yellow represents states with no data.

12 states: Idaho (1.2%, adults only), Indiana (3.6%, 3.9%), Iowa (4.3%, 4.1%), Maryland (3.9%, 3.9%), Michigan (7.7%, 7.8%), Minnesota (4.8%, 4.9%), New Hampshire (6.8%, 6.6%), New Jersey (5.4%, 5.1%), New York (7.0%, 7.0%), Oregon (2.0%, 2.3%), Vermont (8.6%, 11.2%), and Wisconsin (4.9%, 4.9%). Over the 25-yr period, counts of immature eagles decreased most in the Southwest (−2.6% per yr); Arizona, Colorado, Nebraska, Texas, and Tennessee decreased −3.0%, −3.1%, −3.4%, −3.8%, and −2.8% per yr, respectively.

As in the first 15 yr, increasing count trends were greatest in the Northeast; however, estimated rate of increase was lower than that calculated for 1986–2000 (Table 4). Eagle counts from the West and Southeast were stable during the first 20 yr, but with the addition of the last 5 yr of data the trend in the Southwest now indicates a significant decrease in eagle counts (Table 4).

## DISCUSSION

The 25-yr analysis continued to show overall increasing count trends; however, our 25-yr estimate of trend in the North and East shows a rate of increase that was lower than the previous analyses. The increase in counts of wintering Bald Eagles throughout the conterminous U.S., including the more recent significant increase in the Northeast, coincides with an increase in the number of nesting birds and productivity that began soon after the ban on use of the pesticide DDT, which was linked to reproductive failure and population decline (Grier 1982). By the mid-1980s, when the Midwinter Bald Eagle Survey was initiated, increasing Bald Eagle nesting was documented in a variety of study areas (e.g., Todd 2004, Watts et al. 2008, Jorgensen and Dinan 2012), and by 2007, the number of nesting pairs had grown to 9789 (U.S.F.W.S. 2009). Recent analyses of nationwide counts from the Breeding Bird Survey (Sauer et al. 2014), migration count sites, and the Christmas Bird Count also showed significant positive trends (J. Bart unpubl. data). Increases in counts during winter also have been documented independently of the Midwinter Bald Eagle Survey (Fielder and Starkey 1987, Zwank et al. 1996, Dunwiddie and Kuntz 2001).

Bald Eagle migration patterns are complex and dependent on age (immature or adult), location of breeding, local climate, and food availability (Buehler 2000), and likely have some influence on count trends. For example, decreasing count trends in the South and increasing count trends in the North could reflect increased eagle breeding populations in Canadian provinces and Alaska, increased breeding among breeding eagles in northern latitudes in the conterminous U.S., or both. Furthermore, cli-

Table 4. Percent change per yr in the midwinter Bald Eagle count by region for 15-yr, 20-yr and 25-yr analysis periods. Asterisk (*) indicates that trend is significantly different from 0 at $P \leq 0.05$. 95% C.I.s in parentheses.

| Region[a] | Years[b] 1986–2000 | 1986–2005 | 1986–2010 |
|---|---|---|---|
| Nationwide | 1.9%* | 1.7%* | 0.6%* |
| | (0.9%, 3.0%) | (1.1%, 2.4%) | (0.1%, 1.0%) |
| North | 3.5%* | 3.6%* | 1.9%* |
| | (2.0%, 5.1%) | (2.6%, 4.5%) | (1.5%, 2.4%) |
| South | 0.4% | −0.1% | −0.8%* |
| | (−1.1%,1.8%) | (−1.0%,0.8%) | (−1.3%, −0.4%) |
| East | 3.7%* | 3.5%* | 1.5%* |
| | (2.2%, 5.3%) | (2.5%, 4.4%) | (1.1%, 2.0%) |
| West | 0.2% | 0.0% | −0.1% |
| | (−1.2%, 1.6%) | (−0.9%, 0.9%) | (−0.6%, 0.3%) |
| Northeast | 6.1%* | 6.0%* | 3.9%* |
| | (3.4%, 8.8%) | (4.4%, 7.6%) | (2.7%, 5.1%) |
| Southeast | 1.5% | 1.0% | 0.2% |
| | (−0.3%, 3.2%) | (−0.1%, 2.1%) | (−0.7%, 1.1%) |
| Northwest | 1.1% | 1.2%* | 1.1%* |
| | (−0.5%, 2.7%) | (0.2%, 2.3%) | (0.3%, 1.9%) |
| Southwest | −0.7% | −1.2% | −2.2%* |
| | (−3.0%, 1.6%) | (−2.6%, 0.3%) | (−3.3%, −1.2%) |

[a] Regions defined in relation to 40°N and 100°W.

[b] Total eagle count for 15-, 20- and 25-yr analysis periods was 101 777; 178 896; and 237 259, respectively. Number of surveys for 15-, 20- and 25-yr analysis periods was 5180; 8674; and 11 729, respectively. Number of routes for 15-, 20- and 25-yr analysis periods was 563, 746, and 844, respectively. Number of states for 15-, 20- and 25-yr analysis periods was 42, 43, and 44, respectively.

mate change already may be affecting distribution of Bald Eagles, both spatially and temporally, such that northern migrants may not move as far south as in prior years, potentially resulting in what appears to be a declining trend in the south, but increasing trend in the north (National Audubon Society 2014). Additionally, evidence that migration behavior may be changing, possibly due to climate change, has been documented for Bald Eagles (Buskirk 2012) and several other raptors as well (Rosenfield et al. 2011, Millsap et al. 2013).

