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# An unprecedented arrival of Nearctic landbirds in Britain and Ireland in September 2023

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June 2024



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# Abstract

Autumn 2023 saw the biggest single arrival of Nearctic landbirds ever recorded in Britain and Ireland, with around 99 individuals of 27 species. This paper examines the likely causes of this unprecedented event, including the well-timed and ideally attributed transatlantic storm system that likely carried many birds to Europe, as well as indirect causes, such as solar activity and atmospheric pollution.

## Introduction

Pulses of intense autumn bird migration characterise September and October in northeastern North America (Farnsworth *et al.* 2016) and, although most of this migration occurs over land, several hundred million birds migrate over the western North Atlantic (Dokter *et al.* 2018). These transoceanic migrants are vulnerable to displacement by storms, and the annual autumn arrival of small numbers of Nearctic landbirds in Europe is, for many, one of the most anticipated events of the ornithological calendar. These vagrants are typically entrained in circulation around warm and moist air masses with southwesterly winds (i.e. low-pressure systems) ahead of continental cold air masses with northwesterly winds (i.e. high-pressure systems) passing across the eastern coastline of North America and into the western North Atlantic. Once entrained within such a weather system, the birds are carried eastward towards Europe in rapidly moving depressions or along frontal waves (Elkins 1979, 1999; Lees & Gilroy 2009). Between 1967 and 2006, the peak arrival time for transatlantic vagrants in Britain and Ireland was consistently the second week of October (Elkins 2008). This timing has shaped birder

behaviour for decades; for example, it has determined the peak of the 'Scilly Season' and the maximum numbers of observers on that archipelago.

The composition of vagrants has been quite predictable over the decades, too, with a few species dominating – particularly Red-eyed Vireo *Vireo olivaceus*, which has over 170 accepted records in Britain up to 2022; but there has also been a long statistical 'tail' of rare (and hence highly sought-after) species recorded on only a few occasions. The variation in the relative frequency at which different species occur as vagrants in Europe is well predicted by life-history traits, with the species most frequently occurring as vagrants typically being larger-bodied birds that are longer-distance and later-departing migrants, especially species with non-breeding ranges in South America (McLaren *et al.* 2006).

Prior to 2023, the best autumn for number and diversity of Nearctic landbird vagrants in Britain and Ireland was in 1985, when 42 individuals were recorded in October alone. This peak was followed by a gradual decrease in the annual number of records of North American landbirds, hypothesised to relate to changes in the distribution of the tracks of low-pressure systems across the North Atlantic (Elkins 2008). These changes may have favoured increasing arrivals further south on the Azores (Elkins 2008), where, by January 2022, 72 species of Nearctic landbirds (60 passerines and 12 non-passerines) had been recorded on Corvo and Flores (Monticelli *et al.* 2022). However, dedicated autumn birder coverage of the westernmost Azores is only a recent phenomenon (post 2005), so it is unclear whether significant changes in diversity and numbers there are the result of migrant ecology or of increased observer effort. Moreover, Nearctic landbirds have also consistently appeared on Iceland and the Northern Isles throughout the period, highlighting the challenges of such generalisations.

Against this backdrop of seemingly diminishing returns, the mass arrival of Nearctic landbirds in mid September 2023 was, therefore, all the more remarkable. Here, we explore the nature of the arrival of Nearctic landbirds in space and in time through the autumn of 2023 in Britain and Ireland, with an eye on arrivals elsewhere in the Western Palearctic and some speculation on the causes of this displacement. Many records listed below are subject to acceptance by the relevant national committees, and more records may yet be forthcoming.

## The September 2023 fall(s)

The 2023 Nearctic landbird season started when the second-ever Norwegian record of Common Yellowthroat *Geothlypis trichas* was found at Vжгшщ, Nordland, on 7th August – an extremely early date for a Nearctic landbird in Europe. This was followed by an unprecedented influx of at least 22 American Cliff Swallows *Petrochelidon pyrrhonota* into Iceland, starting on 30th August, with the last birds noted on 6th September; four days later, there were ten together at Terceira, the Azores.

The first Nearctic landbird of the autumn in Britain was an American Yellow Warbler *Setophaga aestiva* on Foula, Shetland, on 5th September.

The next arrivals in Europe were another American Cliff Swallow in Iceland on 11th September, which was joined by a second bird on 14th September, and a Tennessee Warbler *Leiothlypis peregrina* on St Kilda, Outer Hebrides, and a Yellow Warbler on Corvo, the Azores, both found on 15th.

American Cliff Swallows reached Fuerteventura, Canary Islands, on 17th

September (the first record for Spain (Pardo de Santayana *et al.* 2023)) and North Foreland, Kent, on 19th September. A Red-eyed Vireo was found on the Isles of Scilly, also on 19th September.

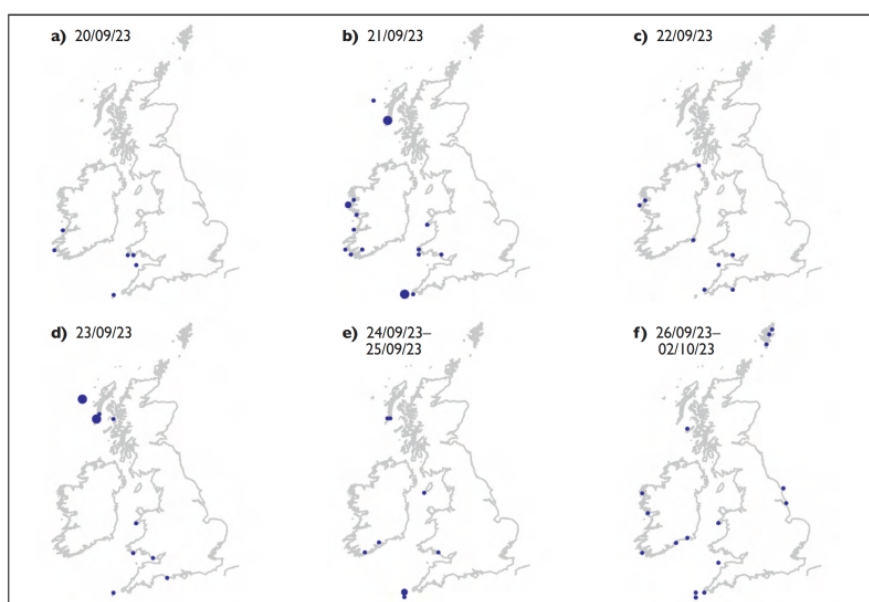
The vast latitudinal span of the birds found between 11th and 19th September suggests that their arrivals were largely unconnected and were brought about by different weather systems or even 'trickle down' movements following an earlier northern arrival.



