

## Kentucky's Midwinter Eagle Survey: 1961–2021

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### Background

Kentucky's Bald Eagle (*Haliaeetus leucocephalus*) population peaks during the winter months, as eagles from Canada and the northern United States migrate south when food availability decreases (Buehler 2020). To monitor wintering eagle populations, annual surveys for Bald Eagles were initiated at several locations across the US during the 1960s. Members of the Kentucky Ornithological Society assisted in conducting the first organized survey of the wintering population of Bald Eagles in Kentucky in 1961 (Wilson and Stamm 1961, Stamm 1962). This initial survey was known as the *Cooperative Bald Eagle Investigation for the Mississippi River Winter Study* and was organized by the National Audubon Society and the Continental Bald Eagle Project (Heyden and Palmer-Ball 2011). Winter eagle surveys were later expanded to include all of the lower 48 states by the National Wildlife Federation in 1979.

Since 1986, the Kentucky Department of Fish and Wildlife Resources (KDFWR) has managed the survey as the state's coordinating agency for what has become known as the Midwinter Eagle Survey (MES), coordinated at the national level by the U.S. Army Corps of Engineers. The objective of the MES was to establish an index of the total wintering Bald Eagle population in the lower 48 states and to identify previously unrecognized areas of important winter habitat (Eakle *et al.* 2015).

Since 1980, the MES has occurred nationwide during the first two weeks of January each year (prior to 1980, the survey took place during the second or third weekend of February). During the survey, participants counted both Bald Eagles and Golden Eagles (*Aquila chrysaetos*) along standard survey routes by airplane, boat, or ground. The survey method and area covered was generally kept consistent from year-to-year. Participants also recorded weather conditions, survey effort data and the age of observed individuals (adult or immature). Some of the larger survey routes were split between multiple cooperators each of whom covered a portion of the target area. Throughout the 60 years of the survey, the number of sites surveyed per year in Kentucky ranged from two in 1961 to 44 in 1993. Since 2000, there have been 18–22 standardized survey routes covered each year.

Further details about the history of Kentucky's Midwinter Eagle survey (MES) can be found in the article "Kentucky's Midwinter Eagle Survey, 50 Years Later" (Heyden and Palmer-Ball 2011).

### Results of the Midwinter Eagle Survey

During the sixty years of the MES in Kentucky, the Bald Eagle population experienced tremendous growth (Figure 1). Very few Bald Eagles were observed during the beginning of the MES, with only five recorded during the first survey. The population began increasing during the late 1970s at a rate of  $12.70 \pm 1.30$  ( $\pm$  standard error) eagles per year (1978–1989) and started to stabilize during the 1990s with a linear population trend of  $2.94 \pm 0.81$  eagles per year (1990–1999). This stability has continued through recent years. Since 2000, the survey effort and methods have been very consistent and the trend for this period was  $0.89 \pm 1.07$ . During the timeframe of the surveys (1961–2021), the total number of Bald Eagles surveyed, including adults and immature eagles, had a linear population trend of  $5.1 \pm 1.09$ . The number of adults counted increased by

3.61±0.96 eagles per year and the population of immature Bald Eagles increased by 1.5±0.60 eagles per year.

The three routes with the highest abundance of Bald Eagles were Land Between the Lakes (LBL), Ballard Wildlife Management Area (WMA), and Mississippi River (Table 1). LBL consistently had the most Bald Eagles observed during surveys, with an average of 95.9 Bald Eagles per year between 1990 and 2021. During this timeframe, the highest number of eagles observed at LBL was 215 Bald Eagles (156 adults and 59 immatures) in 2010. Ballard WMA had the second largest abundance, averaging 30.2 eagles per survey between 1990 and 2021 and had a peak of 58 Bald Eagles (11 adults, 45 immatures, and 2 of unknown age) in 2013. The Mississippi River route had the third most eagles and covered the Kentucky shoreline of the river in Fulton, Hickman, Carlisle, and Ballard counties. It averaged 25 Bald Eagles per year between 1990 and 2021 and had a peak of 85 Bald Eagles (44 adults and 41 immatures) in 2001.

