Maryland Birdlife 66(1):2–19

Long-eared Owl (*Asio otus*) Annual Frequency, Seasonal Chronologies, and Status on the Delmarva Peninsula

Jan G. Reese[1, 3] and Robbie Weterings[2]

[1]*P.O. Box 298, St. Michaels, Maryland 21663*
[2]*Forests and Climate Change Programme, German Society for International Collaboration (GIZ), Jakarta, Indonesia*
[3]*Corresponding author: reesejan@ymail.com*

Abstract: We determined the occurrence distribution, annual frequency, and seasonal chronologies of Long-eared Owls (*Asio otus*) on the Delmarva Peninsula using various types of records from 1941 through 2016. Records were distributed throughout the peninsula with annual peak frequencies fluctuating in a general 3–5-year periodicity. Seasonal records occurred in three periods where the frequency increased and subsequently decreased. An early-March to mid-April period approximating northbound migrants peaked on 19 March (±3.2 SEM), a late-October to mid-December period approximating southbound migrants peaked on 14 November (±2.4 SEM), and a late-November to late-March winter period peaked on 12 January (±2.6 SEM). Historically there is no record of nesting on the peninsula, nor was it confirmed among the few spring and summer records in this study. The Long-eared Owl is a poorly understood species with little to nothing known about it regionally. This study provides some valuable insights to their life history on the Delmarva Peninsula, a more definitive status than that given for the region in the literature, and furnishes baseline information for future study.

Keywords: annual frequency, *Asio otus*, Delmarva Peninsula, distribution, Long-eared Owl, seasonal chronologies, status

Long-eared Owl (*Asio otus*) occurrence and nesting distribution east of the Great Lakes in North America is associated with the contiguous mountain regions north from central Pennsylvania through the Canadian Maritime Provinces. Records of the species occurring and nesting farther east and south are considered rare and local (Marks et al. 1994). Most owls withdraw in winter from northern parts of their range and may be found occasionally wintering as far south as central Georgia and southern Mississippi (Marks et al. 1994, Beaton et al. 2003, Mississippi Ornithological Society 2015).

Long-eared Owls are infrequently detected owing, to their secretive behavior with faint calls, their more post-dusk nocturnal activity in comparison to other

owl species, their superb cryptic plumage coloration and posturing when perched, and temporary seasonal occurrence in southeast regions with abundant prey and lack of prolonged snow cover. These factors make the species a difficult study subject and therefore data concerning their behavior, biology and phenology are limited. This may obscure the actual status of the species throughout their eastern North America range including the Delmarva Peninsula where the species is considered scarce/rare.

Additional factors complicate determining the actual status of Long-eared Owls in the region. One factor is the "broad-scale" at which the status for a species is sometimes assigned. Portions of three political jurisdictions (Delaware, Maryland, and Virginia) comprise the Delmarva Peninsula Coastal Plain. The jurisdictions contain various other physiographic regions to the north, west, and south. Most studies attribute a given species status to the entire political jurisdiction, and not to the individual physiographic regions within (Rives 1890, Kirkwood 1895, Pennock 1904, Rhoads and Pennock 1905, Hampe and Kolb 1947, Murray 1952). Few if any species are found equally dispersed across all physiographic regions due to variation in habitat and food availability within the different regions. Thus, assigning a species status to an entire geographic area, when that area's boundaries are not based on any physiographic or ecological context, may be misleading and create an inaccurate picture of the owl's status in the jurisdictive region.

Historical studies from around the turn of the 20th Century considered Long-eared Owls to be "uncommon" or "resident" on the Delmarva Peninsula despite more abundant concealing habitat and fewer observers to detect owls relative to more modern times (Rives 1890, Kirkwood 1895, Pennock 1904, Rhoads and Pennock 1905). Conversely, studies during the mid-20th Century classified the species status as "rare" (Hampe and Kolb 1947, Murray 1952, Stewart and Robbins 1958). Later studies associated the perceived less frequent detection and/or population decline to a mid-century surge in Great Horned Owl (*Bubo virginianus*) and Red-tailed Hawk (*Buteo jamaicensis*) populations (Bosakowski et al. 1989, Hess et al. 2000). These two species were afforded legal protection after a century of persecution by farmers and hunters. Competition for nest sites and small rodent prey by the Great Horned Owl and other raptors has been suggested as possibly limiting Long-eared Owl numbers in open lands of New Jersey (Bosakowski et al. 1989). There were also reports of Great Horned Owls and Red-tailed Hawks preying/attacking Long-eared Owls (Collins 1962, Bosakowski et al. 1989). It is uncertain whether these factors may have contributed to mixed status reports of "rare to uncommon" for studies including the Delmarva Peninsula in the 21st Century (Hess et al. 2000, Rottenborn and Brinkley 2007).

In this paper, we used regional publications, checklists, reports, seasonal counts, banding records and museum specimens of Long-eared Owl occurrences on the Delmarva Peninsula since the early 1900s to compile a comprehensive dataset. These data were then used to determine annual frequency, seasonal chronologies and status on the peninsula.

