

## Pelagic Bird Species Chronologies and Distributions for Chesapeake Bay and Its Tributaries

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**ABSTRACT:** Contemporary knowledge of pelagic species occurrence in the Chesapeake Bay and its tributaries is lacking, definitively limited, and/or up to six decades old. We used a database comprised of 1912–2017 published records to analyze the occurrence of 35 pelagic species. Northern Gannet (*Morus bassanus*) records are the most plentiful, distributed throughout the Bay and occur in all months. The span of time containing species records ranged from 70 days for Bridled Tern (*Onychoprion anaethetus*) to 324 days for Pomarine Jaeger (*Stercorarius pomarinus*). A total of 80% (n = 28) of the species and groups of difficult to separate species plus those with  $\leq 5$  records occurred in the second half of the year with 63% (n = 22) occurring within the period 4 July–6 September. Approximately 35% (n = 243) of the total species records (n = 701), excluding Sulidae and Alcidae species, were associated with tropical storms. Records show Potomac River with the highest diversity of species (18) with many records over 212 km (132 mi) upstream. This study provides the first pelagic species distribution and definitive chronologies for the Chesapeake Bay and its tributaries while providing important baseline information for future pelagic studies in the Bay.

**KEYWORDS:** Chesapeake Bay, chronologies, distribution, pelagic bird species

In the early 20<sup>th</sup> Century, wars and depressions gripped the country while public roadway systems with waterfront access were most likely inferior to later in the century. Similarly, there were probably fewer and less experienced bird watchers equipped with field guides and optics that would be considered inferior by current standards, and the practice of hiring commercial boats just to search offshore for pelagic species had yet to become a common practice. These factors may have contributed to the limited knowledge of pelagic species distribution, seasonal occurrences, and general habits in the Mid-Atlantic area (Stewart and Robbins 1958). Thus, much of what was known about pelagic species during that period may have been derived from birds blown into or found dead in towns

or cities during storm events in the western Atlantic Ocean (Ball 1931, Lincoln 1934, Dickinson and Calhoun 1939).

By the mid-20<sup>th</sup> Century, the country was again at peace and increasing numbers of bird watchers formed into organizations, field guides using vastly improved identification illustrations and methodologies became available, and constantly improving optical field equipment enabled observers to contribute much more information to our knowledge of pelagic species (Stewart and Robbins 1958). Furthermore, the addition of more regularly scheduled public ferries crossing the Chesapeake Bay and from the mainland to offshore islands (Handley 1934, Reed 1939, Beasley 1947, Scott 1956), plus construction of two bridges (William Preston Lane Jr. Memorial Bridge [Chesapeake Bay Bridge], Lucius J. Kellam Jr. Bridge-Tunnel [Chesapeake Bay Bridge-Tunnel]) across the Chesapeake Bay likely enabled one of the biggest boosts to reports of pelagic species during this period.

