AMERICAN WIND WILDLIFE INSTITUTE

TECHNICAL REPORT

2nd Edition: Summary of Bird Fatality Monitoring Data Contained in AWWIC

Prepared by:
Taber D. Allison, PhD, AWWI Director of Research
Ryan Butryn, AWWIC Program Manager

November 24, 2020

AWWI Technical Report:

2nd Edition: Summary of Bird Fatality Monitoring Data Contained in AWWIC

American Wind Wildlife Institute
1990 K Street NW, Suite 620
Washington, DC 20006
www.awwi.org

For Release November 24, 2020

AWWI is a partnership of leaders in the wind industry, wildlife management agencies, and science and environmental organizations who collaborate on a shared mission: to facilitate timely and responsible development of wind energy while protecting wildlife and wildlife habitat.

Find this document online at https://awwi.org/resources/awwic-bird-technical-report/

Acknowledgments
We thank the wind energy companies who voluntarily contributed data to AWWIC, and AWWI's industry and conservation Partners for supporting the development of the AWWIC database. We thank the National Renewable Energy Laboratory for their support of the development of policies and procedures for data contribution and access to AWWIC. We thank Garry George, Doug Johnson, Leslie New, Dale Strickland, Dave Nelson, and members of the AWWI Research Committee for their review and comment on this report.

Prepared By
Taber D. Allison, PhD, AWWI Director of Research
Ryan Butryn, AWWIC Program Manager

Suggested Citation Format
American Wind Wildlife Institute (AWWI). 2020. AWWI Technical Report: 2nd Edition: Summary of Bird Fatality Monitoring Data Contained in AWWIC. Washington, DC. Available at www.awwi.org.

Contents

Introduction

Bird collisions with wind turbines have been reported at nearly all wind energy facilities. To date, cumulative assessments of bird collision fatalities at wind energy facilities have relied on data gleaned from publicly available studies (Smallwood 2013, Loss et al. 2013, Erickson et al. 2014).

In 2019, AWWI released the first Bird Technical Report summarizing data contained in the American Wind Wildlife Information Center (AWWIC: pronounced "A-wick"; view online: https://awwi.org/wp-content/uploads/2019/02/AWWI-Bird-Technical-Report-02_25_19.pdf). This 2nd edition updates a majority of those data summaries with 109 new studies at 81 projects across the U.S., thus providing wind-wildlife stakeholders with the most up-to-date picture of bird fatality data at wind energy facilities. As new data continue to be added, AWWI will continue to update this report.

The goal of these reports is to provide the most up-to-date understanding of the variability in species composition, timing, and magnitude of bird collisions to support the development of hypotheses that can be tested with additional analysis. When interpreting the data summaries, it is important to note that these data are either publicly available or voluntarily shared with AWWI by participating wind energy companies and do not represent a comprehensive or randomized monitoring dataset. Therefore, conclusions or extrapolations made from these data may change as additional data are added, and we advise accounting for differences in study protocols before further analysis.

Data summarized in this report comes solely from land-based wind energy facilities. We summarize bird fatality incidents and adjusted fatality estimates by avifaunal biome (e.g., Erickson et al. 2014). Avifaunal biomes represent aggregations of Bird Conservation Regions (BCRs; Rich et al. 2004, NABCI 2018) that encompass more similar bird fauna than other biomes. Information about existing wind installations in each region was obtained from the U.S. Wind Turbine Database (https://eerscmap.usgs.gov/uswtdb). These data summaries represent initial steps to evaluate AWWIC's ability to contribute to the goal of addressing the impacts of wind energy on birds in what we hope will be a positive-feedback loop: as the value of the database becomes apparent, more data will be contributed further increasing the value of the database.

AWWIC Description

AWWIC is a cooperative initiative of wind energy companies and AWWI to expand the availability of wind-wildlife data to inform research. For more than 20 years, wind energy companies have conducted surveys to assess risk and impacts to wildlife from wind energy projects. Many of the data are publicly available, but other data have remained confidential, and have been unavailable for analysis. AWWIC includes both publicly available and confidential wind-wildlife data, and is designed to maintain the confidentiality of the data while making more data available to support research intended to decrease impacts from wind energy to wildlife.

Description of AWWIC Data

The AWWIC post-construction database contains data collected during post-construction fatality monitoring (PCM) studies at individual wind energy projects. We define a study in AWWIC as the set of surveys for bird or bat carcasses and bias trials conducted over a specific time that result in a single, adjusted fatality estimate for birds. The results of a study are published in a single report, although variants exist, i.e., results from multiple studies over multiple years at a wind facility can be published in a single report.

Monitoring studies are usually conducted by environmental consulting firms that employ a team of trained field biologists and statisticians to conduct carcass searches, analyze the results, and prepare a

report for the client company. All PCM studies now produce fatality estimates based on observed carcasses that are corrected for detection errors (Huso et al. 2016), although the specific methods used are often tailored to the requirements and conditions at the individual projects. AWWIC captures the data common to PCM studies to facilitate our ability to aggregate data from different studies and to conduct meta-analysis of post-construction fatality data from multiple wind energy projects.

Each wind energy project in the database is assigned a unique and randomly generated Project ID. A sequential Phase ID modifier is used for wind energy projects that have multiple phases, or groups of turbines of a similar capacity and manufacturer that are installed within the same time period (e.g. PRJ1234-PH01). Often, fatality studies are conducted at each of the phases of a wind facility. A detailed listing of data fields contained in AWWIC are provided in Appendix A. For each study the data can be sorted into three main groups: 1) project site description, 2) fatality estimates, 3) fatality incidents.

Project Site Description

These data contain information about a project's installed capacity (number of megawatts, or #MWs), height and rotor swept dimensions of wind turbines installed, year of construction, and the geographic region where the project is located. Geographic regions include U.S. Fish and Wildlife Service Legacy Regions (referred to as "USFWS Regions" or "Regions"), EPA Level III Ecoregions, and Bird Conservation Regions.

Fatality estimation procedures

PCM studies are conducted following established protocols (Strickland et al. 2011). Factors such as observer error in carcass detection and removal of carcasses by scavengers require that raw counts of fatalities be adjusted to more accurately estimate the true number of fatalities. The two bias trials conducted for every study are searcher efficiency trials and carcass persistence trials. Searcher efficiency trials test the field biologist's ability to find carcasses independently placed in the search area while surveying transects. The proportion of carcasses found versus the number of carcasses placed over the course of the study period is typically expressed as a single percentage but may also be calculated for each season. Carcass persistence trials estimate how long a carcass is available to be detected by the field biologist after the carcass falls into the search area. In most studies provided to AWWIC, the result is expressed as the mean number of days a placed carcass remained available before it disappeared. In conducting bias trials, carcasses of target species may be used, but often surrogates, such as quail or pheasants are used.

Fatality Estimates

These data include adjusted fatality estimates and a description of the protocols used to develop those estimates including the search area, search period, search interval, number of turbines searched, and results of searcher efficiency and carcass persistence trials.

Several different fatality estimator equations have been developed to estimate an adjusted fatality rate given the number of carcasses observed and the various sources of detection error (Huso et al. 2016). All estimator equations incorporate the results of bias trials that use carcasses placed by researchers and are conducted simultaneously with carcass searches. How the bias trial results are used, as well as the assumptions about how missed carcasses are treated, are the primary differences among estimator equations and can lead to differences in the adjusted fatality estimate derived from the raw carcass counts from a survey. Fatality estimates are most commonly expressed as the number of birds per installed megawatt (MW) capacity per year of operation, although studies also report fatality estimates on a per turbine basis as well.

Fatality Incidents

A third group of AWWIC data contains information on individual carcass discoveries, called fatality incidents, resulting from scheduled searches, incidental finds, and plot-clearing searches. Scheduled searches occur when plots are searched by trained observers, often along transects established within search plots, at a pre-determined search interval, and bird carcasses are recorded as they are encountered. Incidental finds are carcasses found outside of scheduled searches, and some studies record fatalities when plots are cleared of carcasses before the first search. Fatality incidents from scheduled searches are the raw counts from which adjusted fatality estimates are calculated, although some studies also include incidental finds in estimated fatality rates. Additional data accompany each incident including date of carcass find, species name, carcass condition, and carcass distance to the nearest turbine (see Appendix A for a list of all data fields associated with fatality incident data).

Contributed Data

Owners of wind energy projects have worked extensively with AWWI over the past few years to establish a system that allows PCM data to be shared with AWWI at a level of detail that enables meaningful data analysis while maintaining the anonymity of the individual wind energy project. As the program has evolved, most data now are submitted to AWWI directly by the environmental consultant completing the study. This simplified process reduces errors in data submission. AWWI works directly with the data contributors and consultants to review the data and correct errors that may result during data submission.

Public Data

In addition to the contributed data, AWWIC contains PCM data from publicly available reports and publications. Public reports have been obtained by locating references in previously published meta-analyses, searching online databases, and contacting data stewards at companies or municipalities. Data provided in publicly available studies typically do not contain data for all of the data fields provided in contributed data. For example, not all public reports provide detailed data on individual fatality incidents. Public reports, however, add significantly to the amount of data available for certain analyses. In some cases, the results of some PCM studies have been described in publications, but we have been unable to access the reports. Therefore, we recognize there is a gap between reports that we know exist, and the reports that we have in the AWWIC database.

2nd Edition Updates

Key updates in the 2nd edition of this Technical Report include:

- Automated report generation and more stringent data QA/QC measures (note: may lead to data availability discrepancies from 1st edition)
- Greater emphasis on presenting the data summaries as a tool for generating collision risk hypotheses to be tested with future in-depth analysis of the data
- Format changed to present graphics alongside text
- Fatality incident timing now presented as weeks rather than months
- Fatality estimates now presented as histograms rather than boxplots

Comparison of overall database size between original technical report and this report. Not all studies will meet criteria for inclusion in data summaries

	1st Edition 2018	2nd Edition 2020
Number of wind projects	146	227
Number of studies	227	336
Date range of studies	2002-2016	2002-2018
Number of turbines searched	5,108	7,864
Number of scheduled searches	276,628	445,394
Number of bird carcass finds	6,655	9,573

Data Availability

The following summary aggregates bird fatality data from 275 post-construction fatality monitoring (PCM) studies conducted at 196 onshore wind energy projects in the coterminous United States that meet criteria for inclusion. To maintain a basic level of standardization in our review of fatality estimates in AWWIC, we included studies if they met the following criteria:

1. All species found during scheduled fatality searches were recorded
2. Turbines operated as they would during normal power production (e.g., studies conducted while turbines were experimentally altered to test curtailment regimes were not included)
3. Fatality surveys included seasons of peak bird migration activity
4. Reported fatality estimates adjusted raw carcass counts for searcher efficiency, carcass persistence, and incomplete space and time coverage – and all variables pass QA/QC filters
5. Adjusted fatality estimates were greater than the number of observed carcasses

Studies contained in AWWIC are made available by data contributors or acquired from publicly available reports. Total nameplate capacity of facilities summarized in this report is 26.6 gigawatts (GW), which represents 27.7% of total installed capacity in the coterminous U.S. The projects represented were constructed between 2001 and 2017, and the studies were conducted between 2002 and 2018. Data summaries contained in the tables and figures presented in this report result from 445,394 fatality searches at 7,864 distinct turbines and are aggregated by avifaunal biome. As indicated in Figure 4, the data in AWWIC based on the number of studies and search effort is heavily weighted toward the Prairie Avifaunal Biome.

Table 1. Number of wind energy projects and post-construction fatality monitoring studies for the U.S. and avifaunal biome contained in AWWIC. Some wind energy projects have multiple turbine installations called phases, which often receive separate fatality monitoring studies.

Region name	Number of projects/phases	Number of studies	GW represented by studies	Percentage of installed GW in region
Eastern	24/24	43	2.54	44.1
Northern Forest	17/17	22	1.13	29.5
Northern Rockies	28/35	46	3.36	35.3
Pacific	9/10	16	1.02	67.4
Prairie	108/112	133	17.16	25.9
Southwest	10/10	15	1.41	16.3
Total U.S.	196/208	275	26.62	27.7

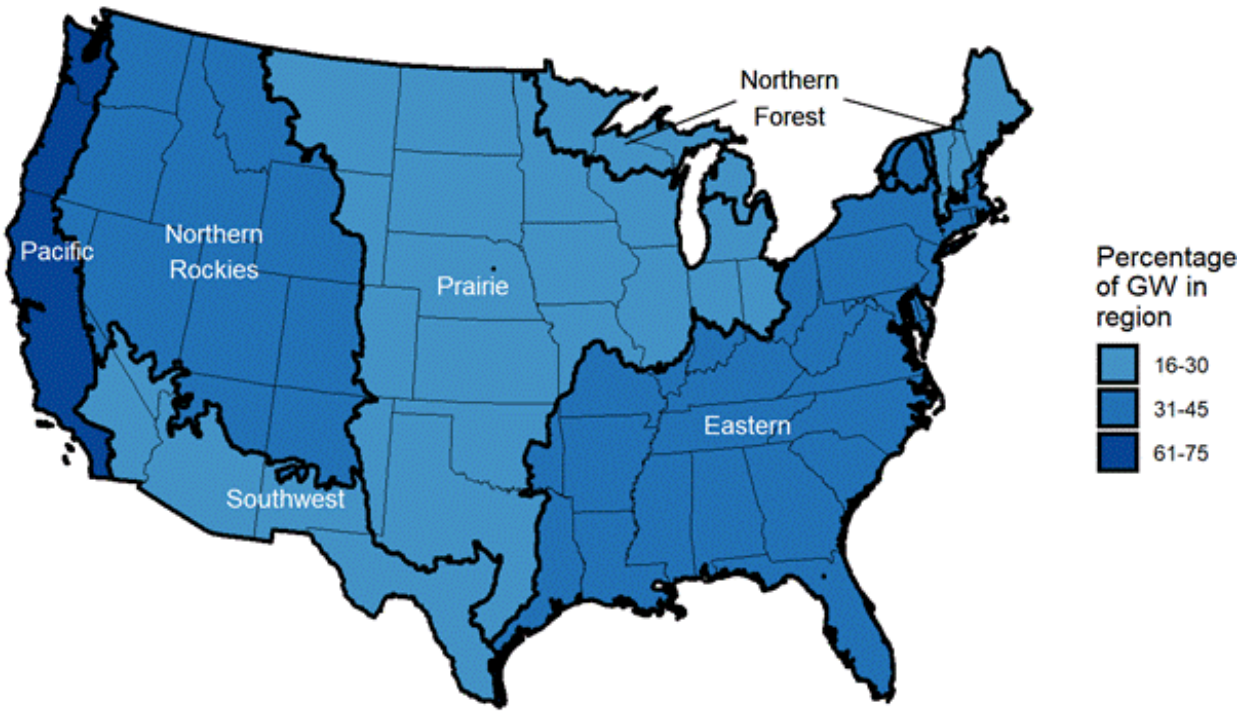


Figure 1. Percent of total installed wind capacity (gigawatts – GW) represented by post-construction fatality monitoring data contained in this report by avifaunal biomes. Only studies meeting criteria for inclusion are presented.