**233.** American Yellow Warbler *Setophaga aestiva*, Hoswick, Mainland, Shetland, 14th October 2023.

The 'main event' of the autumn started on the morning of 20th September, heralded by a Blackburnian Warbler *S. fusca* on the Skellig Islands, Co. Kerry, the first record for Ireland and eighth for the Western Palearctic. At 10.54°W, this is the westernmost point in Europe and first possible landfall for vagrants arriving from the Nearctic (see fig. 1). This was followed on the same day by

American Cliff Swallows on the Isles of Scilly and in Co. Clare, a Red-eyed Vireo on Lundy, Devon, and an Alder Flycatcher *Empidonax alnorum* and a Magnolia Warbler *S. magnolia* in Pembrokeshire. This was eclipsed the following day by the largest and most taxonomically diverse single-day tally of Nearctic vagrant arrivals ever recorded from Britain and Ireland: new landbirds were detected from Scilly to the Outer Hebrides and the list was dominated by nine Red-eyed Vireos (three in Ireland, six in Britain) and three American Cliff Swallows in southwest Ireland. Additionally, there were two Black-and-white Warblers *Mniotilta varia* (one on the Isles of Scilly and one on Bardsey, Caernarfonshire); two Baltimore Orioles *Icterus galbula* on Inishbofin, Co. Galway; a Tennessee Warbler on Barra, Outer Hebrides; and the first of what would eventually become four 'American Pipits' *Anthus rubescens rubescens* on St Kilda. Setting the trend for the following days, it was Pembrokeshire that stole the show again, with a Bobolink *Dolichonyx oryzivorus* joining the Alder Flycatcher on Skokholm and Britain's second Bay-breasted Warbler *S. castaneaeon* nearby Ramsey Island (plate 234).



**Fig. 1.** Timing and location of finding of



individual Nearctic vagrant landbirds between 20th September and 2nd October 2023.



**234.** Bay-breasted Warbler

*Setophaga castanea*, Ramsey Island,  
Pembrokeshire, 21st September 2023.

The following day, 22nd September, was quieter for new finds with 'only' four Red-eyed Vireos, two American Cliff Swallows (in Co. Wexford and Glamorgan), a Bobolink in Glamorgan, an unidentified *Empidonax* flycatcher at Cilan Head, Gwynedd, a Tennessee Warbler on Inishbofin and a Baltimore Oriole on Rathlin Island, Co. Antrim, the last being the only Nearctic passerine of the autumn recorded in Northern Ireland. The next day, 23rd, fell on a Saturday and, likely due in part to more observers in the field, a further 13 new Nearctic landbirds were found, including four Red-eyed Vireos, two of which were on Barra along with a Philadelphia Vireo *V. philadelphicus*. A second Black-and-white Warbler was ringed on Bardsey; an Ovenbird *Seiurus*

*aurocapilla* was on Rum, Argyll; a Northern Parula *Setophaga americana* was on the Isles of Scilly; and Britain's first Canada Warbler *Cardellina canadensis* was discovered on the Pembrokeshire coast – remarkably, only 5 km away from the Magnolia Warbler and found by the same observer.

Only four new birds were discovered on Sunday 24th September: two American Cliff Swallows in Ireland, a Magnolia Warbler in Glamorgan and a new Tennessee Warbler on Barra. The following day, five Red-eyed Vireos and a Bobolink were found. These likely included reorienting individuals, as all except a Red-eyed Vireo on the Calf of Man, which stayed a further nine days and may have been a fresh arrival (see 'Body condition and length of stay'), were gone by the following day. A Blackburnian Warbler on Mainland, Shetland, on 26th (plate 235) was also a one-day wonder, as was another American Cliff Swallow found in Ireland, while a new Red-eyed Vireo on Tiree, Argyll, stayed eight days.



**235.** Blackburnian Warbler *Setophaga fusca*, Mainland, Shetland, 26th September.



The following two days were quiet for Nearctic arrivals, with two more Red-eyed Vireos and, incredibly, a third Black-and-white Warbler ringed on Bardsey. On 29th September, seven individuals of seven species were discovered: an American Cliff Swallow, a Red-eyed Vireo, a Tennessee Warbler, a Baltimore Oriole, a Bobolink, the only Veery *Catharus fuscescens* of the autumn, on mainland Shetland, and Ireland's first Cape May Warbler *S. tigrina*, on Achill Island, Co. Mayo. The last day of the month saw an American Yellow Warbler on Tiree, another Bobolink join the one in residence on St Mary's, Isles of Scilly (with three thought to be present the following day), and the first east-coast Red-eyed Vireo of the autumn, at Bempton Cliffs, Yorkshire.

Elsewhere in the Western Palearctic, records roughly mirrored those in Britain and Ireland. Corvo was inundated with Nearctic landbirds during the last ten days of September, seemingly as a result of the same frontal system. Species composition there was broadly similar to that of the arrival further north with, for example, Red-eyed Vireos, Philadelphia Vireos, American Cliff Swallows, 'American Pipit', Baltimore Oriole, Ovenbirds, Black-and-white Warblers, Tennessee Warbler, Northern Parula, Blackburnian Warbler and American Yellow Warblers all found. Corvo also recorded Yellow-throated Vireo *V. flavifrons*, Grey-cheeked Thrush *Catharus minimus*, Northern Waterthrush *Parkesia noveboracensis*, American Redstart *S. ruticilla*, Chestnut-sided Warbler *S. pensylvanica*, Wilson's Warbler *Cardellina pusilla*, Common Yellowthroats, and the Western Palearctic's first Mourning Warbler *Geothlypis philadelphia*.

Away from the Azores, arrivals elsewhere in Europe were modest but included a Tennessee Warbler in Iceland on 22nd September and three American Cliff Swallows there on 24th, a Red-eyed Vireo on Rogaland,

Norway, on 27th September, a Belted Kingfisher *Megaceryle alcyon* in Spain on the same day, and a American Pipit and American Yellow Warbler in France on 30th September.