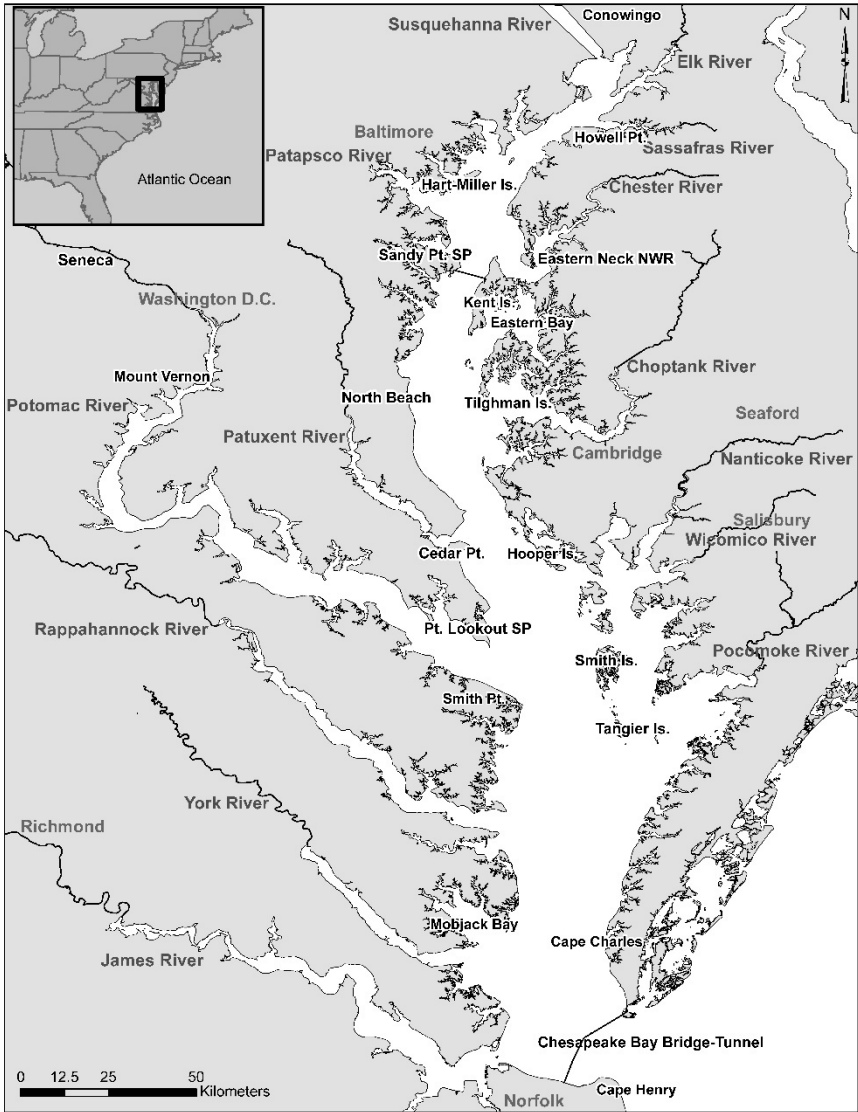
The 21<sup>st</sup> Century found new design technologies in binocular and spotting scopes, digital cameras, and various hand-held field devices available (e.g., GPS; cell telephones; text, visual, and audio species identification aids) plus more public shoreline vantage points for offshore viewing. These advancements vastly facilitated viewing opportunities, offshore detection, and more efficient and accurate identification, thus adding considerably to our knowledge concerning the timing occurrence and abundance of pelagic species.

In preparation for this paper, we systematically searched various reference books and periodic journals to compile a database of published records of pelagic species in Chesapeake Bay and its tributaries dating back to the beginning of the 20<sup>th</sup> Century. We subsequently sorted the database into subsets of individual species for analysis. Here we present the individual species chronology and distribution derived from those analyses.

## METHODS

### Study Area and Data Sources

The study area includes tidewater of Chesapeake Bay and its tributaries, plus locations within 2 km (1.2 mi) of the shorelines containing pelagic species records. Additionally, the portion above tidewater is included for three tributaries with pelagic species records, i.e., up to Richmond on the James River, Seneca on the Potomac River, and Conowingo on the Susquehanna River (Figure 1).



**Figure 1. Chesapeake Bay and its tributaries study area on Mid-Atlantic Coast of United States.**

Only published records in digitized journals and articles available to the public at various websites and/or personal hard copies of regional journals and reference books (Tables 1 and 2) were searched manually for records of pelagic species in Chesapeake Bay and its tributaries. Although the literature search was comprehensive, it was limited by lack of public access to regional publications such as *Bird Lore* (National Audubon Society), *Proceedings of the Biological Society of Washington* (Biological Society of Washington), *Atlantic Naturalist* (Audubon Society of the District of Columbia/Audubon Naturalist Society), *The Wood Thrush* (Audubon Society of the District of Columbia), *Bulletin of the Natural History Society of Maryland* (Natural History Society of Maryland), *Maryland: A Journal of Natural History* (Natural History Society of Maryland), *Transactions of the Maryland Academy of Sciences* (Maryland Academy of Sciences), *The Maryland Naturalist* (Natural History Society of Maryland), and *Maryland Conservationist* (Maryland Department of Natural Resources) which exist only in hard copy form not available outside private libraries. Additionally, there are gaps in consecutive years for some of the digitized journals, e.g., *The Raven* (Virginia Society of Ornithology) and *American Birds* (National Audubon Society). The data sources do not include unpublished records in eBird, museum specimen collections, various types of counts, personal records, and the databases of the Virginia Avian Records Committee (VARCOM) and the Maryland/District of Columbia Records Committee (MD/DCRC).