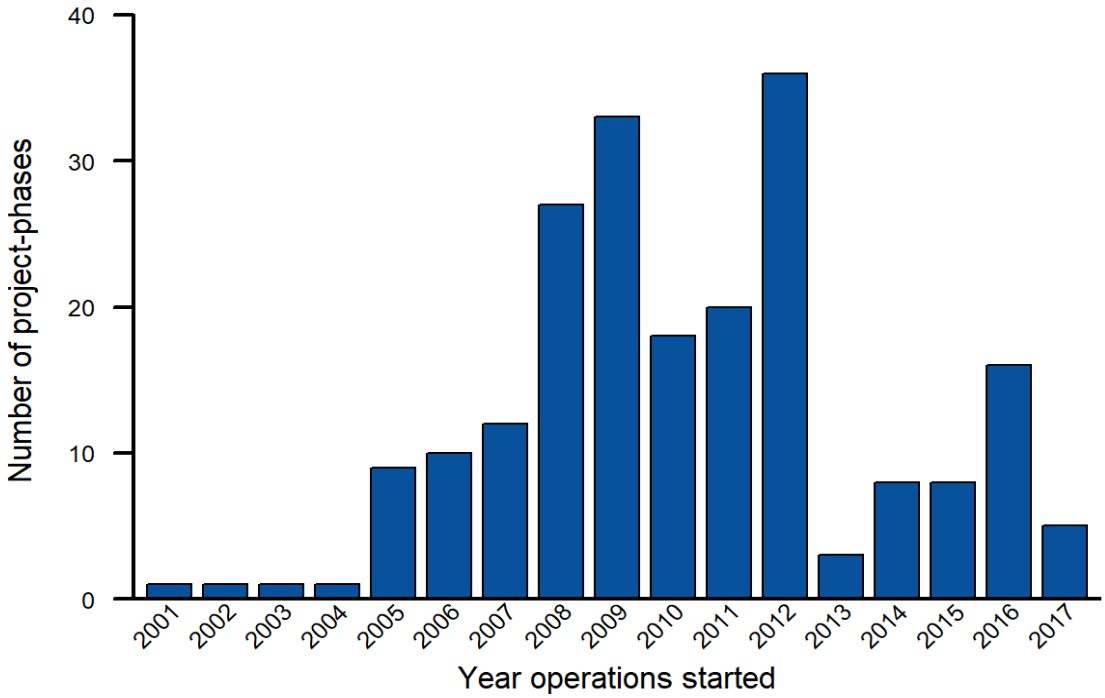


Figure 2. Wind energy project-phases represented in AWWIC (N=208) by year they became operational or repowered.

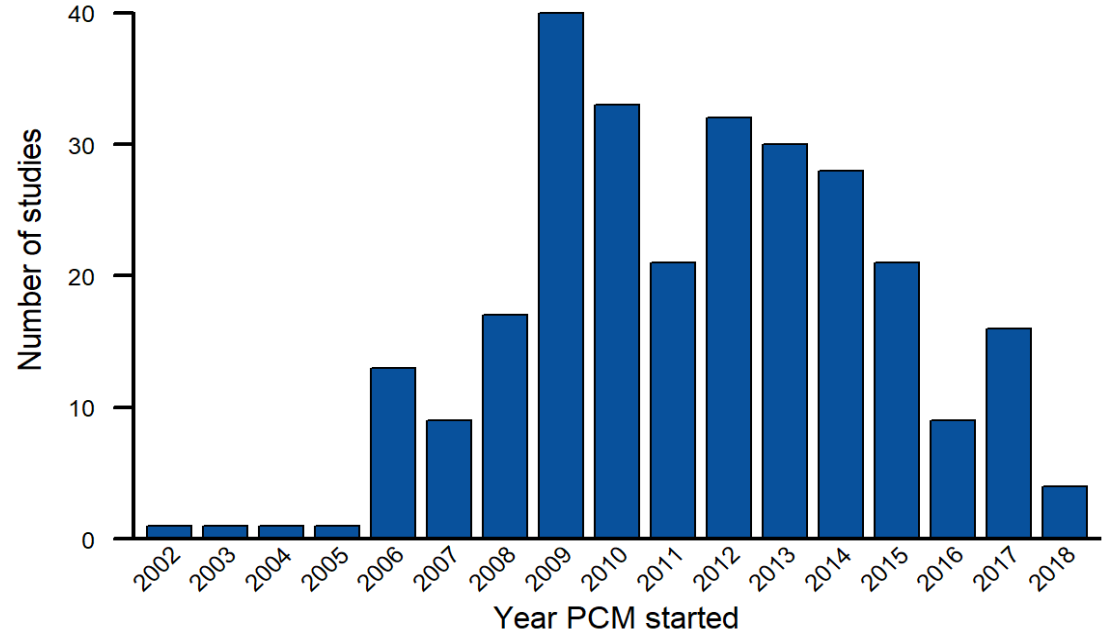


Figure 3. Fatality monitoring studies contained in AWWIC (N=275) by year monitoring occurred.

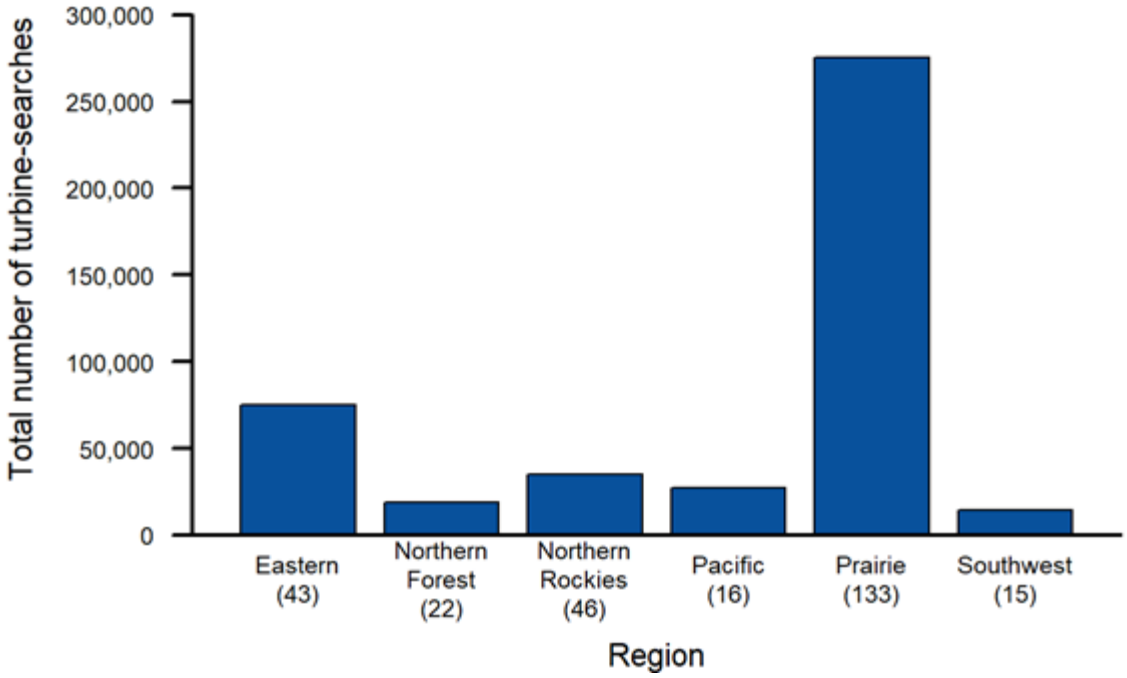


Figure 4. Total number of turbine-searches conducted during fatality monitoring studies by avifaunal biome (N=445,394). Each turbine-search is a scheduled visit by an observer to a turbine. The number of studies reporting for each region is indicated in parentheses.

Study Attributes

PCM studies vary in their search area(s), duration, and search interval. This section summarizes these parameters for the studies included in this report. Each of the figures and tables in this section may include data from a different number of studies because of variation in the consistency, quality, and requirements of reporting.

Search plots are either squares or circles centered around a turbine extending 33–200m from the base of each turbine. Plots are either full plots, a search of the roads and pads surrounding the turbines, or a combination of both types. In more recent studies, a measure of area searched and carcass fall distribution called density weighted proportion has been reported for search plots; as more of those data are collected and submitted to AWWIC, we will include that information in future editions of this report.

The frequency of turbine visits and the length of the study vary widely as biologists aim to ensure that peak activity periods are searched frequently enough to avoid carcasses being removed by local scavengers. Often, wind projects located in areas with snowfall are not monitored during winter months. It is common for carcass search intervals to be more frequent during periods of peak bird and bat fatality within the study period, and in some cases, plot types may change as well. Therefore, complex study designs are approximated in some cases to allow our data summaries to capture general patterns.

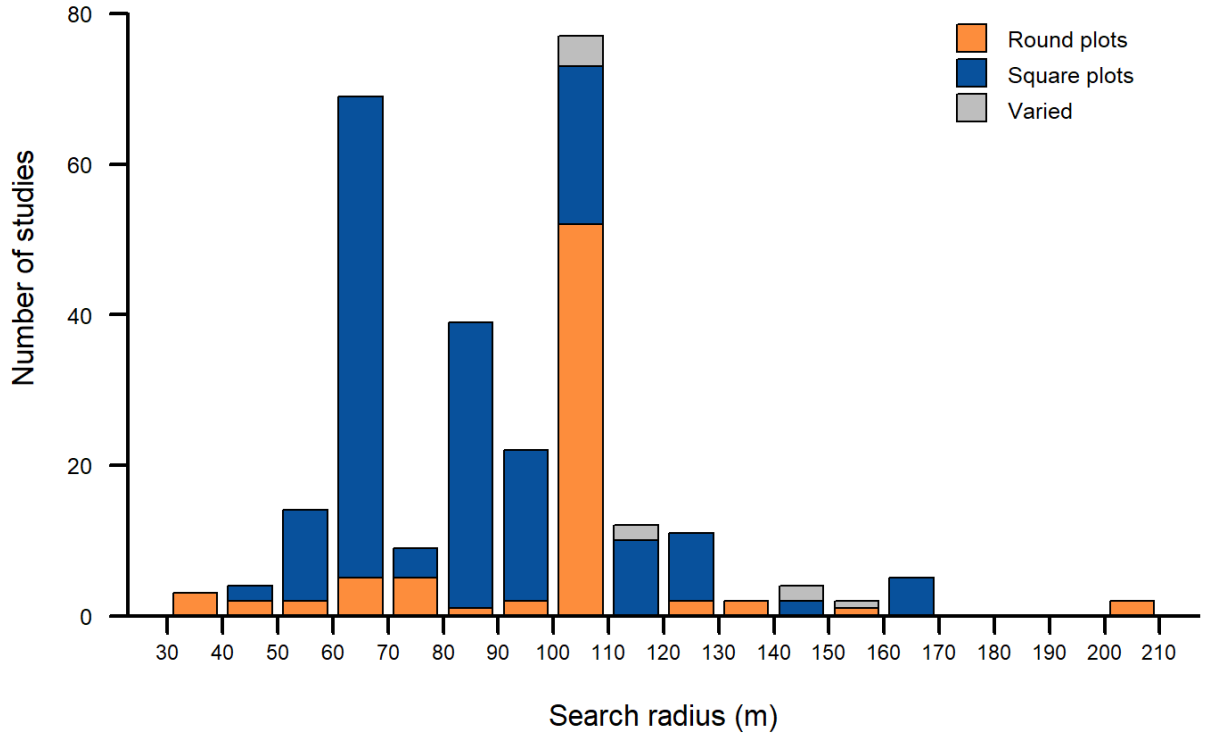


Figure 5. Frequency of plot size in meters around turbines searched during post-construction fatality monitoring (N=275 studies). Square plot radii are determined by the distance to the plot boundary from the turbine.

Table 2. Frequency of survey duration of post-construction fatality monitoring studies by avifaunal biome. Reported for the subset of 275 studies for which start and end dates are known.

Region name	< 6 months	6 - 11 months	Full year	> 1 year
Eastern	5	31	7	0
Northern Forest	8	14	0	0
Northern Rockies	0	13	27	6
Pacific	0	3	10	3
Prairie	13	61	49	10
Southwest	0	1	13	1
Totals	26	123	106	20

Table 3. Frequency of search intervals for scheduled carcass searches by avifaunal biome. Reported for a subset of 275 studies. When studies used variable search intervals in different seasons, a mean interval value for the entire study duration was used.