METHODS

Study Area

The Delmarva Peninsula Coastal Plain is located in the Mid-Atlantic region of North America and comprises a peninsula situated between the Atlantic Ocean on the east and Chesapeake Bay on the west (Figure 1). The peninsula is approximately 290 km (180 mi) long with a north/south aspect, nearly 110 km (68 mi) wide midway its length and tapers towards both ends. Alluvial deposits of silt, sand, clay, and gravel from glacier melt during the Miocene, Pleistocene, and Holocene epochs form the peninsula's substrates. The topography lacks pronounced relief and elevation is generally less than 30 m (98 ft) above sea level. Freshwater streams and rivers, brackish and saltwater tidal creeks, tributaries and bays deeply indent the landscape of prevalent cultivated agricultural fields while coniferous and deciduous forests cover most of the undeveloped areas. Other areas are characterized by herbaceous and forested freshwater wetlands, and herbaceous brackish and saltwater wetlands. Additionally linear barrier islands and bays characterize the coast with the Atlantic Ocean. Average temperatures range is -2.8° to 7.8° C (27° to 46° F) in January and 18.3° to 30.5° C (65° to 87° F) in July at the center of the peninsula. Annual precipitation averages 1143 mm (45 in), and snowfall, 533 mm (21 in). The humidity ranges 54% to 78% while prevailing west winds average 16.1 to 17.7 km/hr (10 to 11 mi/hr). The study area encompasses the entire Coastal Plain peninsula south of its interface with the Piedmont upland physiographic region.

Data Sources

Long-eared Owl records were extracted from sources given in Table 1, plus regional bird books and checklists cited herein. Of these records, two were found to be duplicates within the dataset, one gave no location, one was only reported in an unreliable source, and one museum inventory specimen could not be found in the collection. These records date from the last half of the 20th Century, could not be validated, and were therefore deleted from the dataset. All remaining records used in the dataset occurred during the period 1941–2016. Additionally, private individuals (noted in the acknowledgments) contributed Long-eared Owl records from their personal observations, counts, and/or records.

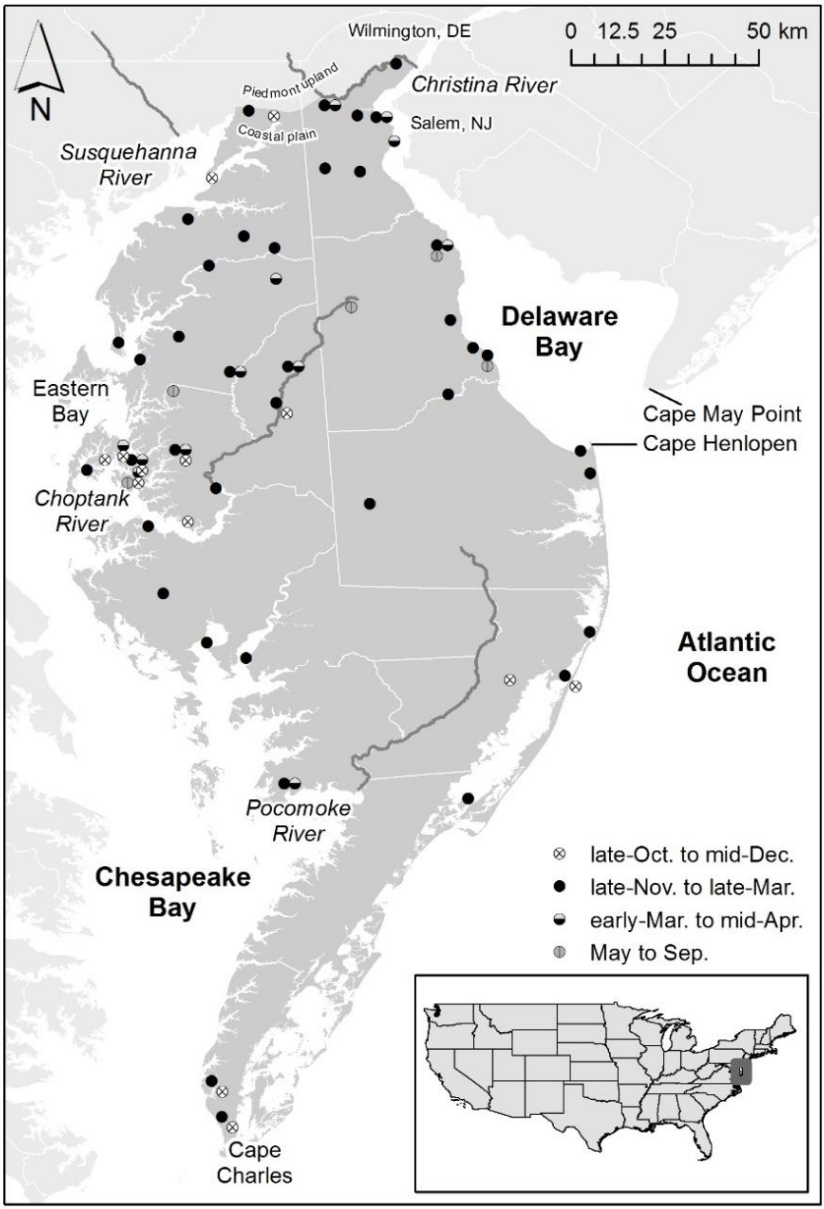

Figure 1. Delmarva Peninsula study area showing the distribution of 50 locations where 218 Long-eared Owls were recorded from 1941 through 2016 (some locations are represented by more than one dot).

Table 1. Publications, museum specimen inventories, and databases used in compilation of the Long-eared Owl dataset.