In contrast to substantial increase in the numbers of Kentucky's Bald Eagles, the number of Golden Eagles counted has remained relatively low, but stable in Kentucky (-0.06±0.21, 1961-2021 trend). Golden Eagles were not counted during the MES until 1966 and then in numbers less than six until the late-1970s. In 1978, the MES's highest number of Golden Eagles was observed during the survey, when 12 individuals were reported (1 adult, 1 immature, and 10 of unknown age). Since 2000, the number of Golden Eagles observed has remained relatively constant (Figure 2).

### Discussion and Looking Ahead

The national survey has been the primary means for assessing winter populations of Bald Eagles in the United States and another method to document the comeback of the species. Even after the species was delisted in 2007, the nationwide MES continued to be a measure for monitoring the population. However, the nationally coordinated MES concluded with the 2021 survey. KDFWR will continue the survey in 2022 at LBL, Ballard WMA, Lake Cumberland, and Green River Lake. These four areas were chosen for continued surveys due to large eagle populations, geographic location, or consistency of survey effort. The maintained routes will allow for KDFWR to monitor for long-term effects of remaining threats to eagles such as contaminants and climate change.

The number of Bald Eagles counted during the MES steadily increased from the initial surveys. This increase in the number of eagles surveyed no doubt reflects the recovery of the species resulting from the ban of the insecticide DDT in 1972 (Grier 1982) and subsequent natural reproduction, as well as reintroduction efforts. Another consideration for the interpretation of survey results is the variation in the number of surveys conducted each year. During the first decade of surveys there were seven survey routes per year on average. In the 1970s, the average number of surveys more than doubled to 17, and the number of surveys conducted peaked in 1993 with 44 routes. However, despite an expanded survey effort during the 1990s, many of the newer routes didn't yield many eagle observations and were discontinued by 2000 (Heyden and Palmer-Ball 2011). Since 2000, 18–22 routes were conducted each year and the effort and survey methods have been very consistent. The trend for 2000–2021 was 0.89±1.07; thus, we assume the population has continued to increase in recent decades, despite variation in survey effort over the course of the entire MES. Further, this positive trend is supported by previous reports on the trends of MES counts in Kentucky and the southeastern U.S. region (Eakle *et al.* 2015).

Although a sustained increase was documented through the MES, the number of Bald Eagles counted began to plateau in the early 1990s. Trends for the entire U.S. and the southeast region were also found to have a lower estimated rate of increase in the latter years of a nationwide analysis of 1986–2010 MES data (Eakle *et al.* 2015). Kentucky's midwinter Bald Eagle counts are no

doubt a mix of local nesting birds, wandering immature birds and migratory birds from northern latitudes. Research has demonstrated a migratory link between Kentucky and the Great Lakes region (Mandernack *et al.* 2012, Slankard *et al.* *In Press*). Kentucky's nesting Bald Eagles do not migrate and are already territorial during the MES (Slankard *et al.* 2021). Most pairs are in the courtship and nest building phase during the survey window, but a few may have laid eggs by then. Kentucky's nesting Bald Eagle population increased 800% between 2000 and 2019 (Slankard 2019). Thus, despite high proportions of adults recorded, we assume a substantial portion of the Bald Eagles counted through the MES were not local nesting birds, since a great increase was not reflected in MES counts during the same timeframe. The survey areas may have neared the limit of individuals they could support in recent decades. MES routes were located on large rivers and lakes, whereas many new Bald Eagle nests were found on smaller creeks and lakes between 2000–2019. The distribution of wintering Bald Eagles may have followed a similar, scattered pattern such that the increase in nesting Bald Eagles seen across the region (USFWS 2020) may not have been fully recorded on MES routes.

Our calculated trends show a greater rate of increase for adult Bald Eagles in comparison to immatures. This is expected to some extent for a species that reaches mature plumage at 5 years but may live up to 25 years in the wild. A greater rate of increase in adults may also reflect the rate of survival in the population at large, or age-based migratory patterns (Buehler 2020).