Region name	≤ 7 days	8 - 14 days	> 14 days
Eastern	39	2	2
Northern Forest	22	0	0
Northern Rockies	2	6	38
Pacific	8	4	4
Prairie	36	57	40
Southwest	3	11	1
Totals	110	80	85

Fatality Incidents

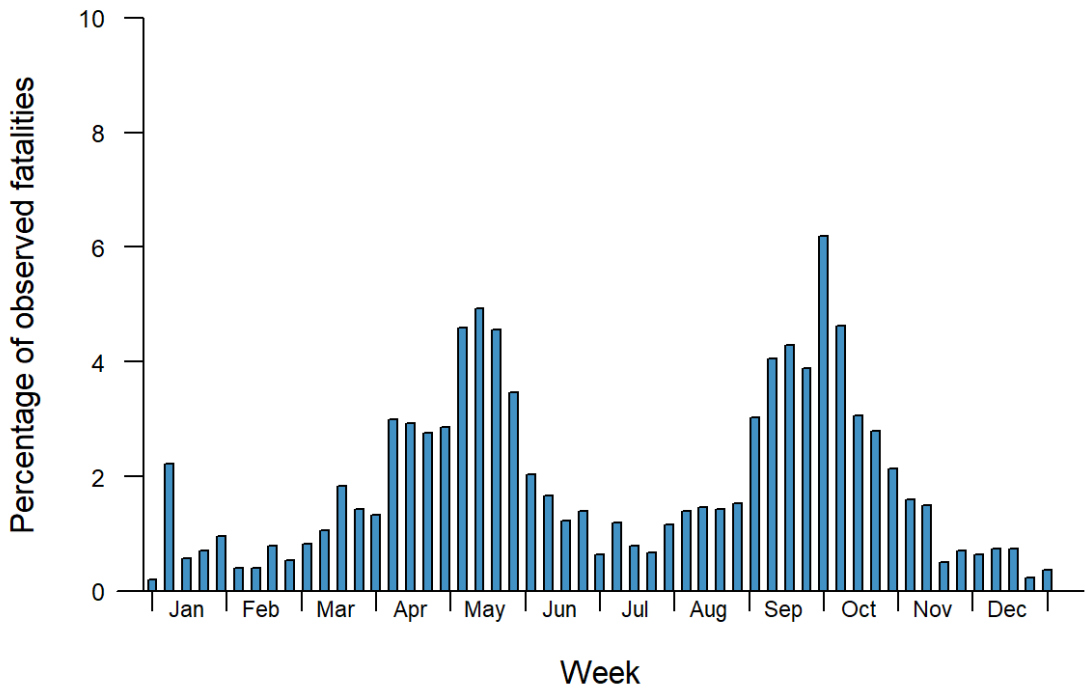
We define a fatality incident as a carcass discovered during a scheduled search of a turbine. Fatality incidents are the unadjusted raw data from which fatality estimates are derived. We summarize fatality incidents to evaluate the species composition of bird fatalities in different regions, to observe patterns in the timing of bird fatalities, and the distance from the turbine that carcasses are found. Each of the figures and tables in this section may be based on a different number of available studies because of variation in the consistency, quality, and requirements of reporting.

AWWIC contains 9,573 bird fatality incidents as reported in 274 PCM studies that provided data. Fatality incidents include 307 identified bird species. The most carcasses found at a single turbine over the course of a study was 53. The maximum number of carcasses found at a single turbine during a single search was 27, and 10 or more carcasses were found during a single search at 3 turbines (0.04% of all turbines searched).

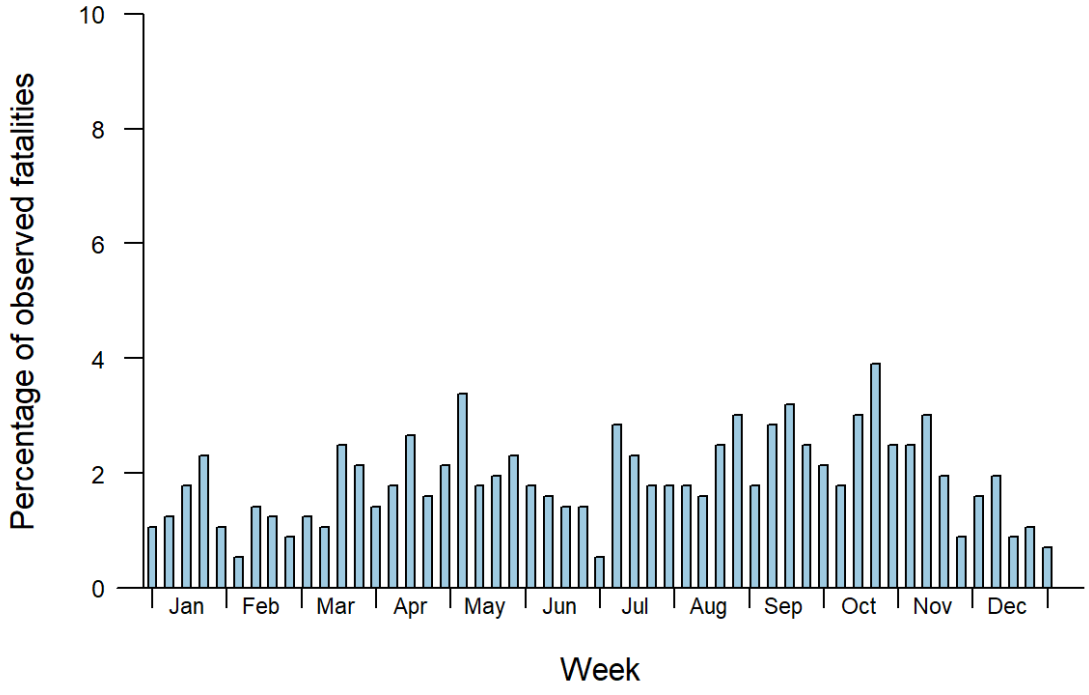
Specific dates for when incidents were found are available for 88.9% of incidents, and thus can provide information on variation in seasonal timing of bird fatalities. We present fatality timing for passerines and raptors separately to highlight the spring and fall fatality peaks in passerines and the more uniform distribution of raptor incidents throughout the year. Seasonal peaks in bird fatality vary in timing and duration among biomes with no discernable seasonality in Pacific and Northern Rockies biomes.

A subset of 99 studies that searched 100m or more from each turbine was used to summarize the fall distribution of carcasses. The available data indicate that approximately 60% of bird carcasses fall within 50m of the turbine –for contrast, 90% of bat carcasses fall within 50m of the turbine. Small birds and large bird carcasses have a similar fall distribution.

(a) Passerines



(b) Raptors



(c) All birds

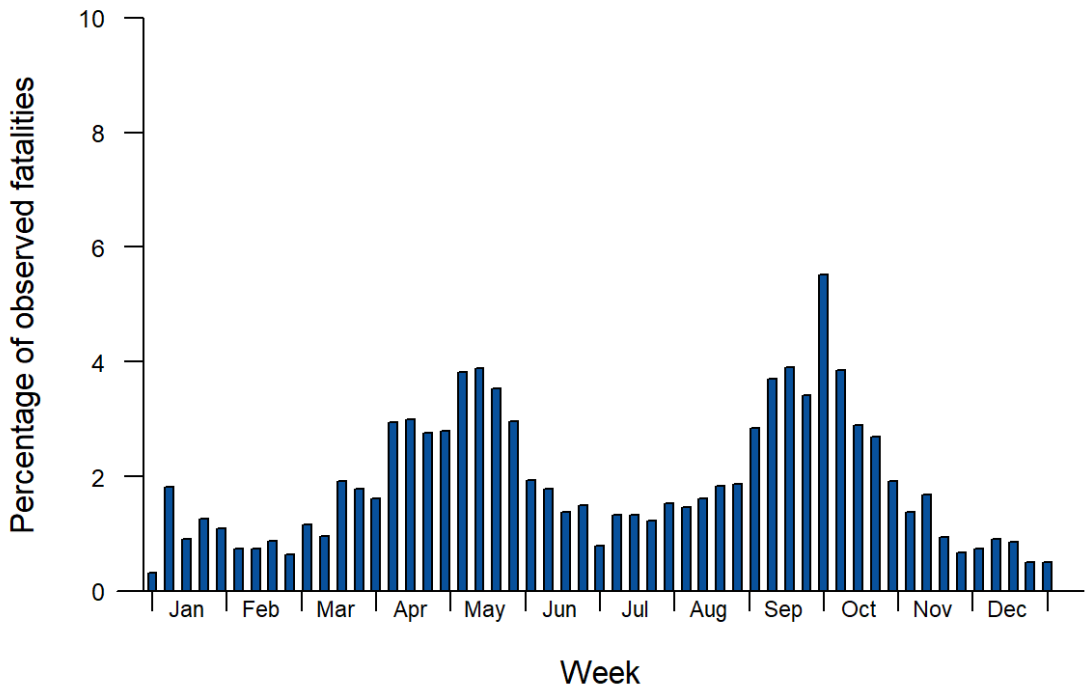


Figure 6. Distribution of bird fatality incidents aggregated by week (7-day intervals) for all U.S. wind energy projects where date of carcass discovery is known for (a) passerines (N=5,355), (b) raptors (N=970), and (c) all birds (N=8,512). Fatality incidents were recorded during scheduled carcass searches conducted at wind energy facilities and provided to AWWIC.

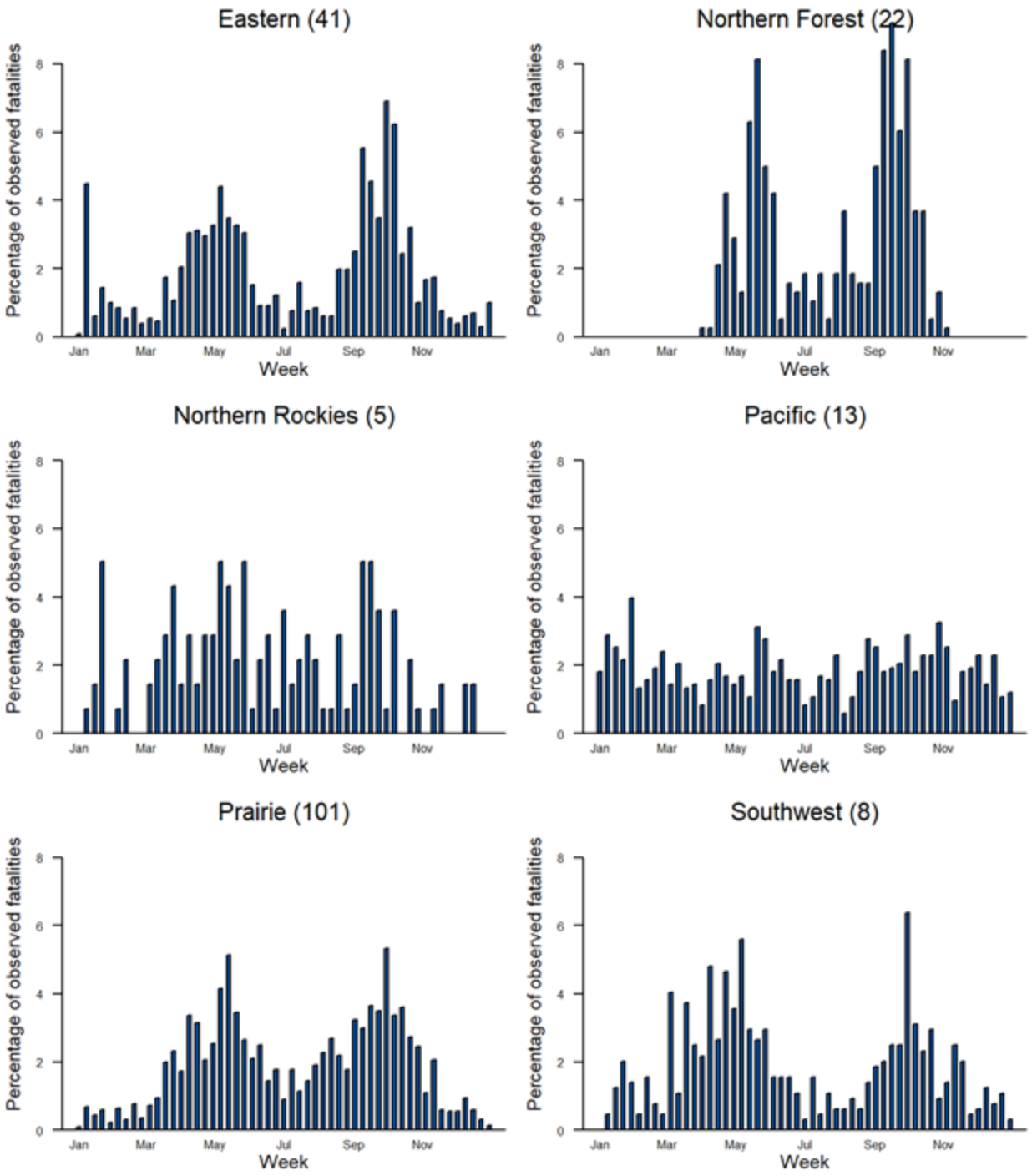


Figure 7. Distribution of all bird fatality incidents aggregated in weekly (seven-day) intervals for each avifaunal biome included in this analysis. Fatality incidents are recorded during scheduled searches of post-construction studies contained in AWWIC.