Journals and Databases	Data Period	URL
Cassinia	1890–2009	http://dvoc.org/Publications/Cassina/Cassinia.htm
Delmarva Ornithologist	1964–1974	http://olddos.dosbirds.org/ornithologists
Maryland Birdlife	1945–2016	https://sora.unm.edu/node/132691 (2006-2016 hardcopy subscription)
The Raven	1930–2013	http://www.ccbbirds.org/resources/the-raven/
North American Birds	1999–2008	https://sora.unm.edu/node/209
National Audubon Society Field Notes	1994–1998	https://sora.unm.edu/node/209
American Birds	1973–1994	https://sora.unm.edu/node/209
National Audubon Society Christmas Bird Counts	1941–2014	http://netapp.audubon.org/cbcobservation/
eBird.org (Explore Data)	Through 1 Mar 2016	http://ebird.org/ebird/explore
List of Caroline County Birds	1946–1978	Fletcher et al. 1956, Fletcher et al. 1979
USGS Bird Banding Laboratory	1941–2016	Unpublished data retrieved 15 SEP 2016, Patuxent Wildlife Research Center, Laurel, MD, USA

Museum and University Bird Collection Inventories	Access Date	Data Sources
Yale University	1 Jan 2016	http://collections.peabody.yale.edu/search/
American Museum of Natural History	1 Jan 2016	http://sci-web-001.amnh.org/db/emuwebamnh/index.php
Philadelphia Academy of Science	5 Jan 2016	http://www.ansp.org/research/systematics-evolution/collections/ornithology/
Delaware Museum of Natural History	5 Jan 2016	http://www.vertnet.org/
Towson University		personal 1988 hard copy inventory (and L. Scott Johnson, in litt., 2010)
Salisbury University		personal 2015 hard copy inventory
University of Maryland (Horn Point & College Park campuses)		personal 1998 hard copy inventories
U.S. National Museum of Natural History	8 Jan 2016	http://collections.nmnh.si.edu/search/birds/

Data Analysis

We converted all records to presence-only data to account for methodological differences among records from the various data sources. These records consisted of single or multiple owls encountered at a single location. In five cases, single or multiple owls were seen at a single location on widely separate dates (>1 weeks). For these observations the first and the last dates were included, e.g., the first and last dates seen at a winter roost site. The locations of all records were geocoded and visualized on a map using ArcGIS 10.1 (Environmental Systems Research Institute 2012). We calculated the total number of records per year for the period 1941–2016 and plotted them to display the annual frequency. We grouped all records from different years to calculate the number of records per week and plotted them to visualize seasonal variation throughout the year. We excluded Christmas Bird Counts from the latter analysis because their inclusion would have disproportionally skewed wintering records falsely high during the annual count period. Using the plotted seasonal records, we identified three clusters during which the number of records increased and subsequently decreased (approximating mid-February to mid-April, late-October to early-December, and mid-December to mid-February), plus six scattered records during May–September. These periods suggest northbound and southbound migration and wintering periods with each period partly overlapping the adjoining period.

To better understand the extent of these periods and overlaps, we assigned each record to one of the seasonal periods. Records of single or multiple owls at historical or known roosts and all owl records in January to mid-February (wintering owls) were assigned to a late-November to late-March period; records of single owls found at random non-roost locations were assigned to either the northbound early-March to mid-April period or the southbound late-October to mid-December period depending on whether they occurred before or after the peak wintering months of January to mid-February. To assure compliance and accuracy we compared the range of these periods with published early/late arrival dates for migrant and wintering owls given for jurisdictions in the Mid-Atlantic region. Only six records were available for the May–September period, hence this period was excluded from analysis.

Finally, we calculated the mean date during which the number of records was highest for the three different periods. Dates were first converted to Julian days in order to ease calculations. The mean dates were then plotted together at the 95% confidence interval (2.5 and 97.5 percentiles). All analyses were conducted in RStudio Version 0.99.491 (RStudio 2015) built on R 3.2.0 (R Development Core Team 2016); plots were created using the ggplot package.

RESULTS

Composition of Records

We extracted and considered 218 valid Long-eared Owl records from the Delmarva Peninsula in 1941–2016. The annual Christmas Bird Counts comprised 121 owl records during the count period 14 December through 5 January involving 18 different count locations. An additional 97 records from 32 locations included 61 sightings other than Christmas Bird Count dates, 12 trapped and banded, eight found dead on the highway, eight heard calling, three purposely shot for collections, three found injured, one found sick, and one tangled in a fence.

Distribution of Records

The early-March to mid-April period records (n = 15) were distributed across the northern portion of the peninsula north of a line from Cape Henlopen at the mouth of Delaware Bay west to the mouth of the Choptank River on Chesapeake Bay with exception of one record on the north side of the mouth of the Pocomoke River on Chesapeake Bay (Figure 1). Conversely, 85% of the late-October to mid-December period records (n = 26) were evenly dispersed at locations south of a line from Cape Henlopen on Delaware Bay west to Eastern Bay on Chesapeake Bay. The late-November to late-March period records (n = 171 including 121 Christmas Bird Counts) were broadly distributed with 81% adjacent to Delaware Bay (n = 60), Chesapeake Bay (n = 33), and Atlantic Ocean (n = 45) tidewater, and the remaining at more inland locations (n = 33). There were six May–September period records all distributed north of a line from Cape Henlopen at the mouth of Delaware Bay west to the mouth of the Choptank River on Chesapeake Bay.

Annual Records

Long-eared Owls have been reported on the Delmarva Peninsula every year since 1964 (52 years) with the exception of 1972 and 1985 (Figure 2). Annual records since the mid-1940s fluctuated generally reaching highs every 3–5 years before an appreciable drop in the number of records the following year(s).