The majority of the Bald Eagles observed during the MES were counted at LBL, Ballard WMA and the Mississippi River (Table 1). Lake Cumberland produced the highest MES counts of any route outside of western Kentucky. The eagle counts at LBL were consistently higher than any other route each year since 2000 (Table 1). The large amount of available habitat in these areas, including the availability of food and communal roosting sites, allows for the wintering population of Bald Eagles to congregate in large numbers. Waterfowl, fish, and carrion abundance are important winter food sources for Bald Eagles and their availability is likely to affect patterns of use (Grubb 2003). The three MES routes with the highest counts were in close proximity to the Mississippi flyway (waterfowl migration corridor), which is likely not coincidental since waterfowl are a staple of the Bald Eagle's diet (Buehler 2020). Lack of human disturbance and development are likely also important in areas with high counts.

Bald Eagle migration patterns are complex, but it is well documented that severe winter weather can impact the movements of Bald Eagles (Lingle and Krapu 1986, Watts *et al.* 2007). Low temperatures and frozen bodies of water in northern latitudes drive Bald Eagles southward in search of better foraging opportunities (Buehler 2020). Kentucky's resident Bald Eagles do not migrate, but during periods of sustained cold weather, resident birds as well as migrants are likely to move to larger bodies of water when smaller ponds and lakes have frozen. This effect most likely accounts for the disparity in the number of observed Bald Eagles that occurs in consecutive years, rather than actual, large fluctuations in population levels. Years with high counts were often those when it was not only exceptionally cold in Kentucky, but in the Great Lakes region as well. For example, harsh winter weather in 2010 and 2014 in Kentucky and further north likely led to the highest counts of wintering eagles in the history of the Kentucky survey (415; 383). Extreme weather conditions during the survey period caused many of Kentucky's smaller creeks, rivers, and reservoirs to freeze over. Lack of food resources at smaller water bodies probably caused a push of wintering eagles to some of our larger water bodies in the state where open surface water remained, and where we have established survey routes. Because eagle movements are linked to weather, climate change has the potential to affect future eagle migration patterns and may already be having some effects (Eakle *et al.* 2015).

The MES routes in Kentucky were predominately set up in areas where there was plentiful habitat for Bald Eagles (e.g., lakes and rivers). As a result, the number of Golden Eagles counted during

the MES has been low. Bernheim Forest is the only route that was established with Golden Eagles as the focus and many of the counts for this species came from that route. Unlike Kentucky's winter Bald Eagle population, the population of Golden Eagles is made up entirely of migrants. Breeding Golden Eagles have been extirpated from the eastern United States since 1997. Prior to that, they were found in small numbers in Maine, Massachusetts, New Hampshire, New York, Pennsylvania, and Vermont (Morneau *et al.* 2015). Any Golden Eagles found during the non-breeding season in the eastern United States have migrated from Canada (Miller *et al.* 2017). Despite the fact that the Golden Eagle is a rarer species than the Bald Eagle in Kentucky (Palmer-Ball 2019), the counts for Golden Eagles may also be underestimated during MES. Due to their similarity in appearance to immature Bald Eagles, Golden Eagles may be misidentified, especially from a distance. A camera trapping survey for Golden Eagles was conducted in Kentucky from 2012–2017 and a better understanding of this species' abundance and distribution in Kentucky resulted from that project (Taylor and Slankard 2018).

The MES provided a yearly snapshot of the high-use, wintering areas for Kentucky's Bald Eagles. Despite some irregularities and biases, we do think these data are a reasonable index on which to measure change in abundance at survey areas. These sixty years of survey data have informed wildlife managers on eagle habitat and abundance, allowing for the identification of some of the more important areas for wintering eagles, and in some cases, leading to habitat protection. The survey fulfilled its primary objective of monitoring the recovery of the Bald Eagle population, not only in Kentucky, but throughout their range. The legacy of the MES will continue through reduced survey efforts and winter eagle-watching events at Kentucky State Parks and Land Between the Lakes National Recreation Area.