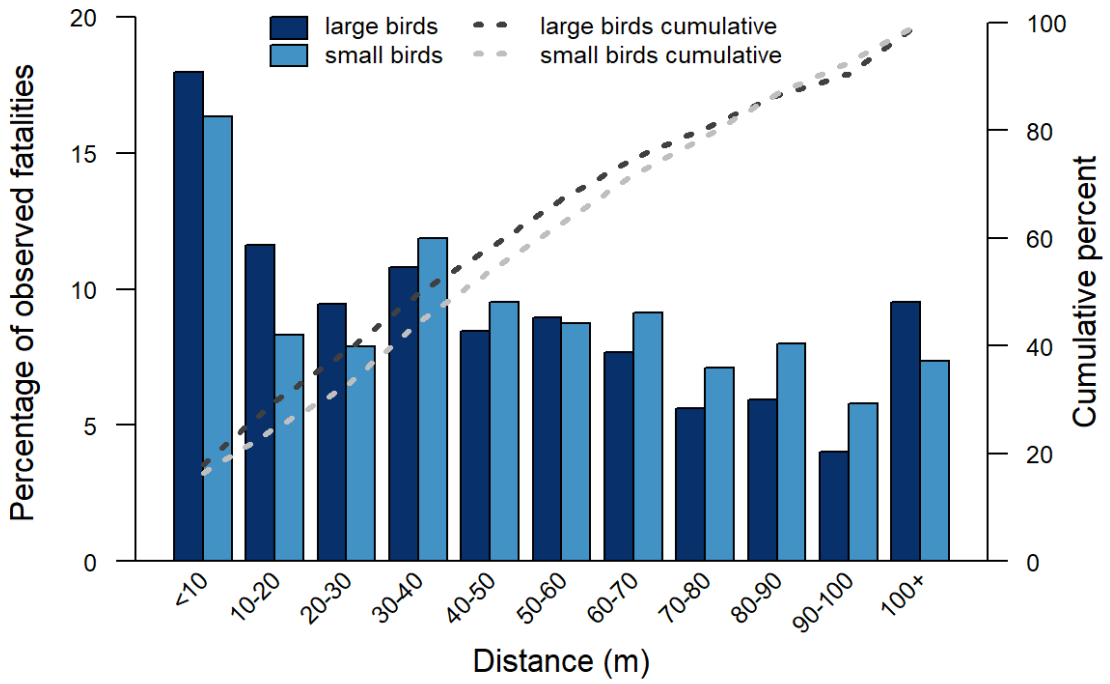


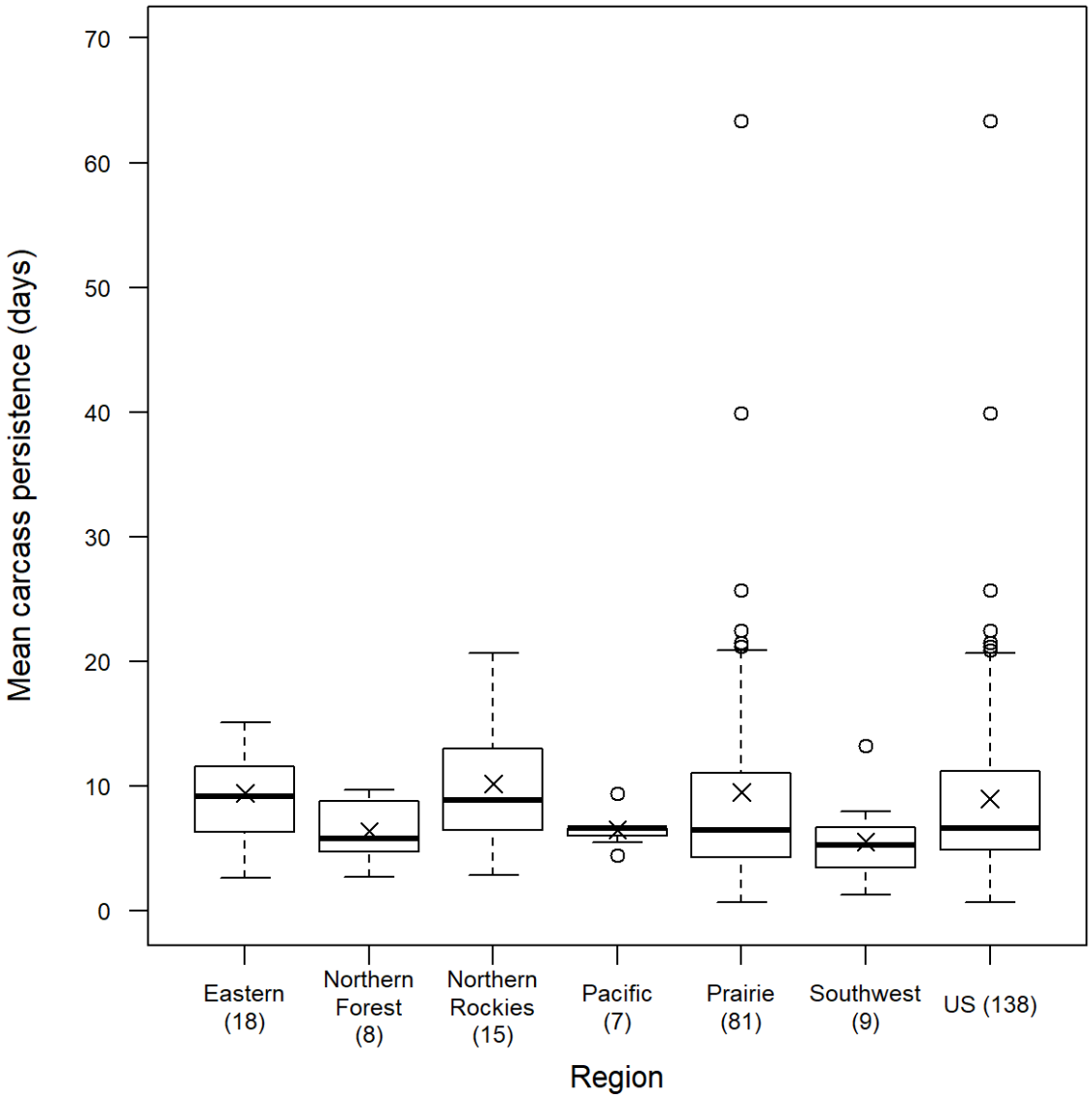
Figure 8. For 115 studies with search radius ≥ 100m, distance from the turbine tower of small bird carcasses (N=5,110) and large bird carcasses (N=1,918) found during scheduled carcass searches. Small birds defined as total length ≤ 30cm. Dashed line shows cumulative percentage (right axis) of carcasses found as distance from the turbine increases.

Bias Trials

Bias trials are conducted with bird carcasses or surrogates placed in search plots in a variety of visibility classes and seasons encompassing the study period. Separate trials are conducted for small birds and large birds in most studies. Each of the figures and tables in this section may have a different number of studies available because of variation in consistency, quality, or requirements of reporting. Descriptions of bias trial data types and collection are in the introduction section of this report.

Mean carcass persistence times reported for birds in AWWIC have a skewed distribution with a median of 7 days for small birds and 11 days for large birds. The median searcher efficiency reported by studies in AWWIC is 58% for small birds and 88% for large birds.

(a) Small birds



(b) Large birds

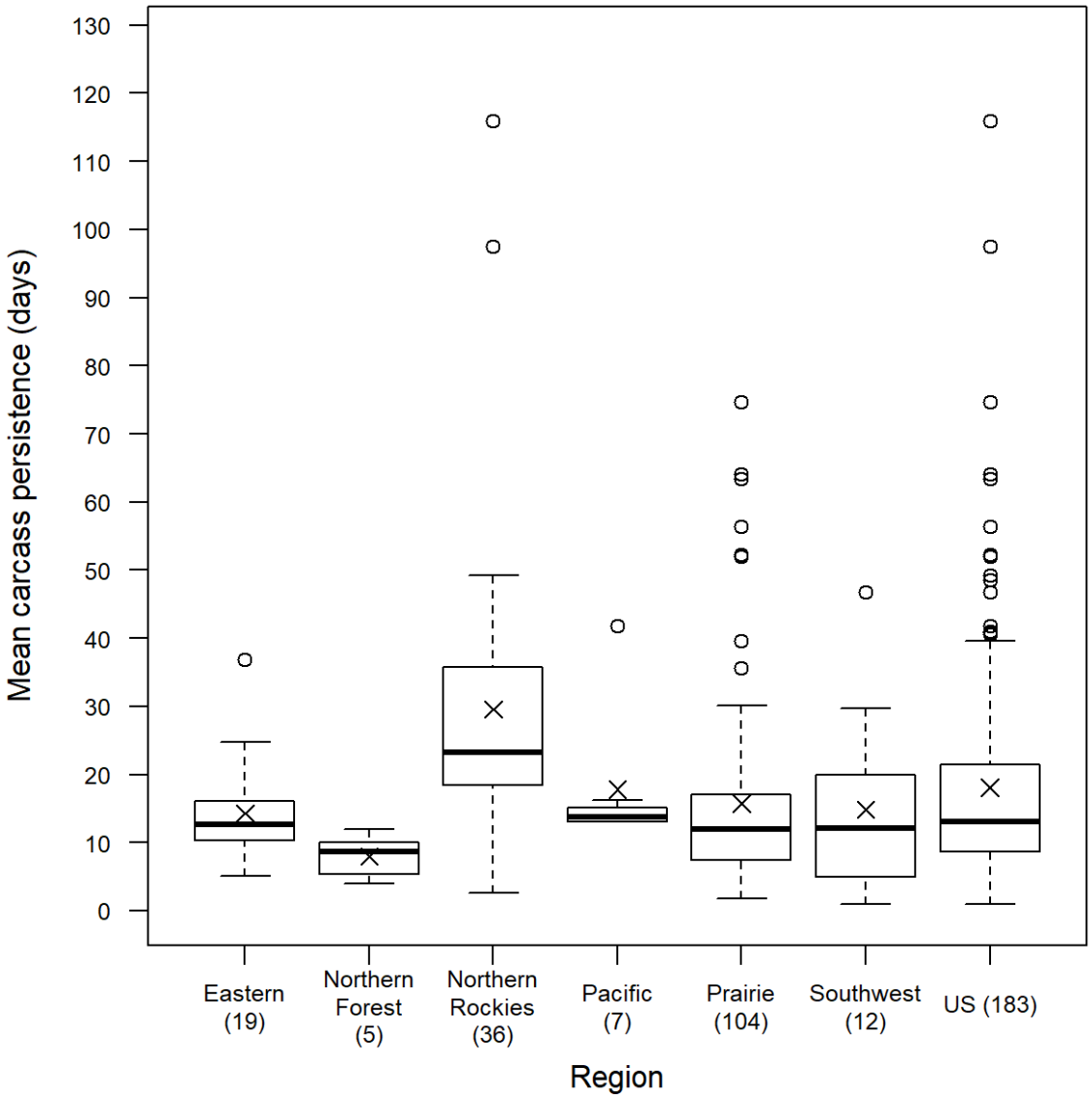
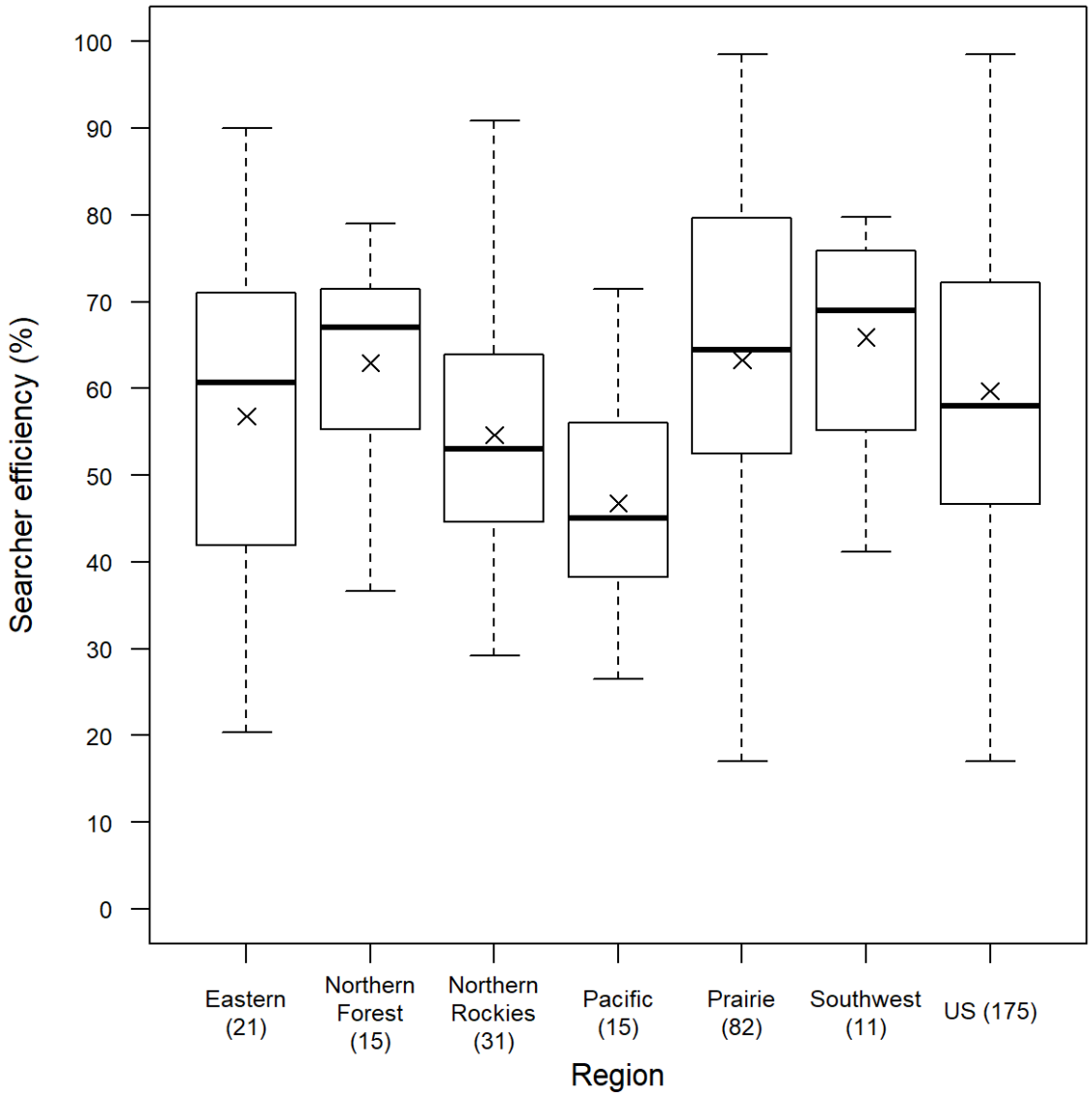


Figure 9. Estimated mean carcass persistence time by avifaunal biome for carcasses used in bias trials for adjusting raw carcass counts obtained during fatality monitoring. Number of studies available in each region is contained in parentheses. Boxplots show median and interquartile range; circles are defined as outliers and 'x' indicates mean value.