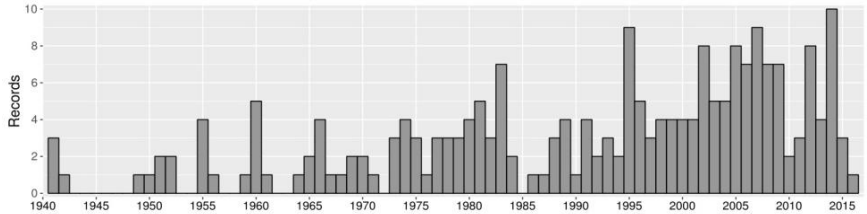

Figure 2. Long-eared Owl annual frequency of records (n = 218) on the Delmarva Peninsula.

Seasonal Records

Figure 3 shows the Long-eared Owl seasonal records on the Delmarva Peninsula. The early-March to mid-April period records (n = 15) ranged from the 2 March early arrival through the 9 April late arrival with a mean peak date for the number of records on 19 March (±3.2 SEM) (Figure 3B). The late-October to mid-December period records (n = 26) ranged from the 23 October early arrival through the 17 December late arrival with a mean date on 14 November (±2.4 SEM). The late-November to late-March period records (n = 50), excluding Christmas Bird Counts, spanned 24 November through 24 March with a mean peak date on 12 January (±2.6 SEM).

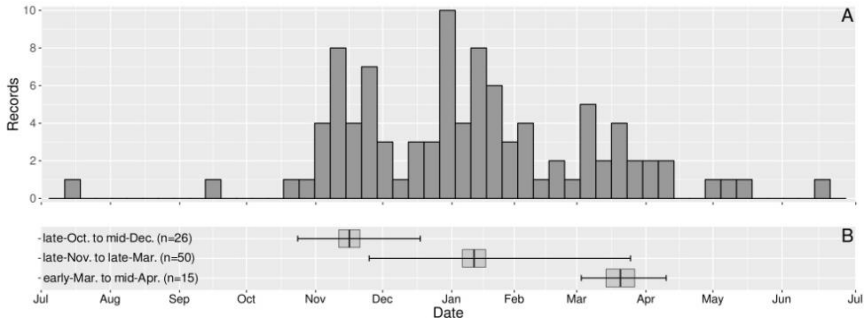

Figure 3. Long-eared Owl seasonal records on the Delmarva Peninsula. A) Each vertical bar represents the number of records found in a week using data for the period 1941–2016 excluding Christmas Bird Counts. B) The vertical line in the box is the mean peak date for the period, the gray represents the confidence interval limits and line whiskers are the period extremes.

Age and Sex of Owls

Age and/or sex given in 28 records of Long-eared Owls trapped and banded, found sick or dead, or purposely collected, designated 16 (57%) as age unknown. Females comprised 85% of 13 owls for which the sex was determined and females were predominant among the migratory and wintering period owls. The age and sex for each of the four seasonal periods are summarized in Table 2.

Table 2. Long-eared Owl age and sex taken from seasonal records on the Delmarva Peninsula during 1941–2016. M = male, F = female, U = unknown sex.

	early-Mar–mid-Apr period (n = 9)			late-Oct–mid-Dec period (n = 10)			late-Nov–mid-Mar period (n = 7)			May–Sep period (n = 2)		
Sex	M	F	U	M	F	U	M	F	U	M	F	U
Age <1	-	-	-	-	1	2	-	-	-	-	-	-
Age >1	-	2	-	-	4	1	1	-	1	-	-	-
Age unknown	-	1	6	-	-	2	-	2	3	1	1	-

May-September Records

Owls calling during the first half of May at locations adjacent to the west shore of Delaware Bay in the northeast portion of the peninsula constituted three May–September records, while others included single owls found sick on a lawn in June and dead on the highway in July adjacent to the east side of Chesapeake Bay in the west-central portion of the peninsula, and another single reported occurring in September near the center of the peninsula.

DISCUSSION

Despite their infrequent detection and perceived rare status, 1941–2016 records of Long-eared Owls on the Delmarva Peninsula indicate they occur throughout the peninsula during migration and/or winter periods more frequently than generally thought. Additionally, there are a few warm-weather records, but no nest confirmations.

Distribution of Records

Most early-March to mid-April period records were distributed in the north portion of the peninsula while the late-October to mid-December period records favored the central and southern portions. Hawk watchers, banding stations, and bird watchers focus along the Atlantic and Chesapeake coasts during the fall migration season, which may have contributed to the seasonal difference found in the distribution. Owls found on the annual Christmas Bird Counts during the study contributed substantially to the late-November to late-March period records distribution.

Annual Records

Periodic spikes in annual frequency (generally every 3–5 years) noted in this study were also found in Long-eared Owl reports in New Jersey during 1966–1986 (Bosakowski et al. 1989). Periodic spikes were also found among banding station records in New York during 1981–1986 and New Jersey during 1980–