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Survey Route	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Ballard WMA	22	28	52	10	16	23	9	11	30	48	30
Barren River Lake	NS	NS	NS	NS	NS	3	1	4	12	6	14
Bernheim Forest	6	5	4	4	12	14	2	2	6	16	6
Cave Run Lake	3	3	4	10	10	9	9	5	12	27	10
Dale Hollow Lake (KY)	15	33	10	NS	33	19	15	12	13	20	29
Grayson Lake	NS	NS	NS	NS	NS	NS	1	2	2	0	0
Green River Lake	1	5	2	7	7	7	3	4	5	2	3
Lake Cumberland	12	7	7	18	12	22	6	18	24	17	25
Land Between the Lakes	83	74	101	44	43	56	57	84	149	150	215
Laurel River Lake	6	1	9	0	3	2	2	2	3	2	2
Mississippi River	41	85	46	18	9	20	10	8	40	44	32
Ohio River: Brandenburg-Louisville	0	0	3	1	0	3	0	1	4	5	1
Ohio River: Carrsville-Henderson	10	10	11	6	8	5	11	4	5	9	7
Ohio: Covington-Ashland	0	0	0	0	0	0	NS	NS	2	11	12
Ohio River: Henderson-Brandenburg	2	3	6	2	3	5	3	6	5	6	9
Ohio River: Wickliffe-Carrsville	19	26	25	12	10	6	2	9	17	6	17
Reelfoot Lake NWR (KY)	4	11	38	21	24	13	0	17	27	7	1
Rough River Lake	NS	NS	NS	NS	1	3	3	2	2	3	2
Taylorsville Lake	1	0	6	4	3	5	3	2	2	2	0
<b>Total Eagles on Routes</b>	<b>225</b>	<b>291</b>	<b>324</b>	<b>157</b>	<b>194</b>	<b>215</b>	<b>137</b>	<b>193</b>	<b>360</b>	<b>381</b>	<b>415</b>

Table 1. The total number of Bald and Golden Eagles, as well as eagles not identified to species, that were reported from 2000 to 2021 on the MES routes. Some routes dropped (due to low counts) prior to 2005 are not included. NS=not surveyed.

Survey Route	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Ballard WMA	33	37	58	47	58	NS	43	44	NS	20	23
Barren River Lake	5	23	10	12	13	19	19	9	10	15	12
Bernheim Forest	5	4	3	3	5	4	3	5	4	4	4
Cave Run Lake	3	7	0	4	1	1	3	4	3	0	1
Dale Hollow Lake (KY)	23	24	NS	NS	NS	NS	NS	NS	NS	NS	NS
Grayson Lake	0	3	0	0	0	0	0	0	0	0	0
Green River Lake	6	3	3	12	3	12	9	9	22	11	13
Lake Cumberland	13	31	34	28	20	25	48	33	19	16	21
Land Between the Lakes	37	76	105	178	88	74	115	95	60	83	58
Laurel River Lake	7	5	10	5	1	4	6	4	9	9	10
Mississippi River	22	33	21	29	9	18	8	21	0	13	22
Ohio River: Brandenburg-Louisville	0	2	1	0	2	1	2	2	5	2	0
Ohio River: Carrsville-Henderson	6	5	5	11	12	6	8	4	5	6	4
Ohio: Covington-Ashland	3	4	2	7	2	3	1	6	16	1	12
Ohio River: Henderson-Brandenburg	2	3	5	5	5	5	2	7	4	2	2
Ohio River: Wickliffe-Carrsville	14	26	8	30	18	20	22	32	14	23	22
Reelfoot Lake NWR (KY)	4	2	3	5	0	6	37	84	NS	1	NS
Rough River Lake	4	2	4	4	4	2	5	1	0	0	2
Taylorville Lake	8	7	7	3	7	0	12	3	15	4	7
<b>Total Eagles on Routes</b>	<b>195</b>	<b>297</b>	<b>279</b>	<b>383</b>	<b>248</b>	<b>200</b>	<b>343</b>	<b>363</b>	<b>186</b>	<b>210</b>	<b>213</b>

Table 1. (continued) The total number of Bald and Golden Eagles, as well as eagles not identified to species, that were reported from 2000 to 2021 on the MES routes. Some routes dropped (due to low counts) prior to 2005 are not included. NS=not surveyed.