**Table 1. Publications searched in compilation of the pelagic bird records database.** Most pelagic species records were gleaned from various types of reports and articles contained within the listed journals.

Journals	Span of Searched Records: Year Volume(Issue)	Source
<i>American Birds</i>	1973 27(1) – 1994 48(1)	<a href="https://sora.unm.edu/node/209">https://sora.unm.edu/node/209</a>
<i>National Audubon Society Field Notes</i>	1994 48(2) – 1998 52(4)	<a href="https://sora.unm.edu/node/209">https://sora.unm.edu/node/209</a>
<i>North American Birds</i>	1999 53(1) – 2007 61(4)	<a href="https://sora.unm.edu/node/209">https://sora.unm.edu/node/209</a>
<i>The Raven</i>	1930 1(1) – 2013 84(2) 2014 85(1) – 2016 87(2)	<a href="http://www.cccbirds.org/resources/the-raven/">http://www.cccbirds.org/resources/the-raven/</a> Hard copies
<i>Virginia Birds</i>	2004 1(1) – 2016 13(1)	<a href="http://www.virginiabirds.org/publications/virginia-birds-journal/">http://www.virginiabirds.org/publications/virginia-birds-journal/</a>
<i>Maryland Birdlife</i>	1945 1(1) – 1999 55(4) 2000 56(1–4) – 2017 66(2)	<a href="https://sora.unm.edu/node/132691">sora.unm.edu/node/132691</a> Hard copies
<i>The Maryland Yellowthroat</i>	1980 1(1) – 2018 38(1)	Hard copies

**Table 2. Regional reference books and additional journal articles containing pelagic bird records used in the database.** This list contains articles from journals not listed in Table 1 with the exception of two articles from *The Raven* that provided multiple records.

Wetmore (1925)	Stewart and Robbins (1958)
Ball (1931)	Larner (1979)
Lincoln (1934)	Kain (1987)
Dickinson and Calhoun (1939)	Bazuin (1992)
Kolb and Bond (1943)	Brinkley et al. (2001)
Hampe and Kolb (1947)	Rottenborn and Brinkley (2007)

### Database

The published records contained 35 pelagic species identified for Chesapeake Bay and its tributaries; their common and scientific names are listed in Table 3. The published records consisted of single or multiple birds encountered at a location, but are recorded in the database as a date-of-record only, regardless of the number of individuals. The occurrence record for many individual species was published in more than one journal with the occurrence date in one journal being slightly different than that given in another journal. Incidences of this sort involved 93 individual occurrences, i.e., 186 published records. Additionally, there were 36 records involving a species seen at the same location on consecutive days. In the database, we used only the earliest date given for the published record when the date disparity was  $\leq 4$  days between that given in different publications. We used both the earliest date and latest date given when the publications disparity was  $\geq 5$  days and similarly when a range of consecutive days seen was given for a record. There were 11 records with non-definitive dates, e.g., “throughout May–June 1999”, “early April 1999”, “late August 1999”, or “September 1999”. We assigned these records a single date commensurate with the middle of months or portion of months provided, e.g., “15 May and 15 June”, “7 April”, “20 August”, and “15 September”, respectively. The database includes all pelagic species records given for Chesapeake Bay and its tributaries in periodic VARCOM and MD/DCRC reports published in their regional publications (i.e., *The Raven*, and *The Maryland Yellowthroat*, respectively) regardless of whether or not the identifications were “accepted” or the review status changed over time. Various count tallies (Christmas Bird Counts, seasonal counts, trip counts, etc.) have been published and/or digitized and made available at public portals, but in many cases specific locations and observers cannot be attributed to individual species from counts with such a wide inclusion of observers and locations. Thus, only records from Christmas Bird Counts known to include the Chesapeake Bay and/or portions of major tributaries (e.g., Newport News, Williamsburg,

Mathews County, Point Lookout, Crisfield, etc.) are included in the database. A few of these counts frequently included Northern Gannet and rarely Parasitic Jaeger, Razorbill, or Black-legged Kittiwake.