1988 (Slack et al. 1987, Duffy and Kerlinger 1992). In the northern boreal forest of eastern North America, and in northern Scotland and Fennoscandia such changes in owl frequency have been associated with low abundance of voles and lemmings in their usual distribution range, e.g., meadow voles, *Microtus* spp. (Harvey and Riddiford 1990); *Microtus* spp. and lemmings, *Lemmus* spp. (Korpimäki and Krebs 1996); and the Southern Red-backed Vole, *Myodes gapperi* (Cheveau et al. 2004). Fluctuations in Long-eared Owl abundance and reproductive success have been positively correlated to density of its primary microtine prey in Scotland (Field Vole, *Microtus agrestis* [Village 1981]) and western Finland (*M. agrestis* and Southern Vole, *M. levis* [Korpimäki and Norrdahl 1991]). Similarly, the closely related Short-eared Owl (*Asio flammeus*) exhibited a positive correlation between the abundance of voles/lemmings and owls in Alaska (Brown Lemming, *L. sibiricus* [Pitelka et al. 1955a, 1955b]), Scotland (*M. agrestis* [Village 1987]), and Finland (*M. agrestis* and *M. levis* [Korpimäki and Norrdahl 1991]). Monitoring prey was beyond the scope of this study, therefore we cannot with any certainty assign the periodicity to prey availability. Nevertheless, prey availability is a likely factor in driving the patterns in our data as is seen for Long-eared Owl in other studies. Finally, decreasing owl habitat with increasing observers utilizing improved detection technologies may have been responsible for the generally increasing annual frequency of owl records after the mid-20th Century.

Seasonal Records

Christmas Bird Counts frequently involve concerted efforts to locate rare species such as Long-eared Owls in the days just prior to the count and confirming their presence on count day. Therefore, Christmas Bird Counts were excluded from the seasonal analysis to avoid biasing the records peak for the wintering period during the 14 December through 5 January Christmas Bird Count period. The three periods seen in the data suggest migrant and wintering periods. The early-March to mid-April period records in this study correspond to northbound migrant Long-eared Owl capture periods of 29 March to 26 April and 21 March to 14 April at banding stations along the west and east portions of the south shore of Lake Ontario in New York (Beardslee and Mitchell 1965, Slack et al. 1987). The late-October to mid-December period records correspond with the 11 October to 27 November period of banding captures at the nearby Cape May Point, New Jersey banding station in 1980–1989 (Duffy and Kerlinger 1992). Owls banded at this station were rarely captured twice in a season suggesting they were south migrants and not resident birds (Katherine E. Duffy, in litt.). Also, a nocturnal visual study of southbound migrant owls at Cape May in 1982 detected owls most frequently during 12 October to 11 November (Russell et al. 1991). The late-October to mid-December period records also correspond to dates (10 October–18 November) for early southbound migrants on the Virginia Coastal Plain (Larner 1979, Kain 1987, Rottenborn and Brinkley 2007). All of

these seasonal chronologies lend support to Long-eared Owls being an annual migrant on the Delmarva Peninsula.

Despite evidence supporting the three periods as representing migrant and wintering periods, it is not without some caution. The seasonal analysis indicates an early-March to late-March overlap of 23 days between the late-November to late-March period records and the early-March to mid-April period records. Similarly there is a late-November to mid-December overlap of 24 days between the late-October to mid-December period records and the late-November to late-March period records. It is difficult to ascertain owl records to migrants or wintering. Furthermore, nest activity has been reported from mid-March into July in adjacent Piedmont and Ridge and Valley physiographic regions (Santner 1992, Rottenborn and Brinkley 2007, Ellison 2010, Gross 2012), while nothing is known about regional owl movements in winter. Regardless, this study contributes to further understanding of the migration and winter chronologies of this poorly understood species.

May-September Records

Historically, the Long-eared Owl was listed as "resident" in Delaware (Rhoads and Pennock 1905) and Virginia (Rives 1890), and "resident, but…not common" and "rare permanent resident" in Maryland (Kirkwood 1895, Hampe and Kolb 1947) which implies potential nesting on the Delmarva Peninsula. Regional studies since the first half of the 20th Century (Murray 1952, Stewart and Robbins 1958, Hess et al. 2000, Rottenborn and Brinkley 2007, Ellison 2010) restrict any potential nesting in those jurisdictions to Piedmont or higher elevations north, south, or west of the Coastal Plain peninsula. Nesting was documented just 3 km (2 mi) east of the Delmarva Peninsula on the New Jersey Coastal Plain near Salem (Stone 1965); 13 km (8 mi) north on the Delaware Piedmont north of Wilmington (B.C. Hiatt in Potter 1937), and 52 km (32 mi) west on the Maryland Piedmont near Baltimore (Kirkwood 1895, Kolb 1947a, Kolb 1947b, Stewart and Robbins 1958). Coincidently, the three 21st Century owl calling records in May are on the west side of Delaware Bay just 12–32 km (7.5–20 mi) southeast of the late 1930s Coastal Plain nesting near Salem, New Jersey and the Piedmont nesting north of Wilmington, Delaware.

Necropsy of a male owl, found sick on a lawn, in June 1981 (JGR catalogue no.1045, USNM cat. No. 582672), and a female, found dead on the highway, in July 1983 (JGR catalogue no. 1400, USNM cat. No.597098) lacked frayed feathers, enlarged gonads, incubation patches, or other signs of nesting. It should be noted however, that with mid-March initiation of nest activity (Stewart and Robbins 1958, Marks et al. 1994, Ellison 2010) and subsequent egg-laying, incubation, and brooding of nestlings could have been completed by May and thereafter exhibit no physical signs of nesting. An owl reported on 14 September 1941 near the center of the peninsula suggests a resident or unusually early

southbound migrant. Clark (1975) found that Short-eared Owls shift their wintering and breeding areas in response to spatial and temporal abundance of small rodents. Perhaps small mammal population dynamics contributed to the occurrence of six spring and summer Long-eared Owl records. Indeed, all of the records coincide with years of high owl abundance on the peninsula. In summary, Long-eared Owl nesting has not been confirmed on the Delmarva Peninsula since the turn of the 20th Century despite several spring and summer records.