(a) Small birds



(b) Large birds

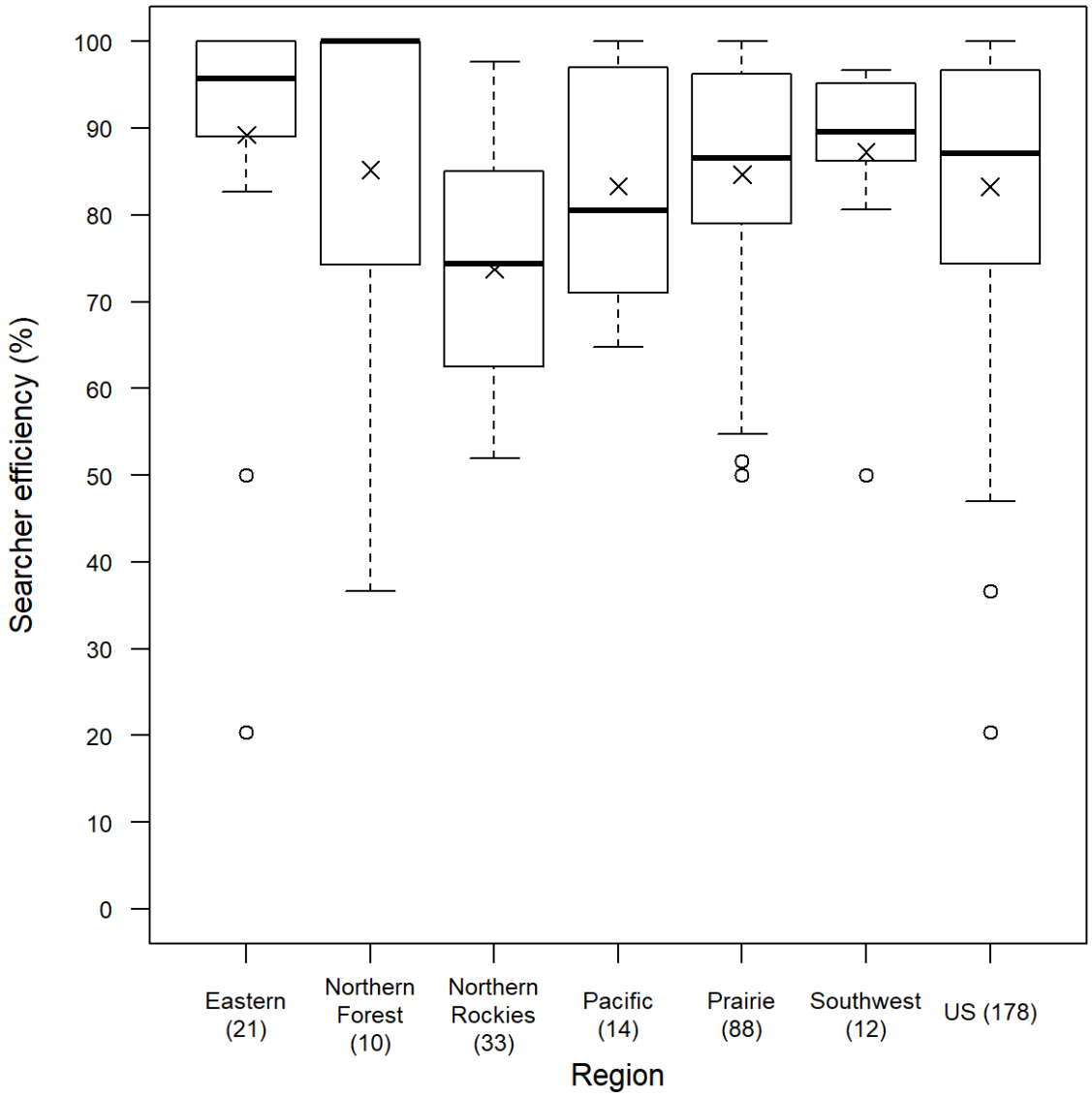


Figure 10. Estimated mean carcass persistence time by avifaunal biome for carcasses used in bias trials for adjusting raw carcass counts obtained during fatality monitoring. Number of studies available in each region is contained in parentheses. Boxplots show median and interquartile range; circles are defined as outliers and 'x' indicates mean value.

Species Composition of Fatality Incidents

Bird fatality estimates are typically only calculated for groups of species, i.e., small birds, large birds, or raptors, and not for individual species. However, an examination of the unadjusted species composition, especially within the groups describe previously, is useful in indicating which species may be at greater risk of turbine collisions. Data in this section are aggregated from results of 274 studies, and include 9,573 fatality incidents comprising 307 identified bird species. This incident summary does not include fatality incidents from studies where turbines are operating under a curtailment regime, i.e., rotor blades are experimentally restricted from spinning wind speeds below 6.9m/s. Incident data are aggregated by species and avifaunal biome. Incident data as reported are not adjusted for detection errors including a yet unknown variation in detectability among bird species.

Similar to Erickson et al. (2014), we have aggregated the percentage of reported fatality incidents into 19 bird groups (Table 5). These 19 bird groups correspond reasonably well to the major orders of North American birds potentially exposed to collisions at wind energy facilities. Of the groups, small passerines constitute the largest percentage of fatalities, followed by doves/pigeons, diurnal raptors, and upland game birds, in that order (Table 5). Percentages for each of these groups vary regionally, although small passerines are the most common in all regions. The representation of diurnal raptors is much higher in the Pacific biome, and representation of upland game birds was highest in the Northern Rockies and Southwest biomes.

Unidentified birds account for 10.6% of all incidents, or more than 1000 fatality incidents. Unidentified birds include all carcasses that could not be identified to species. Many studies have sub-divided the unidentified bird category further (e.g., unidentified passerine, small bird, large raptor); we have combined all of these carcasses into the single category of unidentified bird to avoid reporting uncertain data in this report.

Additional factors to consider when interpreting species composition include:

- Differences in detectability among species
- Under- or over-representation of data from avifaunal biomes
- Variation in local and migrant bird abundance in areas with turbines installed
- Background mortality being assumed as turbine fatalities

Fatality incidents are disproportionately distributed among a few species. The 15 most reported of the 307 species constitute 47.4% of all fatality incidents (Table 4). American kestrel (*Falco sparverius*) and red-tailed hawk (*Buteo jamaicensis*) are in the top ten most frequently reported bird fatalities and are the most frequently reported raptor fatalities across almost all avifaunal biomes. One hundred and nine species (35.5%) are represented in the database by ≤ 3 fatality incidents and cumulatively account for < 3% of all fatality incidents (Appendix B).

Table 4. Number and percentage of bird fatality incidents from scheduled searches. Species representing at least 1% of incidents are included. Frequency is the number of studies containing fatality incidents of each species. No incidents from studies investigating curtailment thresholds were included in this table. Incident numbers are not weighted by numbers of studies from different regions and these differences in regional representation likely influence percentages of incidents by species. See Appendix B1 for full species list.

Species	Number of incidents	Percentage of incidents	Frequency
Horned lark	1268	13.2	128
Mourning dove	531	5.5	114
Red-eyed vireo	377	3.9	81
Golden-crowned kinglet	362	3.8	95
Western meadowlark	324	3.4	58
Red-tailed hawk	240	2.5	95
American kestrel	228	2.4	56
Turkey vulture	219	2.3	70
Killdeer	175	1.8	54
Red-winged blackbird	164	1.7	35
European starling	155	1.6	77
Ruby-crowned kinglet	149	1.6	74
Ring-necked pheasant	130	1.4	51
Rock pigeon	116	1.2	58
Savannah sparrow	109	1.1	39
Other species (292)	3647	36.6	265
Unknown	1379	14.4	211
Total	9573	100	274

Table 5. Percent composition of unadjusted bird fatality incidents for bird groups by avifaunal biome from studies conducted at wind facilities in the U.S. and contained in AWWIC. Number of studies is in parentheses. Region totals are the total number of incidents recorded in each region. (continued below).

Bird Group	Eastern (42)	Northern Forest (22)	Northern Rockies (46)	Pacific (16)	Prairie (133)	Southwest (15)	Total US (274)
Small passerines	57.4	87.8	62.4	51.9	56.3	46.8	57.7
Doves/pigeons	6.5	0.9	5.3	8.4	5.6	18.6	7
Diurnal raptors	3.1	1.1	5.4	21.7	4.8	4.5	6.9
Upland game birds	2.2	2.2	9.1	1.4	4.2	5.3	4.2
Vultures	2.6	0.4	0.1	1.6	4.2	0.8	2.4
Shorebirds	2.3	0.4	0.3	0.6	4.4	0.7	2.3
Waterfowl	1.3	0.7	3.6	1.5	2.3	0.8	2
Rails/coots	0.5	--	0.9	3.3	1.5	0.6	1.4
Large cuckoos	2.8	0.6	--	--	1.4	1.3	1.1
Owls	0.3	--	1.6	2.8	0.5	0.6	1
Woodpeckers	0.5	2.4	1.3	0.6	0.7	0.8	0.8
Swifts/hummingbirds	0.6	0.6	0.3	0.6	0.6	1.2	0.6
Gulls/terns	2.2	--	--	1	<0.1	--	0.5
Goatsuckers	0.3	--	0.8	0.1	0.5	1.6	0.5
Large corvids	0.4	0.4	0.8	0.2	0.2	0.7	0.4

Loons/grebes	0.1	--	0.7	0.2	0.4	0.1	0.3
Waterbirds	0.8	0.2	0.1	0.3	0.2	0.2	0.3
Domestic	--	--	--	--	<0.1	0.2	<0.1
Kingfishers	--	0.2	--	--	<0.1	--	<0.1
Unidentified bird	16.1	2.3	7.2	3.9	12.3	15.1	10.6
Region totals	1557	542	1436	1427	3756	849	9567

Fatality Estimates

Bird fatality estimates from studies included in this report were calculated after cumulative raw carcass counts were adjusted for detection biases as described earlier and are "as reported." No additional adjustments were made to account for differences in sampling period, plot size, or estimator used. If comparison of fatality estimates between regions is desired in future analyses, we recommend adjusting for these methodological differences whenever possible.

For studies that reported multiple adjusted fatality estimates, we used the following criteria adapted from Thompson et al. (2017). We chose the adjusted estimate that was based on:

1. Largest plot size
2. Longest survey duration
3. Greatest number of turbines sampled
4. Greatest number of total searches
5. If more than one estimator was used to calculate adjusted fatality estimates, the estimates were selected in the following sequence - Huso ----> Shoenfeld ----> Others
6. All else being equal, we chose the highest adjusted estimate

Bird fatality estimates were plotted to observe their distribution and variability among biomes for all birds, small birds (< 30 cm total length), large birds (≥ 30 cm total length), and raptors. Not all studies provided estimates for these categories, and a minimum of five studies was required to include a biome in the summary for each group. Estimates are presented as fatalities per MW per year (or study period) where MW is based on the rated power production capacity of the turbine, not the actual power produced.

After applying our selection criteria, this report contains 196 projects and 275 studies with estimates available to use. The pool of studies available for analysis of fatality rates is typically greater than the pool for fatality incidents because some studies did not report fatality incidents. The median fatality estimate for all birds in the U.S. is 1.4 birds per MW per year and 2.2 per turbine per year. Summary statistics are available in Appendix B for both per MW and per turbine values.

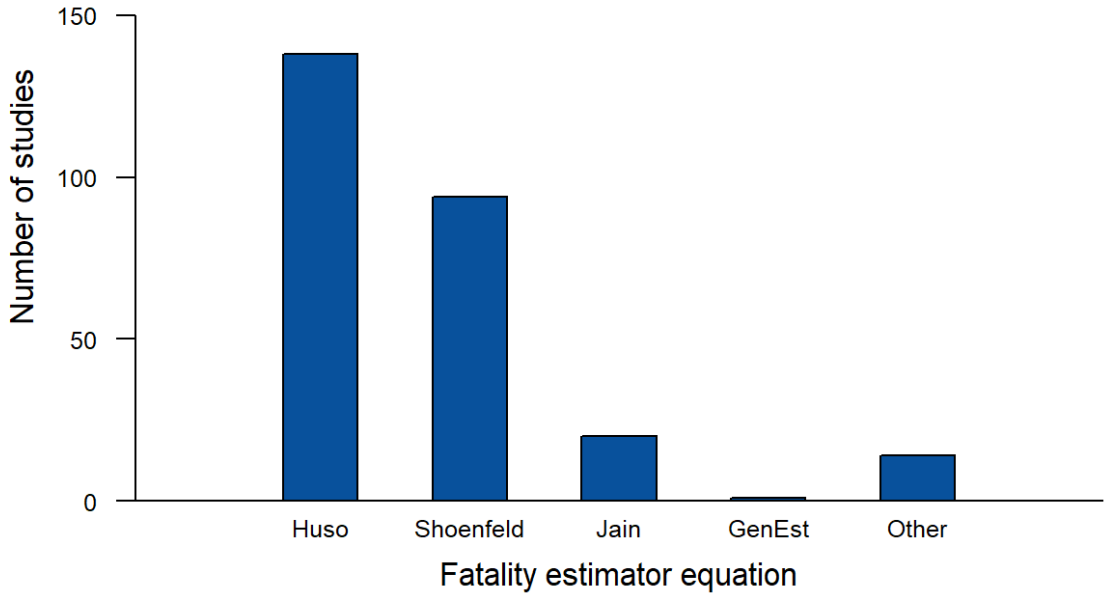


Figure 11. Frequency of fatality estimator equation used to adjust fatality estimates of post-construction studies contained in AWWIC.