**TABLE 3. Pelagic species records for Chesapeake Bay and its tributaries.** Species names follow Chesser et al. (2018).

Family	Common Name	Scientific name
Scolopacidae	Red Phalarope	<i>Phalaropus fulicarius</i>
Stercorariidae	Great Skua	<i>Stercorarius skua</i>
	Pomarine Jaeger	<i>Stercorarius pomarinus</i>
	Parasitic Jaeger	<i>Stercorarius parasiticus</i>
	Long-tailed Jaeger	<i>Stercorarius longicaudus</i>
Alcidae	Dovekie	<i>Alle alle</i>
	Common Murre	<i>Uria aalge</i>
	Thick-billed Murre	<i>Uria lomvia</i>
	Razorbill	<i>Alca torda</i>
	Black Guillemot	<i>Cepphus grylle</i>
	Atlantic Puffin	<i>Fratercula arctica</i>
Laridae	Black-legged Kittiwake	<i>Rissa tridactyla</i>
	Sabine's Gull	<i>Xema sabini</i>
	Brown Noddy	<i>Anous stolidus</i>
	Sooty Tern	<i>Onychoprion fuscatus</i>
	Bridled Tern	<i>Onychoprion anaethetus</i>
	Roseate Tern	<i>Sterna dougallii</i>
	Arctic Tern	<i>Sterna paradisaea</i>
Phaethontidae	White-tailed Tropicbird	<i>Phaethon lepturus</i>
Oceanitidae	Wilson's Storm-Petrel	<i>Oceanites oceanicus</i>
	White-faced Storm-Petrel	<i>Pelagodroma marina</i>
Hydrobatidae	Leach's Storm-Petrel	<i>Oceanodroma leucorhoa</i>
	Band-rumped Storm-Petrel	<i>Oceanodroma castro</i>
Procellariidae	Northern Fulmar	<i>Fulmarus glacialis</i>
	Trindade Petrel	<i>Pterodroma arminjoniana</i>
	Black-capped Petrel	<i>Pterodroma hasitata</i>
	Bulwer's Petrel	<i>Bulweria bulwerii</i>
	Cory's Shearwater	<i>Calonectris diomedea</i>
	Sooty Shearwater	<i>Ardenna grisea</i>
	Great Shearwater	<i>Ardenna gravis</i>
	Manx Shearwater	<i>Puffinus puffinus</i>
	Audubon's Shearwater	<i>Puffinus lherminieri</i>
Fregatidae	Magnificent Frigatebird	<i>Fregata magnificens</i>
Sulidae	Brown Booby	<i>Sula leucogaster</i>
	Northern Gannet	<i>Morus bassanus</i>

A total of 11 published records gave a non-definitive location such as “Nassawadox” or “Accomack County”. These records were deleted from the database since it could not be ascertained if they were on the Atlantic Ocean or Chesapeake Bay side of the Delmarva Peninsula. We deleted an unidentified phalarope and four Bridled/Sooty Terns since they could not be attributed to a species or meet the  $\geq 5$  records necessary for statistical analysis. We did not include pre-1900 records based almost exclusively on a limited number of specimens (museum and mounted) shot or found dead after tropical storm events intermittently occurring in only a few years. Some of these records involved birds with non-validated dates and/or locations deposited with museums or authorities by curious collectors. Inclusion of these records, over a century old, would not add significantly to the database and the analysis. The remaining 1,090 records included in the database occurred during the period 1912–2017. The database was subsequently sorted for analysis into subsets of specific species, as well as groups of difficult to separate species (e.g., jaeger sp., petrel/shearwater sp., etc.).

### Data Analysis

The dates of all records were converted to Julian calendar dates within a single year, such that any record on 1 January would be equal to 1 regardless of the year the occurrence event took place. For species that occupied the Chesapeake Bay and its tributaries over winter (thus splitting between calendar years), Julian dates were scaled to start at 1 on the beginning of their first occurrence date but were still standardized by date across years. The mean date of occurrence, its standard error, and the 95% confidence interval of the mean were calculated for each species with sufficient records ( $>5$ ), while for the Northern Gannet, those values were calculated for two separate annual periods of occurrence. Additionally, the 2.5 and 97.5 percentiles were calculated for each species to provide a date range containing 95% of the records to suggest a focus period that the species is most likely to be found in Chesapeake Bay and its tributaries. All analyses were conducted in R 3.2.0 (R Development Core Team 2016).