Owl Age and Sex

Handling of 28 Long-eared Owls trapped and banded, found sick or dead, or purposely collected enabled the possibility of determining the age and/or sex of individuals. Age determined for 12 November–April owls included nine greater than one-year-old (75%) and three less than one-year-old. Similarly, an overwhelming 97% of 37 northbound migrant Long-eared Owls banded at Nine Mile Point, New York in 1981–1986 (Slack et al. 1987) were greater than one-year-old. Conversely, only 26% of 203 southbound migrants banded at Cape May Point in 1980–1988 (Duffy and Kerlinger 1992) were greater than one-year-old. Age was not determined for any May-September owls. It should be noted that reliable external criteria for determining Long-eared Owl age/sex were lacking or limited prior to publication of the *Identification Guide to North American Birds* (Pyle 1997) that cautions age determination may be unreliable for some Long-eared Owls less than one-year-old or in the following year.

Sex determined for 13 owls in this study included 11 females (85%). In Britain, females constituted 78% of 36 Long-eared Owl southbound migrants banded at Fair Isle, Shetland, Scotland in 1984–1989 (Harvey and Riddiford 1990) while females comprised 76% of 101 owl mortalities autopsied in the United Kingdom during October–April 1963–1995 (Wyllie et al. 1996). Conversely, females comprised only 36% of 36 winter mortalities in Norway (Overskaug and Kristiansen 1994). In Fennoscandia, males winter close to their nest site and territory to assure retaining them for the following spring while females have no constraints and move to other areas in times of food shortage (Harvey and Riddiford 1990). It is not known if this type of movement contributed to the over-representation of females in this study while this domain remains largely unexplored for the Long-eared Owl. In addition, the sex ratios in our study and the southbound migrants banded in Scotland were based on small sample sizes while the contradictory ratio came from a Norway study 2414 km (1500 mi) north of this study. Therefore, it is difficult to make any conclusions about age and sex ratios in our study.

Status

The species general status given in late 19th Century into early 21st Century literature ranges from "rare resident" in the north portion of the peninsula to "rare resident, transient or wintering" in the southern portion (Table 3).

Table 3. Long-eared Owl historical status, occurrence and nesting on the Delmarva Peninsula Coastal Plain.

Political Jurisdiction	Status	Occurrence	Nesting	Source
Delaware	Throughout the year (statewide)	More abundant during cold months	Occasionally breeds within our limits	Pennock 1904
Delaware	Resident (statewide)	N/A	N/A	Rhoads and Pennock 1905
Delaware	Regular winter visitor, uncommon (statewide)	Nov-Mar	Newcastle County 1937; today DE should be considered south of normal breeding range	Hess et al. 2000
Maryland	Resident, not common (statewide)	No records for Coastal Plain	No records for Coastal Plain	Kirkwood 1895
Maryland	Rare permanent resident (statewide)	No records for Coastal Plain	No records for Coastal Plain	Hampe and Kolb 1947
Maryland	Rare and local permanent resident west of Chesapeake Bay, occasionally occurs on Coastal Plain	Fall and winter in Dorchester and Caroline Counties	No records for Coastal Plain	Stewart and Robbins 1958
Maryland	Year-round resident in nesting range (statewide)	N/A	No records for Coastal Plain	Ellison 2010
Virginia	Resident, but seldom seen (statewide)	Occurrence not defined	No records for Coastal Plain	Rives 1890
Virginia	Rare resident (statewide)	Recorded in winter most often	No records for Coastal Plain	Murray 1952
Virginia	Rare winter visitor (Coastal Plain)	18 Nov–20 May	No records for Coastal Plain	Larner 1979
Virginia	Rare winter visitor (Coastal Plain)	31 Oct–28 May	No records for Coastal Plain	Kain 1987
Virginia	Rare transient and winter visitor (Coastal Plain)	10 Oct–28 May	No records for Coastal Plain	Rottenborn and Brinkley 2007

Recent Wildlife Action Plans for jurisdictions comprising the Delmarva Peninsula rank the Long-eared Owl status as "highly state rare breeding and non-breeding" (S1B, S1N) in Delaware (Delaware Division of Fish and Wildlife 2015) and in Maryland (Maryland Department of Natural Resources 2015). In addition Delaware provides an SHB rank, i.e., known historically to breed in Delaware. Virginia provides no ranking for the species on either the Accomack or Northampton County Coastal Plain (Virginia Department of Game and Inland

Fisheries 2015). In view of the variable statuses applied to inclusive multi-physiographic jurisdictions during the past 74 years, it is no wonder status of the species is clouded and/or contradictory. This study found records of Long-eared Owls on the Delmarva Peninsula show regular annual frequency with seasonal chronologies during migrant and wintering periods while fluctuating abundance may decrease the number of records in some years.

Conclusion

This study of 1941–2016 Long-eared Owl records on the Delmarva Peninsula found them distributed throughout the peninsula with annual peak frequencies fluctuating in a general 3- to 5-year periodicity. Seasonal records show three distinct periods approximating migrant and wintering periods. Nesting could not be confirmed among six spring and summer records. Age and/or sex determinations for 28 owls found the majority were females greater than one-year-old. Annual and seasonal chronologies derived from the records provide a more definitive status than previously available in the literature. The Long-eared Owl is a poorly understood species with little known about it regionally. This study provides some valuable insights to their life history on the Delmarva Peninsula furnishing baseline information for future studies.