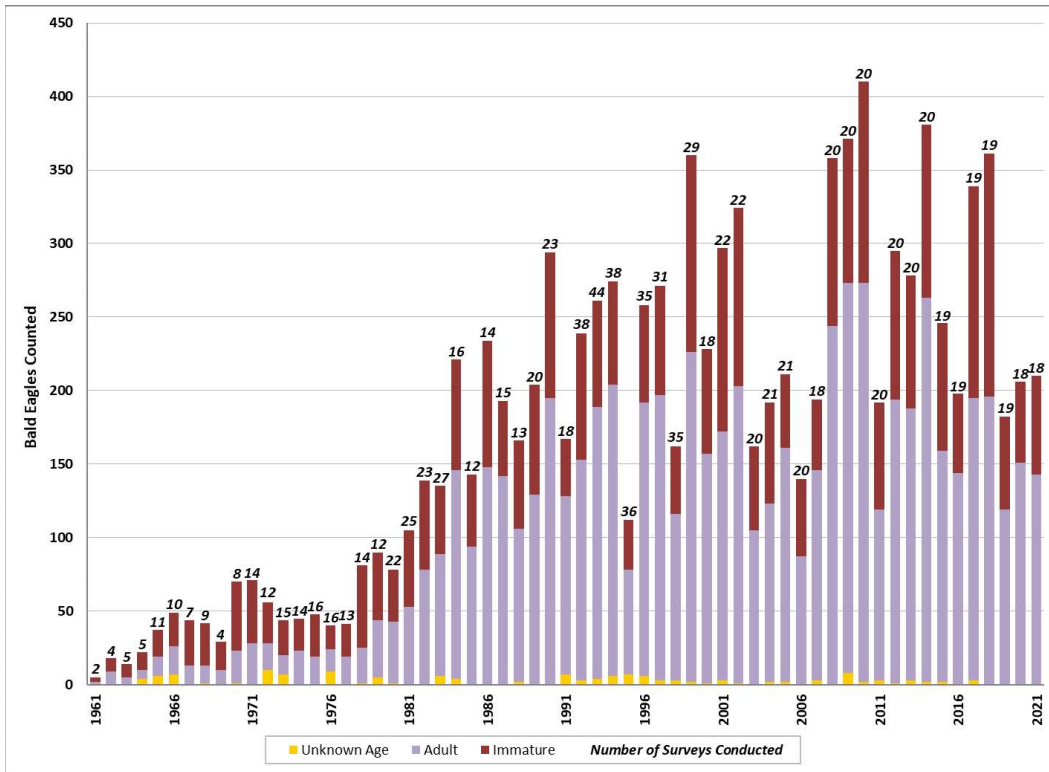


Figure 1. Total Bald Eagles recorded during Kentucky midwinter eagle surveys, 1961-2021. The number of survey routes completed is shown above each yearly column.