## Discoveries in October

No new Nearctic landbirds were discovered in Britain and Ireland on 1st October – the first day with no new records since 19th September; throughout the month, only 16 new individuals were reported, in comparison to 76 in September. On 2nd October, a Red-eyed Vireo was found in Yorkshire, one of three new individuals recorded in the month (the others being on Lundy and the Isles of Scilly).

A number of new species for the autumn were found during the first half of October, including a Mourning Dove *Zenaida macroura* on Inishmore, Co. Galway, on 3rd; a White-crowned Sparrow *Zonotrichia leucophrys* on Fetlar on 8th; and a Swainson's Thrush *C. ustulatus* on Barra on 9th. Additional finds comprised three Black-and-white Warblers (in Co. Cork, Co. Galway and Cornwall) and an American Cliff Swallow, a American Pipit, a Baltimore Oriole and an American Yellow Warbler.

The latter half of October produced two Grey-cheeked Thrushes, on Inishbofin on 20th, and St Mary's, on 26th. An at-sea Black-throated Blue Warbler *S. caerulescens* was recorded off Cork, and a presumed stowaway Great-tailed Grackle *Quiscalus mexicanus* was found in Pembrokeshire (see 'A role for assisted passage?').

Elsewhere in the Western Palearctic, the first half of October was relatively poor for new arrivals, although notable records included the third Scarlet

Tanager *Piranga olivacea* for France on 9th October (preceded by one on Corvo on 8th, along with a White-eyed Vireo *V. griseus*), and the second Swainson's Thrush for Sweden on 10th October.

The second half of the month opened with the fourth German record of Swainson's Thrush, a Hermit Thrush *C. guttatus* in Iceland, and a White-crowned Sparrow on the Faroe Islands. These records were eclipsed two days later when an Ovenbird was ringed in Romania, the first national record. The last series of weather fronts of the month brought a Yellow-billed Cuckoo *Coccyzus americanus* to Vendôme, France, on 19th October; an American Redstart to Snjfellnes, Iceland, the following day; a late Red-eyed Vireo to Ouessant, France, on 25th October; and a Chimney Swift *Chaetura pelagica* to Finistère, France, the next day.

The Azores had been relatively quiet in early October, but things picked up from mid-month onwards with, for example, a Common Nighthawk *Chordeiles minor*, Yellow-billed Cuckoo, Red-eyed Vireos, Baltimore Oriole, Ovenbird and Rose-breasted Grosbeak *Pheucticus ludovicianus* new on Corvo on 16th. A remarkable nine Grey-cheeked Thrushes and 17 Swainson's Thrushes were found on the archipelago between 19th October and the month's end.

## November and into 2024

There were three new discoveries in November: a Rose-breasted Grosbeak at Skibbereen, Co. Cork, on 4th; a Cape May Warbler on Bryher, Scilly (plate 236), found on 10th and remaining for 25 days; and an American Robin *Turdus migratorius* on Dursey Island, Co. Cork, on 13th.



**236.** Cape May Warbler *Setophaga tigrina*,  
Bryher, Scilly, 25th November 2023.

In December, a White-crowned Sparrow was found in Cornwall on 2nd, where it remained for 12 days; a Dark-eyed Junco *Junco hyemalis* was found in Co. Wicklow on 5th; and an American Robin was present in Caithness on 20th.

High hopes for the discovery of more overwintering Nearctic landbirds were left unfulfilled until a Northern Waterthrush was found at Maldon, Essex, on 3rd January 2024, with the bird staying until at least 22nd January; and a Myrtle Warbler was found at Kilwinning, Ayrshire, on 20th February, remaining until 17th April.

Elsewhere, Italy's first American Pipit was found on Linosa Island on 3rd November and Spain's first Blackpoll Warbler *S. striata* was on Fuerteventura, Canary Islands, on 12th November. Another first for Spain – a Swainson's Thrush – was present in Galicia from 23rd to 25th November.

# Causes of September's fall

## Weather

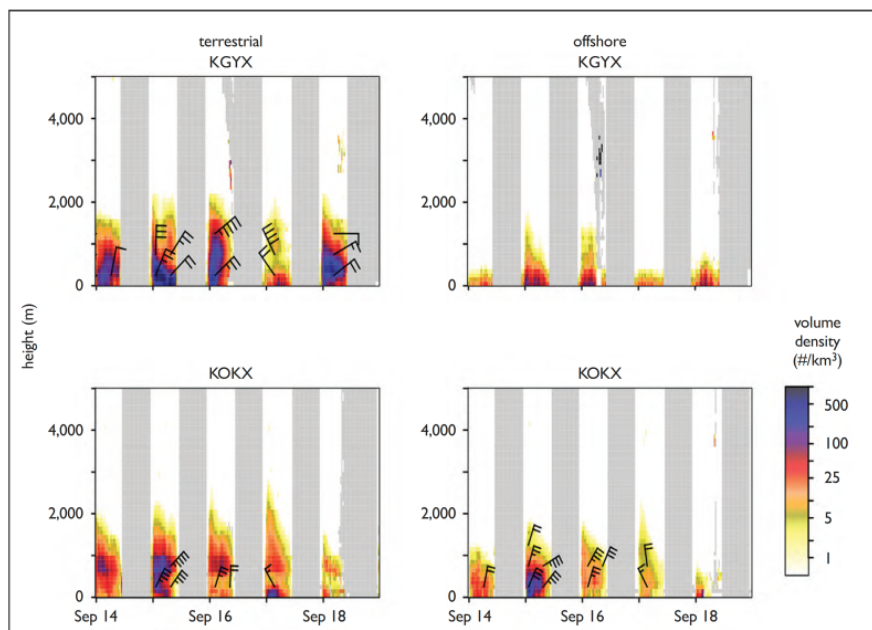
Hurricane Lee was, in many ways, an archetypal example of a vagrant-carrying transatlantic storm. Having rolled slowly northwards from the tropics towards northeastern North America over the duration of several days, it made a dramatic landfall in New England and Nova Scotia on 16th September, before abruptly changing course and speeding eastwards across the Atlantic. As it did so, it dragged an intense 'warm sector' of moist air and fast winds on its southern side, the epicentre of which made a direct pass of the Britain and Ireland over 19th and 20th September. While the trajectory and speed of the storm ticked all the boxes for a classic displacement event, the magnitude of the vagrancy event it delivered still came as a shock. Indeed, objectively similar storms are not all that infrequent – perhaps not quite annual, but storms with similar trajectories and transit speeds are certainly to be expected every one or two autumns – but cannot always be guaranteed to deliver many vagrants, if any. The wind speeds associated with Hurricane Lee were not particularly extraordinary and, while it made a notably rapid transit, it is not unusual for storms of this magnitude to cross the Atlantic in under 48 hours. So, what was it about Lee that made it so special?