Nonetheless, our data show that most northern count trends are now increasing at a lower rate, reflecting a slowing of the growth of the recovering Bald Eagle population. Slower rates of increase and approximately stable counts of nesting Bald Eagles and reproductive rates have been noted at breeding areas across the continent (e.g., Swenson et al. 1986, Watson et al. 2002, Hodges 2011, Mouget et al. 2013). Stinson et al. (2007) monitored growth of nesting Bald Eagle populations in Washington State and found areas with recent declines in nest occupancy rate, and Watts et al. (2008) predicted the Chesapeake Bay Bald Eagle population would be saturated within 10 yr.

Differences among counts from geographic areas probably reflect, in part, differences in regional population dynamics that, in turn, are affected by different environmental factors. Of particular interest is the 25-yr tendency for declining winter counts from the Southwest region that became significant with the addition of the last 5 yr of data, despite an increasing local breeding population in Arizona (Allison et al. 2008). Recently, Harvey et al. (2012) predicted that climate change, including warmer temperatures in the Puget Sound region of Washington, could reduce the prey available for wintering Bald Eagles. Additional monitoring and specific studies are needed to understand how climate change (Cayan et al. 2010) or other factors might be associated with changes in counts, including the decline of Midwinter Bald Eagle Survey counts in the Southwest (Bagne and Finch 2012, Finch 2012).

Stabilization of eagle populations as they reach carrying capacity would be expected as a consequence of density-dependent population regulation due to limited resources. For example, Bald Eagle nesting and wintering populations along the southern coast of British Columbia increased, then stabilized. Elliott et al. (2011) attributed this to density-dependent factors. They noted that density-dependent reductions in breeding population growth are ''partially due to reduced survival'' and that most mortality occurred during winter. Elliott et al. (2011) suggested that eagle populations in the Pacific Northwest are currently limited partially by density on the breeding grounds and partially by adult mortality in late winter. Increasing winter mortality may be due to reduced late winter salmon stocks that force eagles to use more marginal prey supplies.

The availability of food also influences the daily and seasonal use of areas by wintering Bald Eagles (Stalmaster et al. 1979, Knight and Knight 1983, Griffin and Baskett 1985, Keister et al. 1987, Hunt et al. 1992b), and the population size in an area (Elliott et al. 2011). Varying water levels can influence eagle foraging (Hunt et al. 1992a, Brown et al. 1998), and thus, their numbers. The presence of birds on an individual route on a single day could vary from year to year depending on food availability and foraging behavior (Stalmaster et al. 1979, Elliott et al. 2011), weather (Steenhof et al. 1980, Keister et al. 1987), disturbance (Knight and Knight 1984) and other behaviors (Grubb 2003) that affect the movements of Bald Eagles.

The large scope of our analysis, in terms of the time span covered and spatial scale, contributed variability that we attempted to consider in our analysis, but that potentially affected results. As Steenhof et al. (2002) discussed, the historical development of the Midwinter Bald Eagle Survey was not based on statistical design. The routes chosen were places of known Bald Eagle use, and those might have received ''special'' attention and retention through the years because they supported relatively large numbers of birds, consistently had wintering birds present, or were convenient to survey. Those sites might disproportionately represent ''higher quality habitat,'' thus, usually attracting birds to near-capacity each winter. If so, we would expect less change in counts at those sites compared to more ''marginal winter habitat sites,'' many of which may never have been included in the survey. Therefore, if eagles occupied marginal sites more in later years of the recovery, data on birds using marginal sites that are not sampled do not contribute to our trend results.

Second, survey routes were added and deleted during the last 5 yr of the study with potential effects on trends. For example, in the Northeast, 13 routes used in prior analyses were dropped: all of Michigan, and at least two in Iowa, with fairly large trends in the last analysis. In the Southeast, all routes from Virginia were dropped, and in the Southwest, only one route from New Mexico continues to be counted. However, we believe that exclusion of the 13 routes in the Northeast, a potentially serious effect, did not change our results based on the consistency of trend we found when these routes were excluded from the analysis of the 1986–2005 survey period compared to the 1986–2010 survey period. Similarly, for the other regions, where new routes were added since 2006, the pattern was similar among periods.

The annual Midwinter Bald Eagle Survey can be particularly important because it provides information about Bald Eagle distribution, local abundance, and age class, and thus, informs the post-delisting national, regional, and local status of the Bald Eagle. We suggest that careful consideration be given to continuing this winter survey for Bald Eagles in the conterminous U.S., perhaps with a specific sampling design such as used to monitor breeding populations as part of the post-delisting effort (U.S.F.W.S. 2009). As Steenhof et al. (2002) noted, the Midwinter Bald Eagle Survey has become institutionalized in many states across the country, and provides an opportunity to identify and manage important eagle wintering areas. Furthermore, many states use information from this survey for management decisions (e.g., McCarty et al. 2013). Continued monitoring will benefit risk assessment from existing factors such as contaminants (Bowerman et al. 1995, Wayland and Bollinger 1999, Bowerman et al. 2003, Stauber et al. 2010), and disturbance (Stalmaster and Newman 1978, Brown and Stevens 1997) that could influence the birds' fidelity to important winter areas (Harmata and Stahlecker 1993), and potential long-term impacts from climate change (Seager and Vecchi 2010).

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