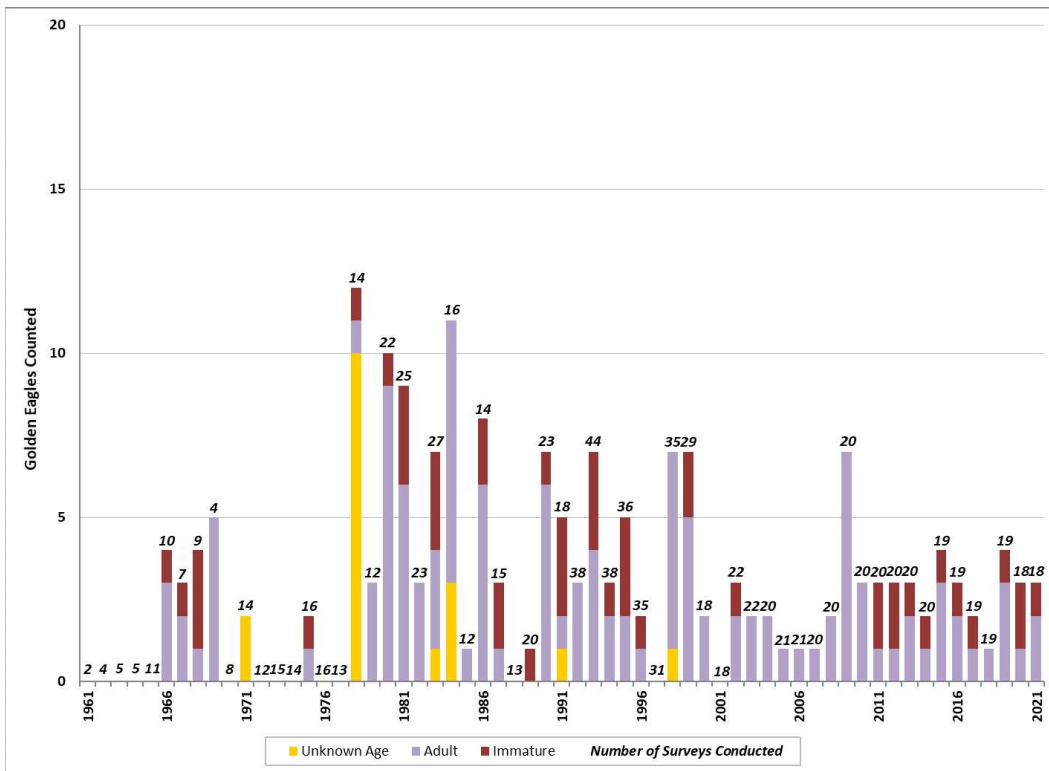


Figure 2. Total Golden Eagles recorded during Kentucky midwinter eagle surveys 1961-2021. The number of survey routes completed is shown above each yearly column.



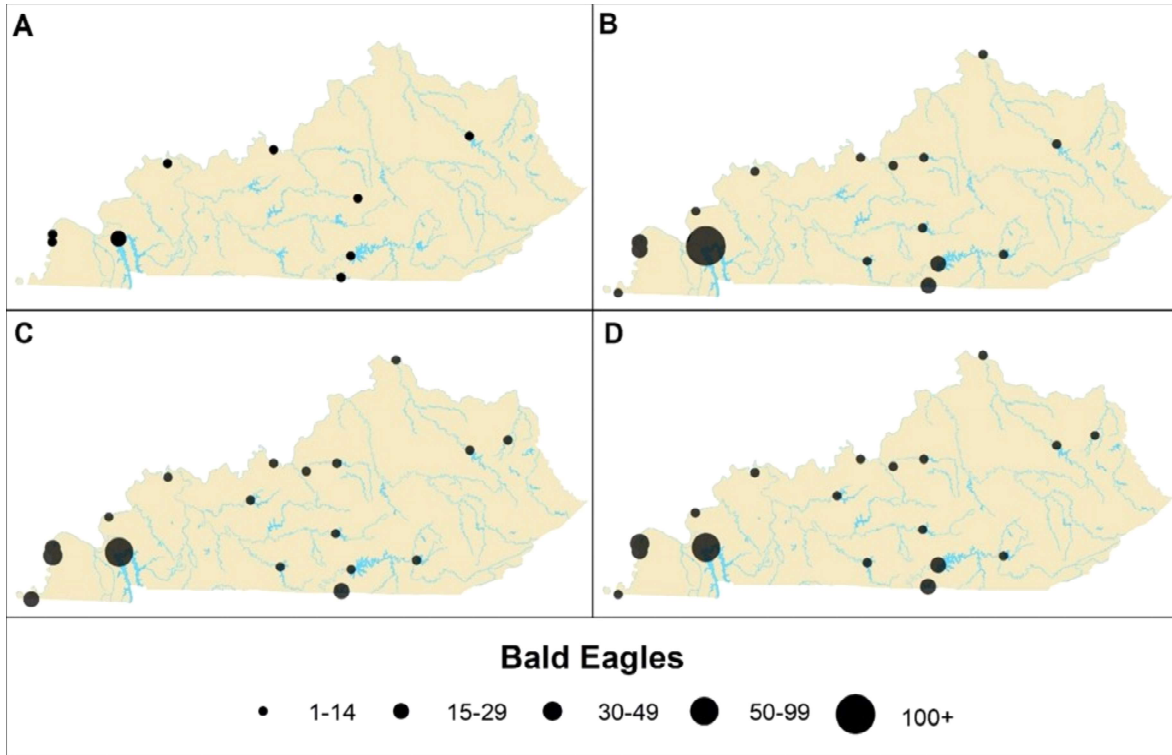


Figure 3. Average number of bald eagles observed at each survey location by year. A: 1980 B: 1990–1999, C: 2000–2009, D: 2010–2021.