The answer, we believe, lies in a suite of inter-related factors that in combination made this a 'perfect storm' (or nightmare storm from a migrant's point of view). Many of these factors were not directly related to the weather system itself (see subsequent sections) but there were nevertheless several important details that likely made Hurricane Lee an unusually potent storm for vagrancy. In particular, the precise timing and pathway of the storm's



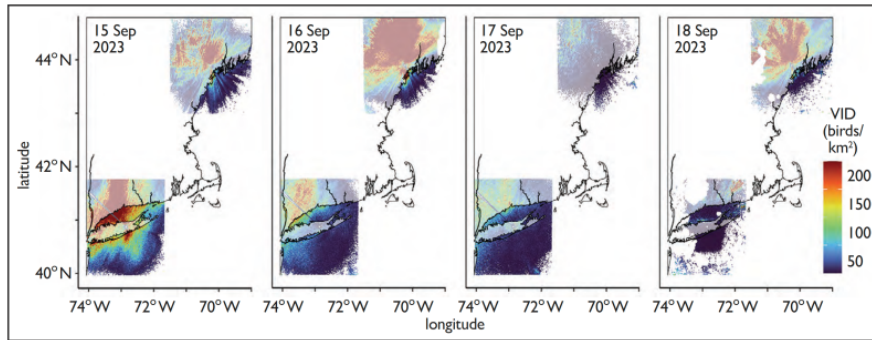
movement during its brief transit of the eastern North American land mass may have been integral to its entrainment of such an unprecedented avian cargo.

An important part of the story concerns the days that preceded Lee's initial approach towards North America. On the nights of 14th and 15th September, with Lee still far to the south, clear skies and light northerly winds across New England provided perfect conditions for migration, triggering huge overnight departures (fig. 2). Analysis of weather-surveillance radar data revealed that, in coastal Maine, approximately 3–7% of total average seasonal migration traffic (an estimated 60–120 million birds) occurred on those nights, with similar proportions in Massachusetts (3–6%) and New York (5–7%). Although the average direction of radar-detected flight was towards the southwest, significant movements were oriented offshore or even perpendicular to the coast, highlighting large numbers of birds moving over water (fig. 3).



**Fig. 2.** Weather-surveillance radar-detected

bird density on five nights in the coastal, northeastern USA by altitude over land and water. Upper row shows data from the KGYX radar station, Portland, Maine, over land (upper left) and over water (upper right); lower row shows data from the KOKX radar station, Brookhaven, New York, over land (lower left) and over water (lower right). Arrows with barbs point to the direction in which birds moved, with each barb representing 10 km/h – this representation is possible only over land (Curley *et al.* in prep.). Note that areas of very high densities (e.g. at 3,000 m height in the offshore KGYX plot) are spurious precipitation data that have broken through meteorological exclusions and do not represent birds; additionally, areas of grey shading represent diurnal periods during which radar data are not presented due to heavily nocturnal bias in migration behaviours in the region. For methodological details, see Dokter *et al.* (2011).