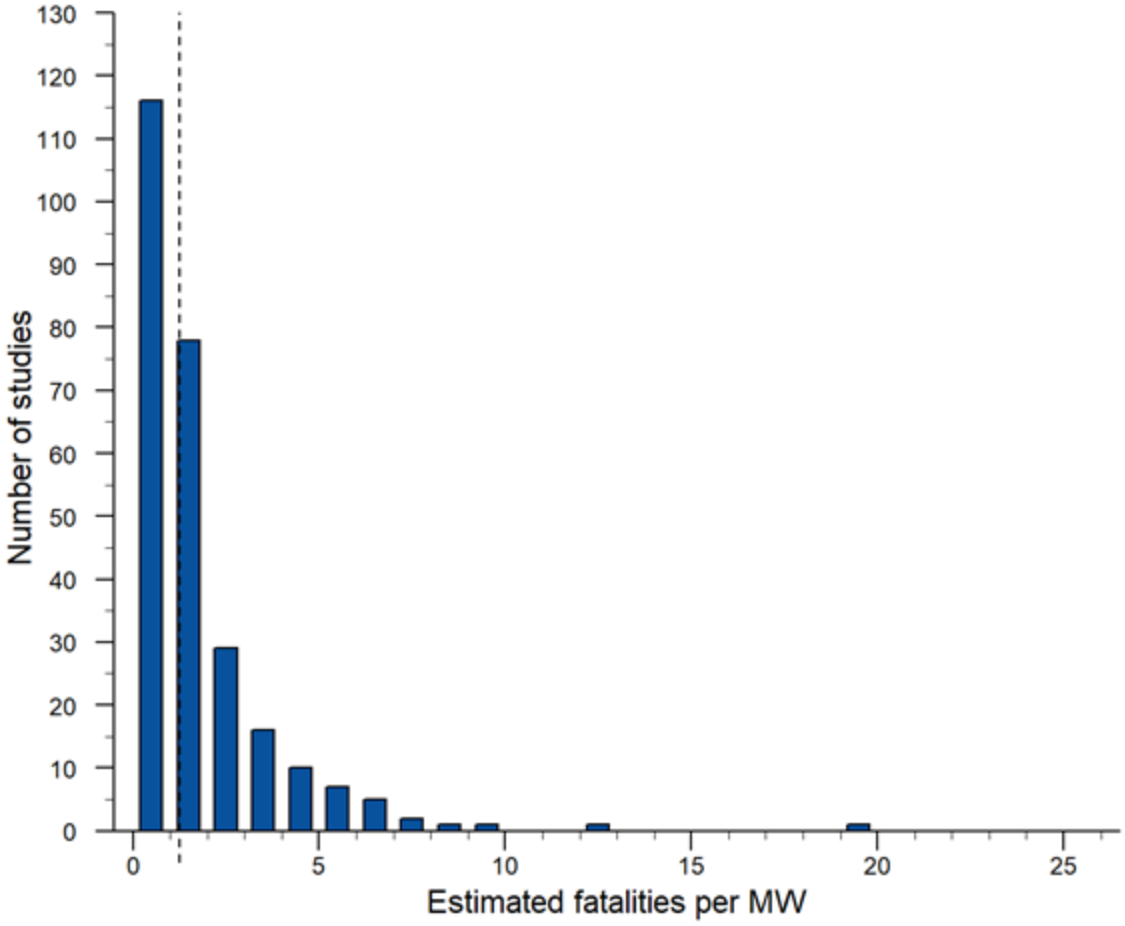
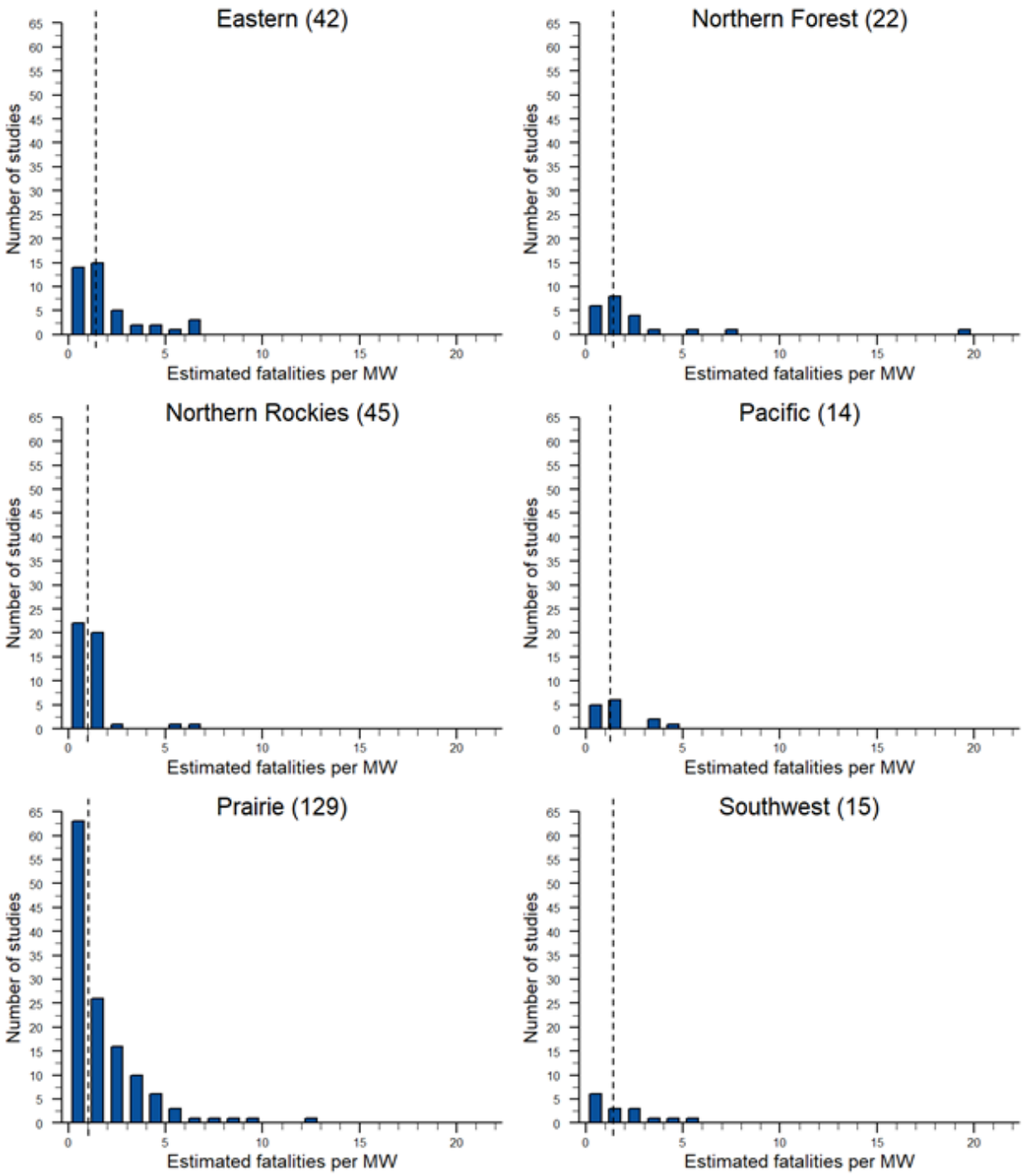
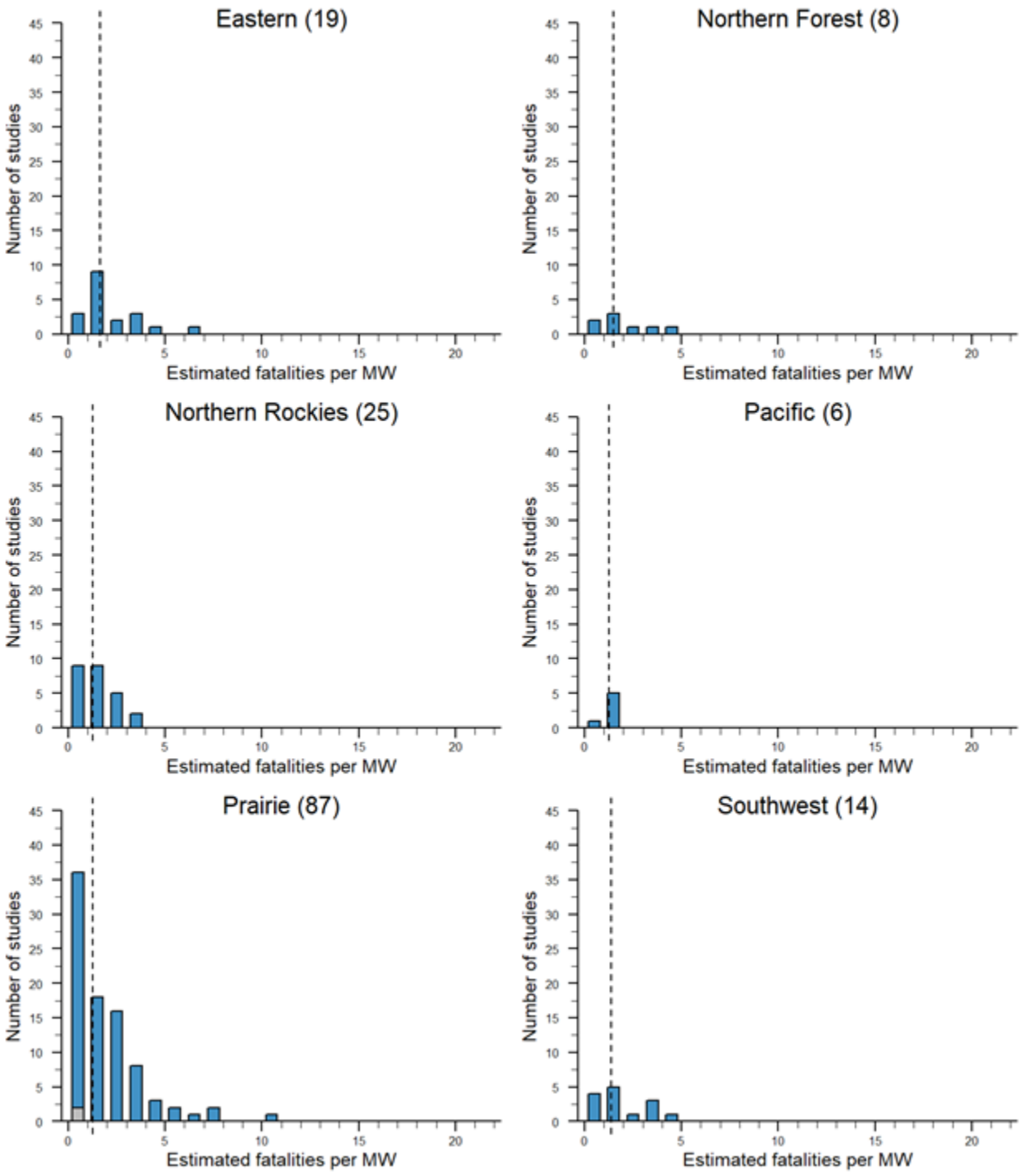


Figure 12. Estimated bird fatalities per installed MW per year from post-construction studies contained in AWWIC. Estimates are presented as reported and not standardized for differences in study methodology. Vertical dashed line indicates median fatality rate.

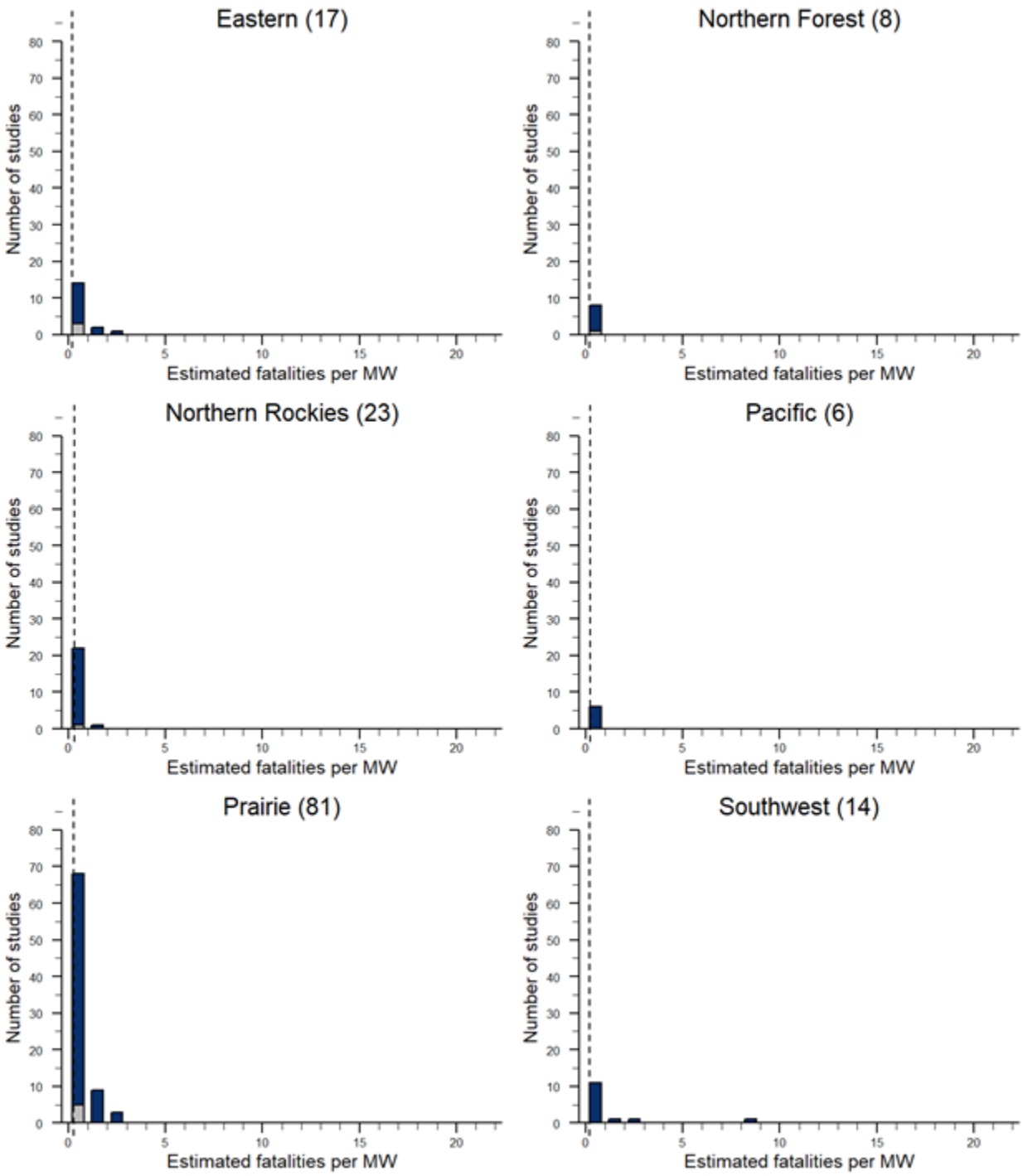
(a) All birds


Eastern (42)
Northern Forest (22)
Northern Rockies (45)
Pacific (14)
Prairie (129)
Southwest (15)
Number of studies
Estimated fatalities per MW