ACKNOWLEDGMENTS

Personal observations, banding records, and/or databases contributed by Harry T. Armistead (Maryland Ornithological Society [MOS]), David F. Brinker (Central Regional Ecologist, Wildlife and Heritage Service, Maryland Department of Natural Resources, Annapolis, MD), Edward S. Brinkley (Editor, *North American Birds*, Cape Charles, VA), Katharine E. Duffy (Cape May Owl Banding Project [part of the Cape May Raptor Banding Project]), Robert F. Ringler (MOS), and Fletcher M. Smith (Research Biologist, The Center for Conservation Biology, College of William and Mary and Virginia Commonwealth University, Williamsburg, VA) added many records to the dataset. Danny Bystrak (Wildlife Biologist, Bird Banding Laboratory, Patuxent Wildlife Research Center, Laurel, MD) provided banding records from the USGS Bird Banding Laboratory database. David Bridge (MOS) and Jean L. Woods (Curator of Birds, Delaware Museum of Natural History, Wilmington, DE) located and confirmed data on museum specimens and provided copies of difficult to locate publications. Walter G. Ellison (Biology Lecturer, Washington College, Chestertown, MD), Jean L. Woods, and two anonymous reviewers made helpful comments on an earlier draft.

AUTHORS' APPEAL: Long-eared Owls are highly sensitive to disturbance. If you happen upon a perched owl, immediately exit the area, do not return that season, and do not relate the owl's specific location to anyone. You could publicly report the owl occurrence, but never give the specific location.

LITERATURE CITED

Beardslee, C.S., and H.D. Mitchell. 1965. Birds of the Niagara Frontier Region: An annotated check-list. *Bulletin of the Buffalo Society of Natural Sciences* 22. 478 pp.

Beaton, G., P.W. Sykes, Jr., and J.W. Parrish, Jr. 2003. *Annotated Checklist of Georgia Birds*. Occasional Publication No.14 (fifth edition). Georgia Ornithological Society. 156 pp.

Bosakowski, T., R. Kane, and D.G. Smith. 1989. Decline of the Long-eared Owl in New Jersey. *The Wilson Bulletin* 101(3):481–485.

Cheveau, M., P. Drapeau, L. Imbeau, and Y. Bergeron. 2004. Owl winter irruptions as an indicator of small mammal population cycles in the boreal forest of eastern North America. *Oikos* 107(1):190–198.

Clark, R.J. 1975. A field study of the Short-eared Owl, *Asio flammeus* (Pontoppidan), in North America. *Wildlife Monographs* 47:1–67.

Collins, C.T. 1962. Red-tailed Hawk attacks Long-eared Owl. *The Wilson Bulletin* 74(1):89.

Delaware Division of Fish and Wildlife. 2015. 2015 Delaware Wildlife Action Plan. Division of Fish and Wildlife, Delaware Department of Natural Resources and Environmental Control. Available at: http://www.dnrec.delaware.gov/fw/dwap/. Accessed 27 January 2017.

Duffy, K., and P. Kerlinger. 1992. Autumn owl migration at Cape May Point, New Jersey. *The Wilson Bulletin* 104(2):312–320.

Ellison, W.G. 2010. Long-eared Owl, *Asio otus*. Pages 186–187 in: Ellison, W.G. (Editor), *2nd Atlas of the Breeding Birds of Maryland and the District of Columbia*. The Johns Hopkins University Press, Baltimore, MD. 494 pp.

Environmental Systems Research Institute. 2012. ArcGIS 10.1. Available at: http://www.esri.com. Accessed 15 January 2016.

Fletcher, A.J., R.B. Fletcher, M.W. Hewitt, A.O'C. Knotts, and A.M. Thompson. 1956. *List of Caroline County Birds*. Maryland Avifauna Number 1, Maryland Ornithological Society, Inc., Baltimore, MD. 22 pp.

Fletcher, A.J., R.B. Fletcher, M.W. Hewitt, A.O'C. Knotts, A.M. Thompson, and V.E. Unger. 1979. *List of Caroline County Birds* (Revised 31 January

1979). Maryland Avifauna Number 1, Maryland Ornithological Society, Inc., Baltimore, MD. 29 pp.

Gross, D.A. 2012. Long-eared Owl, *Asio otus*. Pages 210–211 in: Wilson, A.M., D.W. Brauning, and R.S. Mulvihill (Editors), *Second Atlas of Breeding Birds in Pennsylvania*. The Pennsylvania State University Press, University Park, PA. 586 pp.

Hampe, I.E., and H. Kolb. 1947. *A Preliminary List of Birds of Maryland and the District of Columbia*. The Natural History Society of Maryland, Baltimore, MD. 80 pp.

Harvey, P.V., and N. Riddiford. 1990. An uneven sex ratio of migrant Long-eared Owls. *Ringing and Migration* 11(3):132–135.

Hess, G.K., R.L. West, M.V. Barnhill III, and L.M. Fleming. 2000. *Birds of Delaware*. University of Pittsburgh Press, Pittsburgh, PA. 635 pp.

Kain, T. (Editor). 1987. *Virginia's Birdlife: An annotated checklist*. Virginia Society of Ornithology. Virginia Avifauna Number 3. 127 pp.

Kirkwood, F.C. 1895. A list of the birds of Maryland. *Transactions of the Maryland Academy of Science* 2:241–382.

Kolb, H. 1947a. Breeding of the Long-eared Owl near Baltimore. *Maryland: A Journal of Natural History* 17(2):23–25.