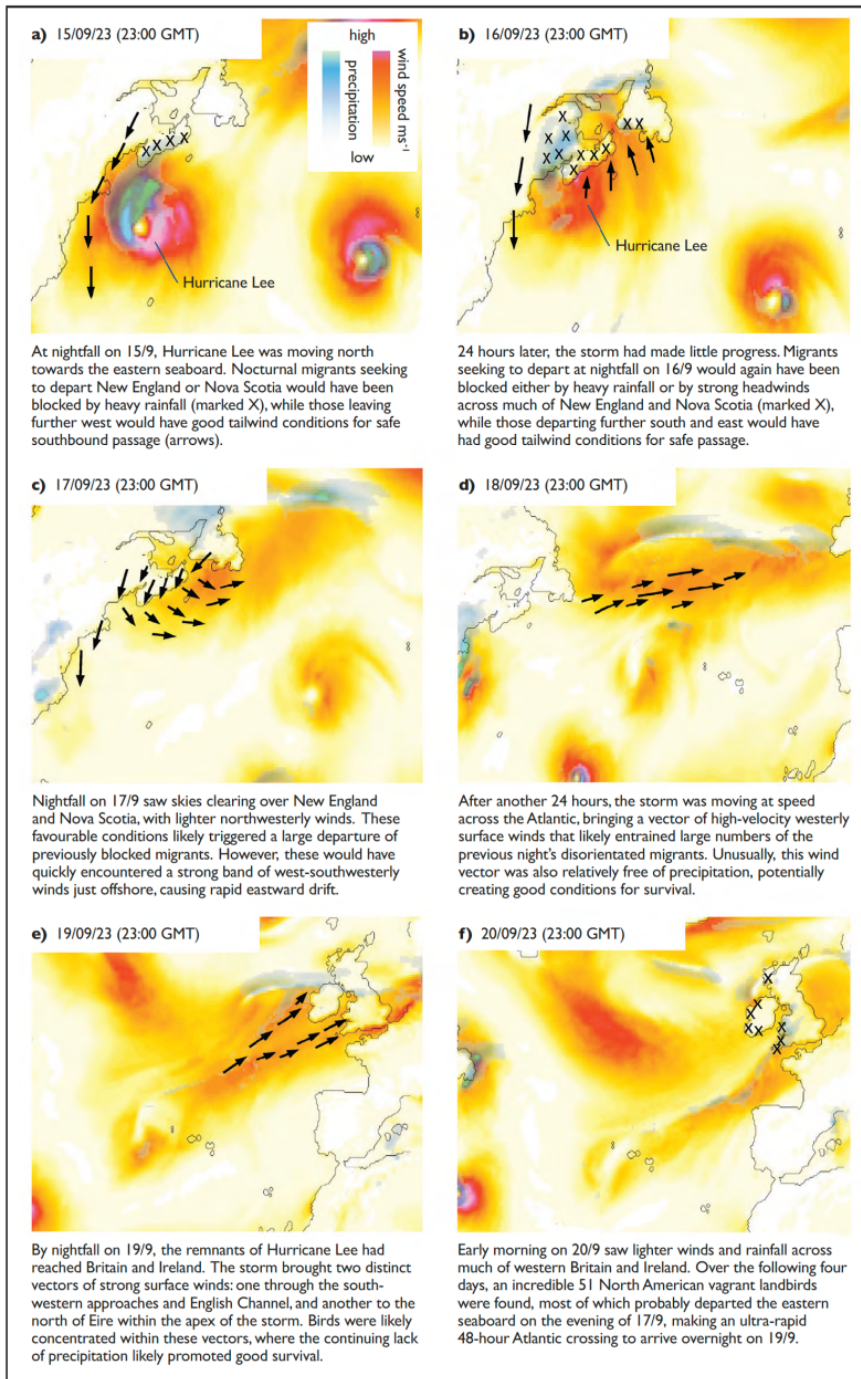


**Fig. 3.** Bird migration volumes in the northeastern USA up to the 48 hours before Hurricane Lee's landfall in Britain and Ireland as recorded by weather radar. Weather surveillance data were downloaded for the period from 0000 UTC on 15th September 2023 to 2359 UTC on 19th September 2023 for radar stations KGYX (Portland, Maine) and KOKX (Brookhaven, New York), within a radius covering terrestrial and offshore areas from 5 km to 75 km from the radars. Precipitation data were excluded based on methods in Dokter *et al.* (2011, 2019). The greater the distance a radar is geographically from a coastline, the more likely its beam will overshoot lower altitude sampling, and therefore not detect migration, in this case, birds offshore; therefore, we applied machine learning models to predict offshore migration densities at low altitudes and account for range corrections (Dokter *et al.* 2019; Kranstauber *et al.* 2020; Curley *et al.* in prep.).

This figure employs compiled altitudinal data up to 4 km above the ground (i.e. polar volumes) sampled three hours after local sunset, when, on average, the highest densities of migrating birds occur aloft over land (e.g. Van Doren & Horton 2018).

Despite the ideal departure conditions over the mainland, many of the departing migrants were heading straight into a band of strong headwinds on the approaching offshore edge of Hurricane Lee, pushing them back northwards towards New England and up towards Nova Scotia. Accounts of huge migrant falls on boats and islands in that region on 14th–16th September indicate the scale of this northward displacement – and many more migrants may have become entrained in the high winds of Lee itself and pushed out into the Atlantic.

This northward displacement likely also delivered large numbers of migrants to areas further north on the North American coastline on 15th and 16th September (fig. 4a), in addition to the huge numbers that would normally be gathering in preparation to depart at this time of year. During the day on 16th September, Hurricane Lee then made landfall in Nova Scotia, bringing torrential rain that inevitably grounded the majority of those birds for another night. Further south, in New England, a window of clearer skies and northerly tailwinds could have encouraged a departure (fig. 4b), with some of these birds potentially then being entrained in strong westerly winds in the tail of the storm and drifted out into the Atlantic.



**Fig. 4.** Annotated weather maps for the period 15th–20th September 2023, detailing hypothesised movements of Nearctic landbirds associated with the passage of Hurricane Lee.



However, the most significant activity of the storm, in our view, likely occurred on September 17th – the day when Lee shifted course and headed back offshore towards Europe (fig. 4c). The precise timing of this shift was significant. Shortly after nightfall on 17th, the storm was centred just offshore of northern Nova Scotia and south of Newfoundland. In this critical window, when nocturnal migrants initiate their flights, the storm's offshore position meant that there were relatively clear skies and northerly tailwinds across much of the Nova Scotia land mass (fig. 4c) – ideal migration conditions that likely triggered another significant departure (unfortunately outside the range of the US radar system; Canadian radar data were not readily available to include in our analysis). These migrants were destined to meet a wall of powerful westerly winds on Lee's southern side. At this point, Lee quickly gained momentum and headed east across the Atlantic. Birds that became entrained in these westerly winds on the night of 17th September would have been rapidly dragged offshore, trapped within a conveyor belt of winds that put them on a course straight for Britain (fig. 4d). This wind belt would then develop into the storm's 'warm sector' as the frontal system expanded on its leading edge. The speed of the storm's crossing meant that any departing migrants entrained on 17th September would have reached Britain and Ireland within just 48 hours, well within the endurance capacity of many long-distance migrant species.

As the storm approached the European coastline on 19th, another interesting feature became apparent: the warm sector behind the leading frontal system was unusually clear of precipitation (fig. 4d), meaning that birds within the warm wind vector were also likely to have been keeping relatively dry. This may have promoted higher than average survival rates, given that birds entrained in such storms often have to contend with intense rainfall

alongside the extreme winds and endurance flight conditions. On the day of the storm's initial landfall, 19th September, only two Nearctic landbirds were found (an American Cliff Swallow in Kent and a Red-eyed Vireo on Scilly); but subsequent days delivered a remarkable number and diversity of vagrants, the majority of which were likely to have made landfall when the storm first arrived. Subsequent weather systems at the end of September and into October may have brought a few additional arrivals, but none had characteristics similar to Lee. It is therefore likely that this single storm was the primary source of the record-breaking numbers of vagrants seen during the autumn.

## A role for assisted passage?

Ship assistance is a significant contributor to transatlantic vagrancy in Nearctic landbirds (e.g. Durand 1963); indeed, twentieth-century ornithologists needed convincing that the unassisted passage of landbirds occurs at all (e.g. Richmond 1954). There were a number of well-documented cases of assisted passage in autumn 2023, starting with four American Cliff Swallows seen resting on the deck of a ship off Reykjavik, Iceland, on 28th August, which was bound for Belfast. Additionally, one American Cliff Swallow was found dead on board a ship at Seaforth Docks, Lancashire & North Merseyside, on 17th September.