Northern Gannet is the only species with records in every month of the year and preliminary review indicated they pass this latitude in two separate seasonal periods (early March–mid-April, mid-November–late December). To better visualize these seasonal periods, we compiled weekly total records and plotted them into a bar graph to clearly show the two seasonal periods. Using extreme dates from the two periods, we calculated the metrics for each period to avoid a potentially misleading mean and range based on records from all 12 months.

Additionally, we created a box plot graph for visual comparison of individual species (23 [including Northern Gannet graphed seasonally]) and grouped species (5) inter-seasonal means and focus periods. Finally, to verify accuracy of our chronologies we compared them to record dates given for the same species

in publications that include Chesapeake Bay and its tributaries (Hampe and Kolb 1947, Stewart and Robbins 1958, Kain 1987, Bazuin 1992, Rottenborn and Brinkley 2007).

## RESULTS

Species in the petrel/shearwater (Procellariidae), alcid (Alcidae), and gull/tern (Laridae) families comprise 63% of the 35 pelagic species among the published records for Chesapeake Bay (Table 4). A few species are represented by over 100 records (Northern Gannet, Wilson's Storm-Petrel) while 43% ( $n = 15$ ) of the species have been recorded less than 10 times. The span of time containing a species records ranged from 70 days for Bridled Tern to 324 days for Pomarine Jaeger. A total of 80% ( $n = 28$ ) of the species and groups of difficult to separate species mean dates plus dates of species with  $\leq 5$  records occurred in the second half of the year with 63% ( $n = 22$ ) occurring within the period 4 July–6 September (Figure 3). There are few records committee review decisions for frequently occurring species, but those decisions take on considerable importance by validating the proportion of rare and more difficult to identify species. The records indicate species such as Northern Gannet are found throughout most of the Chesapeake Bay and lower portions of its tributaries, while other species like Northern Fulmar, Great Skua, and Common Murre have not been found beyond the Bay's interface with the Atlantic Ocean.

Database records from locations along shores of the Potomac River contain 18 pelagic species (51% of 35 species). Of these species, 12 (34%) ranged up to 212 km (132 mi) upstream to Washington, DC or above (Table 4). Database records from the James River contain 16 species (46%) with only two species ranging 111 km (69 mi) upstream to Richmond. The database contains 10 species from the Tangier and Pocomoke Sounds region that is comprised of the mouths of the Nanticoke, Wicomico, and Pocomoke Rivers with only three of the species ranging up to 35 km (22 mi) upstream from confluence waters in the sound.

Chronology dates determined for species in this study are comparable to the record dates for the same species in publications that include the Chesapeake Bay and its tributaries. Approximately 35% ( $n = 243$ ) of the total pelagic species records, excluding Sulidae and Alcidae species ( $n = 1090 - 389 = 701$ ) were associated with tropical storm events impacting regions of the Atlantic Coast.

Plotting the number of Northern Gannet record dates for seven-day intervals shows they increased and subsequently decreased two separate times annually (Figure 2).



**Table 4. Pelagic species dates of extreme occurrence, mean, and standard error (SE) for records from Chesapeake Bay and its tributaries.** “n” is the number of records used in analysis. “Extreme Dates” followed by ( ) are multiple reports for one day. “Period of Focus” is the span of time containing 95% of the records. “RC” is VARCOM and MD/DCRC acceptance “Y” or not “N” of species requiring identification review. “Extent of Ingress in Chesapeake Bay and Its Tributaries” is the distribution from the Atlantic Ocean as records indicate.