Kolb, H. 1947b. Breeding of the Long-eared Owl near Baltimore. *Maryland Conservationist* 24(2):18, 22.

Korpimäki, E., and C.J. Krebs. 1996. Predation and population cycles of small mammals: A reassessment of the predation hypothesis. *BioScience* 46(10):754–764.

Korpimäki, E., and K. Norrdahl. 1991. Numerical and functional responses of Kestrels, Short-eared Owls, and Long-eared Owls to vole densities. *Ecology* 72(3):814–826.

Larner, Y.R. (Chairman of the Checklist Committee). 1979. *Virginia's Birdlife: An annotated checklist*. Virginia Society of Ornithology. Virginia Avifauna Number 2. 118 pp.

Marks, J.S., D.L. Evans, and D.W. Holt. 1994. Long-eared Owl, *Asio otus*. The Birds of North America (P. G. Rodewald, Editor). Cornell Lab of

Ornithology, Ithaca, NY. Available at: https://birdsna.org/Species-Account/bna/species/loeowl. Accessed 1 March 2016.

Maryland Department of Natural Resources. 2015. 2015 Maryland State Wildlife Action Plan. Wildlife and Heritage Service, Maryland Department of Natural Resources. Available at: http://dnr2.maryland.gov/wildlife/Pages/plants_wildlife/SWAP_Submission.aspx. Accessed 27 January 2017.

Mississippi Ornithological Society. 2015. Checklist of Birds of Mississippi. Mississippi Ornithological Society Bird Records Committee. 2 pp. Available at: http://www.missbird.org/Files/Mississippi%20State%20Checklist/MOS_Checklist_Aug_2015.pdf. Accessed 27 January 2017.

Murray, J.J. (Editor). 1952. *A Check-list of the Birds of Virginia*. Virginia Society of Ornithology. 113 pp.

Overskaug, K., and E. Kristiansen. 1994. Sex ratio of accidentally killed Long-eared Owls *Asio otus* in Norway. *Ringing and Migration* 15(2):104–106.

Pennock, C.J. 1904. *Some of Our Useful Birds*. Bulletin No. 5. State Board of Agriculture, Dover, DE. 16 pp.

Pitelka, F.A., P.Q. Tomich, and G.W. Treichel. 1955a. Breeding behavior of jaegers and owls near Barrow, Alaska. *The Condor* 57(1):3–18.

Pitelka, F.A., P.Q. Tomich, and G.W. Treichel. 1955b. Ecological relations of jaegers and owls as lemming predators near Barrow, Alaska. *Ecological Monographs* 25(1):85–117.

Potter, J.K. 1937. The Season, CXVII April 15 to June 15, 1937: Philadelphia Region. *Bird Lore* 39(4):312–326.

Pyle, P.1997. *Identification Guide to North American Birds, Part I: Columbidae to Ploceidae*. Slate Creek Press, Bolinas, CA. 732 pp.

R Development Core Team. 2016. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. (software)

Rhoads, S.N., and C.J. Pennock. 1905. Birds of Delaware: A preliminary list. *The Auk* 22(2):194–205.

Rives, W.C. 1890. *A Catalogue of the Birds of the Virginias*. Proceedings of the Newport Natural History Society 1889–90, Document VII. Newport, RI. 100 pp.

Rottenborn, S.C., and E.S. Brinkley. 2007. *Virginia's Birdlife: An annotated checklist*. Virginia Avifauna, No. 7 (Fourth Edition), Virginia Society of Ornithology. 330 pp.

RStudio. 2015. RStudio: Integrated Development Environment for R (Version 0.99.491). RStudio, Boston, MA. (software)

Russell, R.W., P. Dunne, C. Sutton, and P. Kerlinger. 1991. A visual study of migrating owls at Cape May Point, New Jersey. *The Condor* 93(1):55–61.

Santner, S. 1992. Long-eared Owl, *Asio otus*. Pages 162–163 in: Brauning, D.W. (Editor). *Atlas of Breeding Birds in Pennsylvania*. University of Pittsburgh Press, Pittsburgh, PA. 484 pp.

Slack, R.S., C.B. Slack, R.N. Roberts, and D.E. Emord. 1987. Spring migration of Long-eared Owls and Northern Saw-whet Owls at Nine Mile Point, New York. *The Wilson Bulletin* 99(3):480–485.

Stewart, R.E., and C.S. Robbins. 1958. *Birds of Maryland and the District of Columbia*. North American Fauna, No. 62, United States Government Printing Office, Washington D.C. 401 pp.

Stone, W.T. 1965. *Bird studies at Old Cape May: An ornithology of Coastal New Jersey*, Volume II (reprint). Dover Publications, Inc., New York, NY. 457 pp.

Village, A. 1981. The diet and breeding of Long-eared Owls in relation to vole numbers. *Bird Study* 28(3):215–224.

Village, A. 1987. Numbers, territory-size and turnover of Short-eared Owls *Asio flammeus* in relation to vole abundance. *Ornis Scandinavica* 18(3):198–204.

Virginia Department of Game and Inland Fisheries. 2015. Virginia's 2015 Wildlife Action Plan. Available at: http://bewildvirginia.org/wildlife-action-plan/. Accessed 27 January 2017.

Wyllie, I., L. Dale, and I. Newton. 1996. Unequal sex-ratio, mortality causes and pollutant residues in Long-eared Owls in Britain. *British Birds* 89(10):429–436.