No reports were received of live landbirds aboard ships close to or in ports in Britain or Ireland during the main arrival period from mid to late September (although see later comments about American Pipits south of Greenland), but the first Belgian record of Black-and-white Warbler was found adjacent to the Port of Antwerp on September 24th and was presumably ship-assisted for at least the last part of its journey.

However, there were two significant records of Nearctic landbirds on boats in October. First, an *Empidonax* flycatcher sp. alighted on a boat 17 km southwest of Skokholm on 1st. Second, a Black-throated Blue Warbler was recorded on 15th October on *The Sky Princess* in Irish waters, c. 225 km off Mizen Head, Co. Cork, and was then observed flying towards the mainland.

A Great-tailed Grackle at Nolton Haven, Pembrokeshire, on 25th–29th October was almost certainly ship-assisted, as the species is only a partial migrant with little evidence for historical vagrancy in North America. St Brides Bay is a regular anchoring point for shipping in transit from the US to Milford Haven and the species has been widely reported as making ship-assisted movements, even colonising multiple Caribbean islands by this mode of dispersal (Kirwan *et al.*2019).

Only a single North American sparrow arrived during autumn 2023, a White-crowned Sparrow, on Fetlar on 8th–11th October. This species is one of the most migratory of North American sparrows but, along with Mourning Dove, is still a short-distance migrant compared with the majority of species recorded during the autumn. North American sparrows have long been treated with justifiable scepticism in comparison with records of long-distance Nearctic– Neotropical migrants (e.g. Nisbet 1963). North American sparrows comprised 60 out of 114 of the passerines observed on R.M.S. *Mauretania* during a transatlantic voyage from 7th to 14th October 1962 and comprised seven of the eight passerines remaining on the ship as it arrived in Europe (Durand 1963). The sole record of any North American sparrow on the Isles of Scilly concerns a single White-throated Sparrow *Zonotrichia albicollis* on St Agnes in May 2010. The bird had flecks of green paint on its plumage, likely acquired on board a ship. This was one of seven individuals recorded in Britain that spring, a tally that does not

include one that arrived in Southampton Docks, Hampshire, on 6th May, which was one of five that had been aboard the *Queen Mary II* since it departed New York a week earlier. Four of the five birds had still been aboard the vessel on 5th May, when it passed within 30 km of the Isles of Scilly and the southern coastlines of Cornwall and Devon, but they left ship before the boat docked in Southampton (Hudson 2011).

The relative rarity of North American sparrows on the Isles of Scilly (an otherwise prime location for Nearctic landbird vagrants) can best be explained by the avoidance of this navigationally hazardous archipelago by commercial shipping and it seems possible that no members of this group make unassisted crossings to Europe. A Dark-eyed Junco was ship-assisted to Iceland in November 2023 and it would appear likely that the bird seen in Ireland came by the same route. Along with other North American sparrows, the distribution of records of juncos is quite different from that of, for example, *Catharus* thrushes, with most records away from west-coast headlands and many records occurring in spring. These spring records are also likely to be ship assisted; for example, a Dark-eyed Junco transiting between North Ronaldsay and Fair Isle on board a ship headed for Norway on 25th April 2023 was keeping company with a Song Sparrow *Melospiza melodia*, a species for which records of European vagrants are tightly clustered around ports or islands near major shipping lanes. Considering the species composition (long-distance migrants), timing of arrival (concurrent with the weather front) and arrival locations (westerly headlands and islands), it would seem likely that ship assistance was not responsible for at least most of the vagrants detected in the September fall, but was probably at least partly responsible for several October arrivals.

# Geomagnetic storms and ash clouds

Migrant birds use the earth's magnetic field as a sensory cue and geomagnetic disturbances from solar storms decrease the reliability of this field for avian orientation and navigation (e.g. Schreiber & Rossi 1978, Bianco *et al.* 2019). A recent Doppler radar study showed that fewer birds migrate during periods of geomagnetic disturbance, possibly owing to increased difficulty orienting and navigating; this is especially true during overcast conditions, when migrants are more subject to wind drift during periods of geomagnetic disturbances (Gulson-Castillo *et al.* 2023). Consequently, it should come as no surprise that there is also strong correlative evidence from North America that disruption to the earth's magnetic field leads to increased rates of vagrancy during autumn migration (Tonelli *et al.* 2023).

There were three significant geomagnetic storm events in September 2023 around the time of Hurricane Lee's passage, with the two most significant being a moderate 'G2' storm (Kp index = 6) on 13th September and a strong 'G3' geomagnetic storm on 18th September (Kp 7). These storms coincide with an increasingly active period of the sun's 11-year solar cycle, with peak solar flare activity estimated to occur in 2025 after a minimum in 2020. Combined with overcast conditions on the Atlantic western seaboard, the solar storms could have contributed to bird misorientation and increased the chance of eastward wind drift with the remnants of Hurricane Lee.

An additional source of interference for bird migration is atmospheric pollution, including from wildfires. Summer boreal forest fires have been increasing in extent, frequency and severity in recent years (Zheng *et al.* 2023; Li *et al.* 2024) and extending unseasonably into September and October. In



autumn 2023, intense burning on 15th and 22nd September in British Columbia and Alberta fuelled several pyrocumulonimbus clouds that lifted smoke high in the atmosphere, where fast-moving, upper-level winds then spread it widely (<https://earthobservatory.nasa.gov/images/151985/tracking-canadas-extreme-2023-fire-season>), with smoke plumes reaching the US eastern seaboard. Earlier in the year, record-setting fires burned 4.5 million ha of forest in Quebec (Boulanger *et al.* 2024). It has been shown recently that wildland fires can disrupt bird migration; for example, satellite-tagged White-fronted Geese *Anser albifrons* in North America have been observed deviating from their normal migration routes to avoid areas of atmospheric pollution caused by wildfires, including back-tracking and exhibiting unusual stopover behaviour (Overton *et al.* 2022). It would seem likely that continent-spanning ash clouds in mid September also had the potential to contribute to bird displacement and disorientation. Moreover, widespread breeding failures appeared to occur for many boreal breeding songbirds, with numerous accounts of observers detecting low-weight adults in unexpected and unseasonably early times and places, suggesting additional impacts on birds' movement ecology.