(b) Small birds



(c) Large birds



(d) Raptors

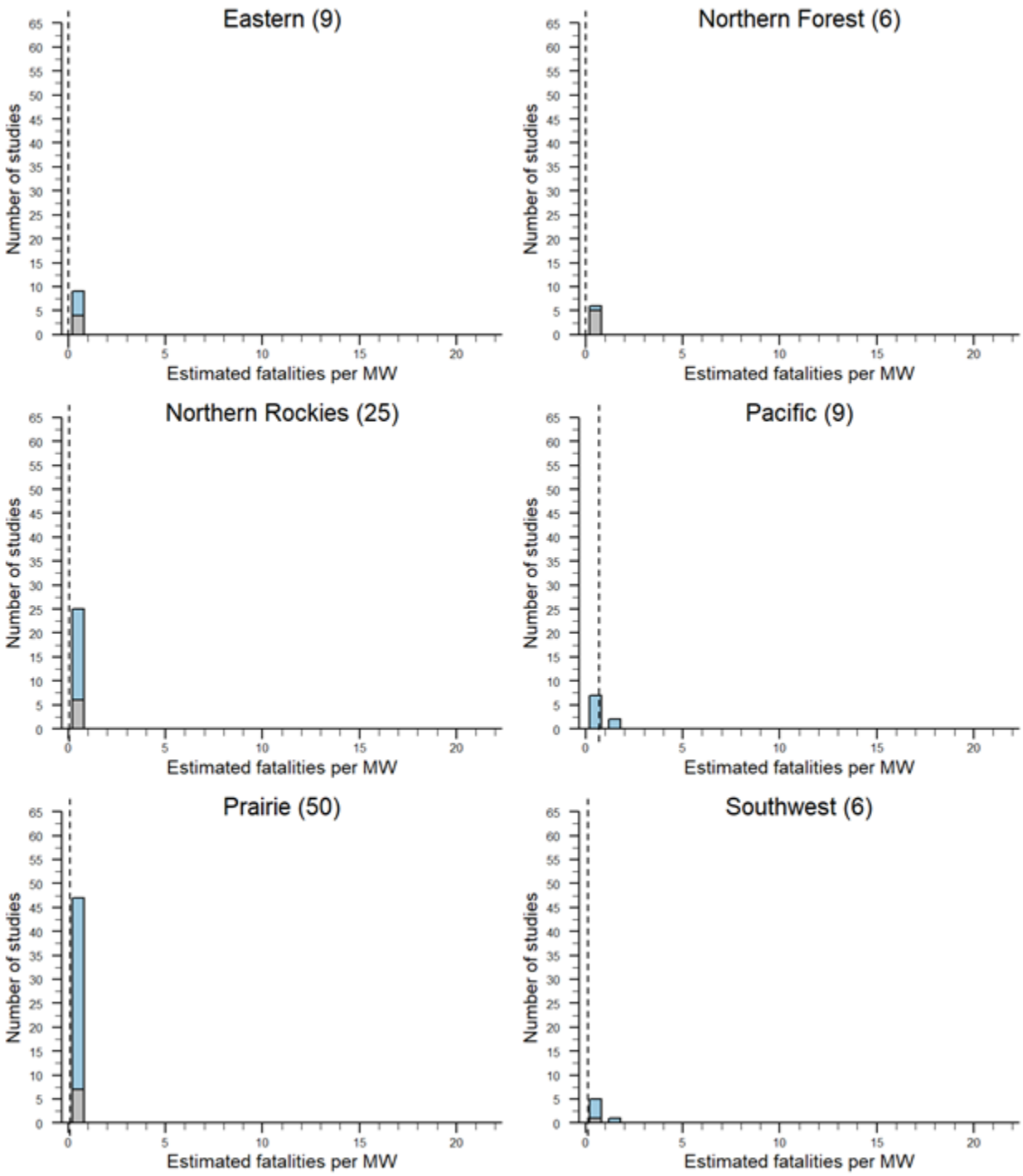


Figure 13. Estimated bird fatalities per installed MW per year by avifaunal biome from post-construction studies contained in AWWIC. Estimates are presented as reported and not standardized for differences in study methodology. Number of studies available in each region is contained in parentheses. Vertical dashed line indicates median fatality rate. Gray bar indicates number of studies reporting zero fatalities. See Appendix A1 for tables of summary statistics.

Conclusions

Results presented in this updated summary of AWWIC bird fatality data remain consistent with conclusions from previous comprehensive assessments of publicly available data (Loss et al. 2013, Erickson et al. 2014) and the first edition of this report. Although containing more data than previous assessments, the AWWIC database comprises a non-random dataset, where representation varies among defined geographic regions and where systematic differences in protocols among studies likely influence detection. Thus, any conclusions about patterns should be considered tentative or as potential hypotheses explaining variation in regional and species-specific collision risk among bird species. The primary findings were:

- A few species, e.g., horned lark, have consistently presented high numbers of fatality incidents, likely reflecting the over-representation of studies within the species ranges
- Hundreds of North American bird species are only rarely represented or have yet to be found as fatality incidents at wind energy facilities
- Because of their life history attributes of low adult mortality and reproductive potential, the impact of collisions on raptors are of concern. Representation in AWWIC varied among species in this group and additional analysis, including data from underrepresented regions, would be useful in evaluating whether this variation in representation was related to variation in collision risk among raptor species

Notable Results in 2nd Edition

The additional data has sharpened our picture of patterns in bird fatalities and highlighted observed differences in the patterns of bird and bat fatalities (as described in the 2nd Edition of the Bat Technical Report: https://awwi.org/resources/awwic-bat-technical-report/). We can expect to see some changes in data summaries reported in this edition with the addition of new studies to AWWIC, especially from under-represented regions. Changes that emerged in 2nd edition of this Technical Report include:

- Additional reports added 28 new species to the list of those that have been found as collision fatalities (Appendix B). This ~10% increase in the species list was coincident with a 61% increase in the number of searches in AWWIC.
- Most of the species had only 1 or 2 incidents. The results suggest that further studies and search effort, especially in under-represented regions, would add species to the list, but there will be a "diminishing return" in finding new species.
- The rank order of fatality incidents by species or bird guild remained roughly the same, both nationally and across regions, although the proportion of diurnal raptors was reduced.
- The timing of all-bird fatalities nationally and in some avifaunal biomes shows two distinct seasonal peaks associated with spring and fall migration, while some biomes show no seasonality in the timing of reported fatalities.
- The number of studies and fatality incidents has increased substantially providing a more robust picture of the dispersion of bird fatalities around turbines. Interestingly, there is no apparent difference in the dispersion of large and small birds. For 80m plots, the data indicate that approximately 20% of bird carcasses will fall beyond the plot limits as compared to observed ~2% of bat carcasses

Literature Cited

American Wind Energy Association (AWEA). 2016. U.S. Wind Industry Fourth Quarter 2016 Market Report. American Wind Energy Association. Available at: https://www.awea.org/resources/publications-and-reports/market-reports/2016-u-s-wind-industry-market-reports.

American Wind Wildlife Institute (AWWI). 2018. Bats and Wind Energy: Impacts, Mitigation, and Tradeoffs. Washington, DC.

Huso, M., D. Dalthorp, T. J. Miller, and D. Bruns. 2016. Wind energy development: methods to assess bird and bat fatality rates post- construction. Human–Wildlife Interactions 10.

Loss, S. R., T. Will, and P. P. Marra. 2013. Estimates of bird collision mortality at wind facilities in the contiguous United States. Biological Conservation 168:201–209.

North American Bird Conservation Initiative (NABCI). 2018. Bird conservation regions. Available at: http://nabci-us.org/resources/bird-conservation-regions/.

Rich, T., C. Beardmore, H. Berlanga, P. Blancher, M. Bradstreet, G. S. Butcher, D. W. Demarest, E. H. Dunn, W. C. Hunter, E. E. Iñigo-Elias, J. A. Kennedy, A. M. Martell, A. O. Panjabi, D. N. Pashley, K. V. Rosenberg, C. M. Rustay, J. S. Wendt, and T. C. Will. 2004. Partners in Flight North American Landbird Conservation Plan. Cornell Lab of Ornithology. Ithaca, NY. Available at: https://www.partnersinflight.org/resources/north-american-landbird-conservation-plan/.

Smallwood, K. S. 2013. Comparing bird and bat fatality-rate estimates among North American wind-energy projects. Wildlife Society Bulletin 37:19–33.

Strickland, M. D., E. B. Arnett, W. P. Erickson, D. H. Johnson, M. L. Morrison, J. A. Shaffer, and W. Warren-Hicks. 2011. Comprehensive Guide to Studying Wind Energy/Wildlife Interactions. Washington DC USA.

Thompson, M., J. A. Beston, M. Etterson, J. E. Diffendorfer, and S. R. Loss. 2017. Factors associated with bat mortality at wind energy facilities in the United States. Biological Conservation 215:241–245.

Appendix A. Data Fields Contained in AWWIC

Project Site Information	
	Site Size
	USFWS Region
	EPA Level III Ecoregion
	Bird Conservation Region
	Landscape Types (e.g. row crop, forested, grassland)
	Year Operations Started
	Turbine Details (e.g. make, model, size)
	# Turbines
Fatality Estimates	
Study Protocols	**Study Start/End Date**
	Search Interval (weekly, monthly, etc.)
	# Turbines Searched
	Plot Dimensions
Fatality Estimates	**Fatality Estimate Group** (e.g. bird, bat, large bird)
	Estimator Used (e.g. Shoenfeld, Empirical Pi, Huso)
	Estimated Fatalities per MW & per Turbine
	Fatality Estimate Confidence Intervals
Bias Trials	**Searcher Efficiency Specimen Type**
	SE: # placed, # available, # found, %found
	Carcass Removal Trial Specimen Type
	CR: # trials, # specimens placed, mean removal time, % remaining
Fatality Incidents	
	Species
	How Found (Scheduled Search, Cleanup Find, Incidental Find, Other)
	Action Taken (Collected, Released, Euthanized, Transported, None)
	Date Found
	Location Type (Turbine, Power Line, Met Tower, Other, N/A)
	Distance and Bearing from Turbine
	Nearest Turbine
	Find Type (Large Bird, Small Bird, Bat, Other)
	Sex
	Age (Adult, Juvenile, Unknown)
	Condition (Intact, Partial, Dismembered, Feather Spots, Other)
	Scavenged By (None, Carnivores, Corvids, Insects, Other, Unknown)
	Decomposition
	Est. Time Since Death
	Possible Cause (Turbine Collision, Non-turbine Collision, Unknown)

Appendix B. Fatality Estimate Summary Statistics

Table B1. Summary statistics of estimated bird fatalities per MW by avifaunal biome. Estimates are based on post-construction studies contained in AWWIC and are not standardized for differences in study methodology. Number of studies available in each region is contained in parentheses.

(a) All birds

Region	Mean	25th percentile	Median	75th percentile
Eastern (42)	2	0.85	1.43	2.2
Northern Forest (22)	2.77	0.97	1.43	2.63
Northern Rockies (45)	1.22	0.56	1.01	1.48
Pacific (14)	1.72	0.91	1.25	1.89
Prairie (129)	1.83	0.46	1.02	2.48
Southwest (15)	1.87	0.71	1.42	2.48
U.S. (267)	1.83	0.63	1.26	2.28

(b) Small birds

Region	Mean	25th percentile	Median	75th percentile
Eastern (19)	2.09	1.12	1.64	3
Northern Forest (8)	1.98	0.92	1.5	2.75
Northern Rockies (25)	1.44	0.45	1.28	2.03
Pacific (6)	1.23	1.2	1.25	1.45
Prairie (87)	1.86	0.49	1.27	2.58
Southwest (14)	1.88	1.04	1.36	2.94
U.S. (159)	1.8	0.61	1.31	2.53

(c) Large birds

Region	Mean	25th percentile	Median	75th percentile
Eastern (17)	0.48	0.14	0.19	0.5
Northern Forest (8)	0.25	0.08	0.19	0.38
Northern Rockies (23)	0.34	0.13	0.31	0.44

Pacific (6)	0.28	0.2	0.23	0.29
Prairie (80)	0.53	0.13	0.27	0.77
Southwest (14)	1.01	0.15	0.19	0.4
U.S. (148)	0.51	0.14	0.24	0.55

(d) Raptors

Region	Mean	25th percentile	Median	75th percentile
Eastern (9)	0.05	0	0.01	0.06
Northern Forest (6)	0.04	0	0	0
Northern Rockies (25)	0.08	0.03	0.06	0.12
Pacific (9)	0.66	0.42	0.69	0.95
Prairie (47)	0.11	0.03	0.07	0.2
Southwest (6)	0.33	0.05	0.11	0.15
U.S. (102)	0.16	0.01	0.06	0.2

Table B2. Summary statistics of estimated bird fatalities per turbine by avifaunal biome. Estimates are based on post-construction studies contained in AWWIC and are not standardized for differences in study methodology. Number of studies available in each region is contained in parentheses.