Family and Common Name	n	Extreme Dates <sup>a</sup>	Mean Date	SE	Period of Focus	RC Y N	Extent of Ingress in Chesapeake Bay and Its Tributaries		
							West	North	East
<b>Scolopaciidae</b>									
Red Phalarope	40	12 Mar–30 Oct	26 Aug	9.65	3 Apr–30 Oct	10 1	NW Washington DC, Potomac R	Havre de Grace, Susquehanna R	Fruitland, Wicomico R
<b>Stercorariidae</b>									
Great Skua	2	13 Nov, 8 Feb <sup>a</sup>				1		Bay/ocean interface (Chesapeake Beach?)	
Pomarine Jaeger	37	4 April–21 Feb <sup>a</sup>	17 Sep	13.4	14 Apr–11 Feb	1	Seneca, Potomac R	Fort Smallwood Pk, Patapsco R	Rumbly Pt, Pocomoke R
Parasitic Jaeger	83	18 Apr–24 Feb <sup>a</sup>	3 Sep	9.2	23 Apr–17 Jan	1 2	Washington DC, Potomac R	Conowingo, Susquehanna R	Broad Cr, Choptank R
Long-tailed Jaeger	12	8 May–16 Nov	27 Aug	15.8	10 May–5 Nov	2	Washington DC, Potomac R	North Point SP, Patapsco R	Tilghman Is, Choptank R
jaeger sp. <sup>b</sup>	20	25 May–30 Dec	21 Sep	10.8	17 Jun–18 Dec	2	Seneca, Potomac R	North East R, head of Bay	Rumbly Pt, Pocomoke R
<b>Alcidae</b>									
Dovekie	13	11 Nov–3 Mar <sup>a</sup>	1 Jan	8.9	19 Nov–2 Mar	3 1	Baltimore, Patapsco R	Eastern Neck NWR,, Chester R	Cambridge, Choptank R
Common Murre	3	30 Dec, 15 Jan, 2 Feb <sup>a</sup>						Bay/ocean interface	
Thick-billed Murre	3	26 Jan, 12 Feb, 7 Mar				2		Bay/ocean interface (dead bird, Baltimore)	
Razorbill	30	4 Dec–13 May <sup>a</sup>	3 Feb	6.3	20 Dec–5 Apr		Norfolk, Little Cr	Cape Charles	
Thick-billed Murre/Razorbill <sup>b</sup>	8	31 Dec–23 Mar <sup>a</sup>	14 Feb	10.7	1 Jan–20 Mar	1	Hampton Roads, James R	Bay/ocean interface	

Family and Common Name	n	Extreme Dates <sup>a</sup>	Mean Date	SE	Period of Focus	RC Y N	Extent of Ingress in Chesapeake Bay and Its Tributaries		
							West	North	East
Black Guillemot & sp. <sup>c</sup>	3	30 Nov, 26 Dec, 11 Mar <sup>a</sup>				1		Sandy Point SP, Chesapeake Bay Bridge	
Atlantic Puffin & sp. <sup>d</sup>	3	28 Aug, 16 Jan, 16 Mar <sup>a</sup>				1 1		Point Lookout SP, mouth Potomac R	
<b>Laridae</b>									
Black-legged Kittiwake	43	19 Sept–7 Apr <sup>a</sup>	10 Dec	6.2	30 Sep–16 Feb	12	Seneca, Potomac R	Conowingo, Susquehanna R	Oxford, Choptank R
Sabine’s Gull	23	21 May–9 Dec	28 Aug	10.0	22 May–3 Nov	12 3	Seneca, Potomac R	Conowingo, Susquehanna R	Dames Quarter, Wicomico R
Brown Noddy	5	24 Jul, 2 Sept (4)				1 1	Port Royal, Rappahannock R	Cape Charles	
Sooty Tern	64	13 Jul–17 Oct	1 Sep	2.0	14 Jul–19 Sep	21 3	Seneca, Potomac R	Sparrows Point, Patapsco R	Salisbury, Wicomico R
Bridled Tern	31	13 Jul–20 Sep	5 Sep	2.5	28 Jul–19 Sep	5	Washington DC, Potomac R	Sandy Point SP, Chesapeake Bay Bridge	Salisbury, Wicomico R
Roseate Tern	29	12 Apr–19 Sept	6 Jul	9.7	25 Apr–18 Sep	1 1	Alexandria, Potomac R	Hart Miller Is, Back R	Fishing Bay, Nanticoke R
Arctic Tern	21	8 May–19 Sep	4 Jul	11.5	9 May–17 Sep	7 2	Seneca, Potomac R	Conowingo, Susquehanna R	Oxford, Choptank R
<b>Phaethontidae</b>									
White-tailed Tropicbird	2	19 Sep				1	Richmond, James R	Bay/ocean interface	
<b>Oceanitidae</b>									
Wilson’s Storm-Petrel	154	21 Mar–5 Oct	14 Jul	2.5	31 May–19 Sep	2 2	Alexandria, Potomac R	Wye Is, Eastern Bay	Roaring Pt, Nanticoke R
White-faced Storm-Petrel	1	6 Sep				1	Hog Is, James R	Hog Is, James R	
<b>Hydrobatidae</b>									
Leach’s Storm-Petrel	18	10 Jan–17 Oct	26 Jul	17.0	9 Feb–11 Oct	3	Washington DC, Potomac R	Matapeake SP, Kent Island	Salisbury, Wicomico R
Band-rumped Storm-Petrel	8	12 Jul–19 Sep	26 Aug	10.1	12 Jul–19 Sep	4 1	Mount Vernon, Potomac R	Mount Vernon, Potomac R	Cape Charles
storm-petrel sp. <sup>b</sup>	7	13 Jul–19 Sep	30 Aug	9.1	19 Jul–19 Sep	1	Mount Vernon, Potomac R	North Beach	