## Budworm outbreaks

Alongside fire, another major agent of disturbance in boreal forests is outbreaks of defoliating insects, such as the Eastern Spruce Budworm *Choristoneura fumiferana*, a moth that can cause heavy tree mortality, particularly of Balsam Fir *Abies balsamea* and White Spruce *Picea glauca*. Outbreaks in 1910, 1940 and 1970 were estimated to have covered 10, 25 and 55 million ha respectively (Blais 1983). Budworm outbreaks also temporarily increase fire frequency by boosting fuel load of dead vegetation,

leading to a synergy between these two agents of forest disturbance (Sato *et al.* 2023). Outbreaks can lead to rapid increases in insectivorous passerine population density, with 30 species shown to respond positively to this increased food abundance (Venier & Holmes 2010). Three species in particular are known to be strongly linked to budworm outbreaks and have been labelled 'budworm-linked warblers' – Tennessee, Cape May and Bay-breasted Warbler (Perrier *et al.* 2021) – although this association is sometimes extended to other species too, such as Canada Warbler and Ovenbird.

Patten & Burger (1998) found that budworm population density was an excellent predictor of the annual totals of vagrant Cape May, Bay-breasted and Canada Warblers in California, with records of these species temporally clustered; records of Cape May and Bay-breasted Warbler were especially highly correlated. They also found that records of Magnolia Warbler were negatively associated with those of budworm specialists – likely because of competition with those species. Black-throated Green *S. virens* and Blackburnian Warblers showed no association with budworm abundance. A major budworm outbreak has been building in Quebec since 2006 and has now impacted more than 13 million ha of forests ([www.sprucebudwormmaine.org/resources/maine-spruce-budworm-task-force-report](http://www.sprucebudwormmaine.org/resources/maine-spruce-budworm-task-force-report)) and is likely to be positively impacting population sizes of the 'linked' warblers.

The second and third Western Palearctic records of Tennessee Warbler both occurred in 1975, at the height of the 1970s budworm outbreak, while over half of the ten British records and both Irish records have occurred since 2020, a highly clumped distribution coinciding with the current budworm outbreak. Similarly, of 11 records of Cape May Warblers in Europe following

the first in Scotland in 1977, nine have occurred since 2019 (four away from the Azores). For Bay-breasted Warbler, six of seven have been since 2017; all bar the first, in Cornwall in 1995, and 2023's Welsh bird, have been found on Corvo. The clumping in space and time of records of these three species is strongly suggestive that the current budworm outbreak has increased vagrancy rate by boosting populations of these species, and hence shaped the composition of vagrant species in autumn 2023 (and other recent years).

## Taxonomic and life-history diversity

Across the whole autumn there were reports of 99 Nearctic landbirds of 27 species in Britain and Ireland, of which around 73 individuals of 18 species were found in the last ten days of September (fig. 5). The slightly staggered timing and locations of their arrival (first in the southwest and west, then further to the northwest) is highly suggestive of arrivals from a southwesterly vector.

Nearly all of the species arriving during the major fall were long-distance, Neotropical migrants, including 47 individuals of eight species that spend the non-breeding season largely in South America: Bay-breasted, Blackburnian and Canada Warblers in northwest South America; Red-eyed Vireo, Alder Flycatcher and Veery across widespread areas of tropical lowlands; and American Cliff Swallow and Bobolink further south in temperate South America. Several other species, such as Black-and-white, Tennessee and Yellow Warblers, winter widely in the Neotropics, including northern South America.

By contrast, there were only four records of American Pipit which is a migrant

but is found exclusively at temperate latitudes. All records in autumn 2023 came from St Kilda and may have been associated with a different weather system. Intriguingly, a single American Pipit was recorded at sea aboard a ship southeast of Greenland (57°36'23.5"N 33°08'18.1"

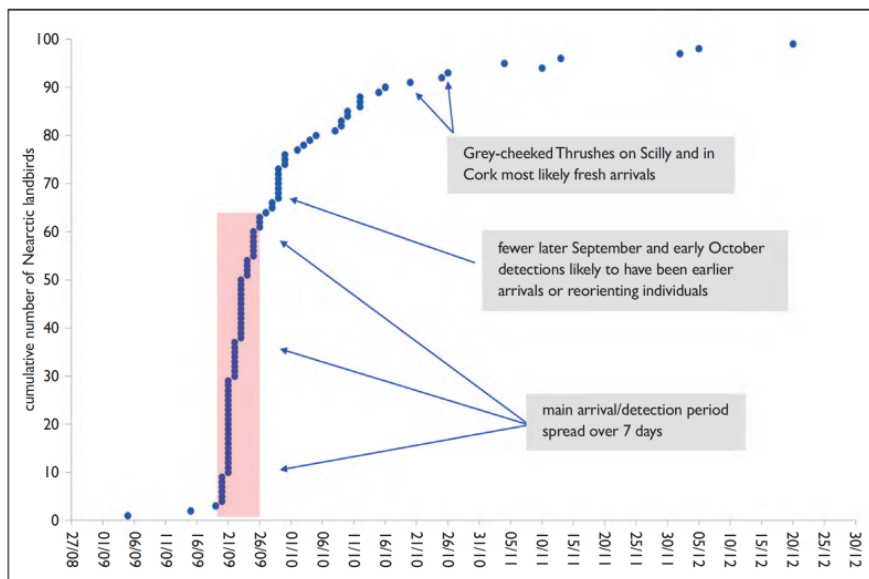
W; ebird.org/checklist/S150436316) on the afternoon of the 18th September and was still present at dusk, while it or a different bird followed the ship the next day east of the Labrador Sea (55°31'08.8"N 42°10'48.2"

W; ebird.org/checklist/S150436069) but failed to come aboard (Mike Pennington pers. comm.). However, this species was also recorded on the Azores and from France during this period, suggesting a potentially broader arrival.

Population size and trends are important predictors of vagrancy likelihood (e.g. DeBenedictis 1971, McLaren *et al.* 2006, Ralph and Wolfe 2018) and it should not come as a surprise that Red-eyed Vireos (estimated population size 130 million) and American Cliff Swallows (estimated population size 83 million), species with increasing population sizes and which undertake long-distance flights to South America in autumn, were recorded most frequently.