(a) All birds

Region	Mean	25th percentile	Median	75th percentile
Eastern (42)	3.91	1.38	2.95	5.19
Northern Forest (22)	4.47	1.53	2.35	4.3
Northern Rockies (45)	2.16	1.3	1.87	2.4
Pacific (14)	3.54	1.62	2.76	4.35
Prairie (129)	3.52	0.84	2.18	5.26
Southwest (15)	3.42	1.58	2.13	5.37
U.S. (267)	3.43	1.16	2.18	4.47

(b) Small birds

Region	Mean	25th percentile	Median	75th percentile
Eastern (19)	4.25	2.24	2.53	5.61
Northern Forest (8)	3.14	1.46	2.24	4.41
Northern Rockies (25)	2.33	0.72	1.92	2.98
Pacific (6)	2.5	2.42	2.55	2.98
Prairie (87)	3.71	0.82	2.58	5.18
Southwest (14)	3.74	2.12	2.69	5.57
U.S. (159)	3.48	1.11	2.5	4.64

(c) Large birds

Region	Mean	25th percentile	Median	75th percentile
Eastern (17)	0.96	0.25	0.35	1.15
Northern Forest (8)	0.4	0.13	0.29	0.68
Northern Rockies (23)	0.77	0.27	0.54	0.97
Pacific (6)	0.56	0.42	0.54	0.6
Prairie (80)	1.1	0.25	0.56	1.41

Southwest (14)	2.1	0.27	0.38	1.02
U.S. (148)	1.07	0.25	0.5	1.16

(d) Raptors

Region	Mean	25th percentile	Median	75th percentile
Eastern (9)	0.1	0	0.02	0.09
Northern Forest (6)	0.07	0	0	0
Northern Rockies (25)	0.15	0.06	0.11	0.18
Pacific (9)	1.41	0.63	1.59	2.16
Prairie (47)	0.21	0.05	0.13	0.36
Southwest (6)	0.67	0.1	0.23	0.34
U.S. (102)	0.31	0.02	0.12	0.36

Appendix C. Full Species List

Table C1. Number and percentage of bird fatality incidents contained in AWWIC for all bird species reported from all available scheduled searches. Frequency is the number of studies containing fatality incidents of each species. No incidents from projects using curtailment at low wind speeds were included in this table. Incident numbers are not weighted by numbers of studies from different regions, and these differences in regional representation likely influence percentages of incidents by species.

Species	Number of incidents	Percentage of incidents	Frequency
Horned lark	1268	13.2	128
Mourning dove	531	5.5	114
Red-eyed vireo	377	3.9	81
Golden-crowned kinglet	362	3.8	95
Western meadowlark	324	3.4	58
Red-tailed hawk	240	2.5	95
American kestrel	228	2.4	56
Turkey vulture	219	2.3	70
Killdeer	175	1.8	54
Red-winged blackbird	164	1.7	35
European starling	155	1.6	77
Ruby-crowned kinglet	149	1.6	74
Ring-necked pheasant	130	1.4	51
Rock pigeon	116	1.2	58
Savannah sparrow	109	1.1	39
Magnolia warbler	90	0.9	39
Yellow-rumped warbler	89	0.9	51
Gray partridge	85	0.9	27
American coot	81	0.8	36
Yellow-billed cuckoo	76	0.8	33

Northern bobwhite	72	0.8	18
Tree swallow	64	0.7	35
Dark-eyed junco	56	0.6	37
Yellow warbler	54	0.6	40
House wren	52	0.5	37
Swainson's hawk	52	0.5	28
Mallard	51	0.5	32
Wilson's warbler	51	0.5	31
House sparrow	48	0.5	31
Barn owl	45	0.5	25
Northern flicker	45	0.5	39
American robin	43	0.4	35
Cliff swallow	43	0.4	25
Blackpoll warbler	42	0.4	13
Yellow-breasted chat	41	0.4	8
Common yellowthroat	39	0.4	31
Brewer's blackbird	38	0.4	13
Chukar	38	0.4	15
American redstart	37	0.4	21
Common nighthawk	37	0.4	15
Chipping sparrow	36	0.4	31
Vesper sparrow	35	0.4	25
Townsend's warbler	34	0.4	18
Northern parula	33	0.3	20
Nashville warbler	32	0.3	16
Sedge wren	32	0.3	17

Grasshopper sparrow	31	0.3	15
Black-throated green warbler	29	0.3	17
Blue-headed vireo	27	0.3	21
Ovenbird	27	0.3	18
Sora	27	0.3	22
Black-and-white warbler	26	0.3	20
Black-throated blue warbler	26	0.3	18
Tennessee warbler	26	0.3	18
Lincoln's sparrow	25	0.3	21
Wild turkey	25	0.3	13
Barn swallow	24	0.3	18
Brown-headed cowbird	24	0.3	21
Song sparrow	23	0.2	21
Brown creeper	22	0.2	16
Lark bunting	22	0.2	14
Blackburnian warbler	21	0.2	16
Dickcissel	21	0.2	15
Gray catbird	21	0.2	16
Purple martin	21	0.2	16
White-crowned sparrow	21	0.2	16
Wood thrush	21	0.2	9
American pipit	20	0.2	6
House finch	20	0.2	13
Marsh wren	20	0.2	13
Northern harrier	20	0.2	14
Swamp sparrow	20	0.2	14

Blue-winged teal	19	0.2	15
Bobolink	19	0.2	10
Yellow-bellied sapsucker	19	0.2	16
American goldfinch	18	0.2	16
Short-eared owl	18	0.2	11
Swainson's thrush	18	0.2	11
Warbling vireo	18	0.2	12
Black-billed cuckoo	17	0.2	13
Lapland longspur	17	0.2	12
Orange-crowned warbler	17	0.2	14
Ruffed grouse	17	0.2	12
Black-throated gray warbler	16	0.2	9
Brewer's sparrow	16	0.2	14
Cooper's hawk	16	0.2	13
Great horned owl	16	0.2	12
Greater roadrunner	16	0.2	8
Red-breasted nuthatch	16	0.2	11
Ruby-throated hummingbird	16	0.2	14
Upland sandpiper	16	0.2	12
Western tanager	16	0.2	14
White-throated swift	16	0.2	11
Yellow-bellied flycatcher	16	0.2	11
Cassin's sparrow	15	0.2	5
Golden eagle	15	0.2	12
Laughing gull	15	0.2	4
Rock wren	15	0.2	9

Virginia rail	15	0.2	11
American crow	14	0.1	12
Canada goose	14	0.1	12
Common grackle	14	0.1	12
Common raven	14	0.1	11
Eastern kingbird	14	0.1	12
Indigo bunting	14	0.1	10
Lark sparrow	14	0.1	8
Pine warbler	14	0.1	9
Sharp-shinned hawk	14	0.1	14
Western scrub-jay	14	0.1	3
Cape may warbler	13	0.1	5
Chimney swift	13	0.1	11
Eared grebe	13	0.1	8
Ferruginous hawk	13	0.1	10
Field sparrow	13	0.1	9
Hermit thrush	13	0.1	13
Loggerhead shrike	13	0.1	10
Veery	13	0.1	8
White-eyed vireo	13	0.1	9
Winter wren	13	0.1	11
Bay-breasted warbler	12	0.1	8
Cedar waxwing	12	0.1	10
Spotted towhee	12	0.1	11
American tree sparrow	11	0.1	7
Baltimore oriole	11	0.1	9

Black-headed grosbeak	11	0.1	7
Black vulture	11	0.1	3
Chestnut-sided warbler	11	0.1	7
Green-winged teal	11	0.1	8
Northern mockingbird	11	0.1	11
Snow goose	11	0.1	3
Yellow-throated vireo	11	0.1	10
Clay-colored sparrow	10	0.1	7
Golden-crowned sparrow	10	0.1	5
Long-billed curlew	10	0.1	5
Mountain quail	10	0.1	2
Philadelphia vireo	10	0.1	7
Blue jay	9	0.1	9
California quail	9	0.1	2
Least flycatcher	9	0.1	6
Pacific-slope flycatcher	9	0.1	7
Rough-legged hawk	9	0.1	7
Ruddy duck	9	0.1	7
Western grebe	9	0.1	7
White-winged dove	9	0.1	3
Common poorwill	8	0.1	6
Eastern meadowlark	8	0.1	6
Eurasian collared-dove	8	0.1	8
Peregrine falcon	8	0.1	7
Ring-billed gull	8	0.1	3
American white pelican	7	0.1	3

Common ground-dove	7	0.1	3
Downy woodpecker	7	0.1	7
Lesser scaup	7	0.1	6
Northern pintail	7	0.1	7
Northern shoveler	7	0.1	3
Northern waterthrush	7	0.1	7
Palm warbler	7	0.1	7
Acadian flycatcher	6	0.1	6
American woodcock	6	0.1	4
Black-billed magpie	6	0.1	6
Blue-gray gnatcatcher	6	0.1	5
Bullock's oriole	6	0.1	5
Burrowing owl	6	0.1	3
Canada warbler	6	0.1	5
Great-tailed grackle	6	0.1	2
Hammond's flycatcher	6	0.1	6
Hooded warbler	6	0.1	4
Northern rough-winged swallow	6	0.1	5
Osprey	6	0.1	5
Pied-billed grebe	6	0.1	6
Sage thrasher	6	0.1	6
White-throated sparrow	6	0.1	6
Broad-winged hawk	5	0.1	5
Eastern wood-pewee	5	0.1	5
Gadwall	5	0.1	4
Gray-cheeked thrush	5	0.1	3

Great blue heron	5	0.1	5
Hairy woodpecker	5	0.1	5
LeConte's sparrow	5	0.1	4
Mountain bluebird	5	0.1	5
Domestic chicken	5	0.1	4
Rose-breasted grosbeak	5	0.1	5
Varied thrush	5	0.1	5
Vaux's swift	5	0.1	5
White-tailed hawk	5	0.1	4
Black-throated sparrow	4	<0.1	4
Cassin's vireo	4	<0.1	3
Dunlin	4	<0.1	3
Eastern bluebird	4	<0.1	4
Eastern phoebe	4	<0.1	4
Fox sparrow	4	<0.1	3
Great crested flycatcher	4	<0.1	2
Greater sage-grouse	4	<0.1	3
Kentucky warbler	4	<0.1	3
Long-eared owl	4	<0.1	4
MacGillivray's warbler	4	<0.1	3
Scarlet tanager	4	<0.1	3
Scissor-tailed flycatcher	4	<0.1	4
Bell's vireo	3	<0.1	2
Black rail	3	<0.1	2
Blue-winged warbler	3	<0.1	3
Cattle egret	3	<0.1	3

Cinnamon teal	3	<0.1	3
Eastern towhee	3	<0.1	3
Green heron	3	<0.1	3
Harris's hawk	3	<0.1	1
Merlin	3	<0.1	3
Northern cardinal	3	<0.1	3
Pine siskin	3	<0.1	3
Prairie falcon	3	<0.1	3
Red-naped sapsucker	3	<0.1	3
Redhead	3	<0.1	3
Ring-necked duck	3	<0.1	3
Scaled quail	3	<0.1	2
Semipalmated sandpiper	3	<0.1	3
Snow bunting	3	<0.1	2
Steller's jay	3	<0.1	1
Tricolored blackbird	3	<0.1	2
Western kingbird	3	<0.1	3
White-tailed kite	3	<0.1	1
Willow flycatcher	3	<0.1	3
Yellow-throated warbler	3	<0.1	3
Ash-throated flycatcher	2	<0.1	2
Bald eagle	2	<0.1	2
Bank swallow	2	<0.1	2
Belted kingfisher	2	<0.1	2
Bewick's wren	2	<0.1	2
Black-bellied whistling-duck	2	<0.1	2

Black-capped chickadee	2	<0.1	2
Black-crowned night-heron	2	<0.1	2
Brown thrasher	2	<0.1	2
Bushtit	2	<0.1	1
Carolina wren	2	<0.1	1
Chestnut-collared Longspur	2	<0.1	2
Chuck-will's-widow	2	<0.1	2
Common gallinule	2	<0.1	2
Crested caracara	2	<0.1	1
Double-crested cormorant	2	<0.1	2
Flammulated owl	2	<0.1	2
Golden-winged warbler	2	<0.1	2
Green-tailed towhee	2	<0.1	2
Lesser goldfinch	2	<0.1	2
Long-billed thrasher	2	<0.1	1
McCown's longspur	2	<0.1	1
Orchard oriole	2	<0.1	2
Purple finch	2	<0.1	2
Sharp-tailed grouse	2	<0.1	2
Spotted sandpiper	2	<0.1	2
Townsend's solitaire	2	<0.1	2
Western bluebird	2	<0.1	2
White-breasted nuthatch	2	<0.1	2
Wood duck	2	<0.1	2
Yellow rail	2	<0.1	2
American wigeon	1	<0.1	1

Anna's hummingbird	1	<0.1	1
Black-tailed gnatcatcher	1	<0.1	1
Buff-bellied hummingbird	1	<0.1	1
Cactus wren	1	<0.1	1
California gull	1	<0.1	1
Calliope hummingbird	1	<0.1	1
Canvasback	1	<0.1	1
Cassin's finch	1	<0.1	1
Cerulean warbler	1	<0.1	1
Chihuahuan raven	1	<0.1	1
Common merganser	1	<0.1	1
Connecticut warbler	1	<0.1	1
Costa's hummingbird	1	<0.1	1
Couch's kingbird	1	<0.1	1
Dusky flycatcher	1	<0.1	1
Eastern whip-poor-will	1	<0.1	1
European goldfinch	1	<0.1	1
Evening grosbeak	1	<0.1	1
Franklin's gull	1	<0.1	1
Fulvous whistling-duck	1	<0.1	1
Gambel's quail	1	<0.1	1
Glaucous-winged gull	1	<0.1	1
Gray-crowned rosy-finch	1	<0.1	1
Great black-backed gull	1	<0.1	1
Great egret	1	<0.1	1
Greater white-fronted goose	1	<0.1	1

Greater yellowlegs	1	<0.1	1
Groove-billed ani	1	<0.1	1
Gull-billed tern	1	<0.1	1
Harris's sparrow	1	<0.1	1
Hermit warbler	1	<0.1	1
Herring gull	1	<0.1	1
Lazuli bunting	1	<0.1	1
Least bittern	1	<0.1	1
Long-billed dowitcher	1	<0.1	1
Mourning warbler	1	<0.1	1
Oak titmouse	1	<0.1	1
Olive-sided flycatcher	1	<0.1	1
Prairie warbler	1	<0.1	1
Prothonotary warbler	1	<0.1	1
Red-bellied woodpecker	1	<0.1	1
Red-shouldered hawk	1	<0.1	1
Red crossbill	1	<0.1	1
Ross's goose	1	<0.1	1
Rusty blackbird	1	<0.1	1
Sage sparrow	1	<0.1	1
Short-billed dowitcher	1	<0.1	1
Tufted titmouse	1	<0.1	1
Western gull	1	<0.1	1
Western wood-pewee	1	<0.1	1
White-faced ibis	1	<0.1	1
Wilson's phalarope	1	<0.1	1

Yellow-headed blackbird	1	<0.1	1
Unknown	1379	14.4	211
Total	9573	100	274