October was marked by relatively few new arrivals and some records during this time may have made landfall further north in September before recommencing southward movements – especially those individuals making short stays at well-watched sites, such as the Red-eyed Vireo trapped and ringed at Spurn, Yorkshire, on 2nd October (plate 237). However, the correlation with arrivals on the Azores and elsewhere in Europe is strongly indicative of fresh arrivals in the second half of the month, probably as a result of the gradual appearance of ship-assisted migrants and new crossings made by late-season highly migratory species, such as Grey-cheeked Thrush and Rose-breasted Grosbeak, for which parallel arrivals were

noted on the Azores. Many observers remarked on the absences of certain species; for instance, there were no reports of *Coccyzus* cuckoos or Blackpoll Warbler (the second-commonest Nearctic passerine vagrant) from Britain all autumn. However, these species, along with Grey-cheeked Thrush, for example, have a later peak migration, and it is likely that the September storm came too early to entrain them in large numbers, while subsequent October storms lacked the ideal conditions for vagrancy to western Europe.



**Fig. 5.** Over the whole September–December period, 60 of 99 records of Nearctic landbirds (61%) were first recorded in a seven-day window from 20th September (pink bounding box).



**237.** Red-eyed Vireo *Vireo olivaceus*, Spurn, Yorkshire, 2nd October 2023.

## Body condition and length of stay

Stopover length and body condition can give important clues as to when migrants undertook a transatlantic crossing. Individual vagrants are likely to be underweight immediately after completing a transatlantic crossing, as they will have exhausted most of the fat reserves they use as fuel to complete the journey. This necessitates a protracted, often multi-day stopover period to put on weight before resuming their migration. Across the whole autumn period, mean length of stay across all species was 3.9 days (SD 4.6, range 1–31 days). For arrivals during the period 20th–26th September, it was 3.1 days (SD 2.6, range 1–10 days). Feldman *et al.* (2021) investigated stopover behaviour of Red-eyed Vireos during autumn migration on the coast of the Yucatan Peninsula, Mexico, in 2016 and 2017, finding that around half of the tagged birds in the study departed on the day they were captured while the remainder stayed between one and seven nights, with one



outlier staying for 16 nights. These figures are quite comparable with the length of stay of vagrant Red-eyed Vireos in autumn 2023, with the average length of stay just 3.6 days.

Examination of the body masses of the five Red-eyed Vireos trapped in autumn 2023 is instructive for our understanding of their arrival and departure times. For example, the individual first caught on Lundy on 20th September weighed just 15.6 g (Joe Parker/Lundy Bird Observatory pers. comm.), which is close to the minimum range for individuals trapped on migration in the eastern USA during autumn migration (mean 18.5 g, range 15.5–25.1 g,  $n = 100$ , Monticelli *et al.* (2022)) and only 0.1 g heavier than one trapped on Corvo in October 2019 (Monticelli *et al.* 2022). This same Lundy individual was retrapped the next day, when it weighed 15.7 g, and again the day after, when it weighed 16.6 g. It stayed a further four days before departing. The initial low body weight and long stay are consistent with an individual attempting to regain mass in good habitat after a long flight. A Red-eyed Vireo trapped at Portland, Dorset, at 10.00 hrs on 23rd September weighed 16.2 g and was retrapped the following morning when it had lost 0.2 g overnight. The bird disappeared shortly thereafter, presumably seeking richer refuelling grounds (Martin Cade/Portland Bird Observatory pers. comm.).

By contrast, the second Red-eyed Vireo trapped on Lundy in autumn 2023 was present for just a single day, on 9th October, and weighed 20.3 g, which is above the mean weight of birds in the USA and consistent with a bird that has travelled only a modest distance on an overnight flight (i.e. from elsewhere within Britain), and thus was able to resume active migration the following night. Another one-day individual trapped at Spurn Bird Observatory on 2nd October weighed 19.5 g (Sarah Harris/Spurn Bird Observatory pers.

comms.), which is also consistent with a short migration hop.

A Red-eyed Vireo on the Calf of Man was first trapped on 25th September, when it weighed 14.3 g (Aron Sapsford/Calf of Man Bird Observatory pers. comms.). This is an extremely low weight for this species and indicative of an extremely recent arrival, presumably following a transatlantic crossing on the weather front that arrived the previous evening. This individual stayed for nine days. It was retrapped on 26th September and had gained 1.4 g (15.7 g) and, by 29th, it weighed 18.9 g. However, when it was caught for the final time on 3rd October, the day it was last seen, its weight had dropped to 16.6 g, perhaps indicating it was struggling to find sufficient food to put on weight. Its stay of nine days was longer than the stopover that most migrants make at the Calf of Man (Aron Sapsford/Calf of Man Bird Observatory pers. comms.).

## Conclusions

The total of around 99 individuals of 27 species is the highest-ever number of Nearctic landbirds found in Britain and Ireland in a single autumn, and echoes the record total from the Azores in 2023, which hosted 181 individuals of 36 species. We suggest that this richness in number and diversity was the result of several key factors, being directly related to the passage of a well-timed and ideally attributed storm system and indirectly related to impacts from contemporaneous conditions for atmospheric, environmental and anthropogenic activities. While extremely exciting for birders, large offshore displacements are obviously bad news for individual birds and there is some correlative evidence that increasing autumn storm intensity may drive declines in North American landbirds that have transoceanic migration routes

(Butler 2000). Major displacement events may thus have a significant impact on bird populations as the few vagrants that arrive in the Palearctic are assumed to represent the tip of the iceberg of displaced individuals. There is strong support for this hypothesis in the 50% reduction in Chimney Swifts in Quebec in the summer of 2006, following the displacement of large numbers of this species by Hurricane Wilma in late October 2005, which included 16 birds in Britain and Ireland (Dionne *et al.* 2008). Any increase in early autumn storms driven by a climate change may drive an increase in vagrancy in Nearctic landbirds, and whilst this may provide a temporary boon for birders, it will be short-lived if overall population sizes are impacted through mortality on migration.

## Acknowledgments

We would like to thank Sarah Harris at Spurn Bird Observatory, Joe Parker at Lundy Bird Observatory, Aron Sapsford at Calf of Man Bird Observatory and Martin Cade at Portland Bird Observatory for providing biometric data for trapped Red-eyed Vireos, and Mike Pennington for details of at-sea American Pipits.

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2024 Vol.117: Pages 292–307

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