Family and Common Name	n	Extreme Dates <sup>a</sup>	Mean Date	SE	Period of Focus	RC Y N	Extent of Ingress in Chesapeake Bay and Its Tributaries		
							West	North	East
<b>Procellariidae</b>									
Northern Fulmar	3	30 Sep, 22 Oct, 4 Mar <sup>a</sup>						Bay/ocean interface	
Trindade Petrel	2	13 Jul, 11 Sep				1 1	Herndon, Potomac R	Herndon, Potomac R	
Black-capped Petrel	10	13 Jul–25 Sep	23 Aug	9.2	13 Jul–24 Sep	3		Bay/ocean interface	(dead bird, Eastern Bay)
Bulwer’s Petrel	1	2 Sep				1		Bay/ocean interface	
Cory’s Shearwater	7	7 Jul–19 Sep	12 Aug	12.2	7 Jul–17 Sep	1	Alexandria, Potomac R	Alexandria, Potomac R	
Sooty Shearwater	14	20 May–2 Sep	20 Jun	9.6	21 May–29 Aug	1	College Creek, James R	Smith Island, Tangier Sound	Fox Is, Tangier Sound
Great Shearwater	13	14 Jun–6 Sep	15 Jul	7.45	15 Jun–6 Sep	1 1	Hog Is, James R	Smith Is, Tangier Sound	
Manx Shearwater	4	26 Dec (2), 14 Jan, 15 Jun <sup>a</sup>				1		Bay/ocean interface	
Audubon’s Shearwater	6	9 Jul–8 Oct	21 Aug	14.2	10 Jul–4 Oct			Bay/ocean interface	
petrel/shearwater sp. <sup>b</sup>	8	15 Jun–23 Sep	23 Aug	11.5	22 Jun–20 Sep	1 1	Mount Vernon, Potomac R	Howell Pt, Sassafras R	Oxford, Choptank R
<b>Fregatidae</b>									
Magnificent Frigatebird & sp. <sup>c</sup>	19	20 May–21 Nov	22 Aug	14.8	21 May–19 Nov	3 4	Washington DC, Potomac R	Eastern Neck NWR, Chester R	Broad Cr, Choptank R
<b>Sulidae</b>									
Brown Booby	14	26 Jun–3 Dec	5 Sep	13.1	26 Jun–27 Nov	4 3		Baltimore, Patapsco R	Love Pt, Chester R
Northern Gannet (Jan–Jul)	227	1 Jan–2 Jul	23 Mar	2.2	6 Jan–14 Jun		Washington DC, Potomac R	Turners Cr, Sassafras R	Cambridge, Choptank R
Northern Gannet (Aug–Dec)	98	19 Aug–31 Dec	30 Nov	2.4	24 Sep–30 Dec		Mount Vernon, Potomac R	North Point SP, Patapsco R	Oxford, Choptank R

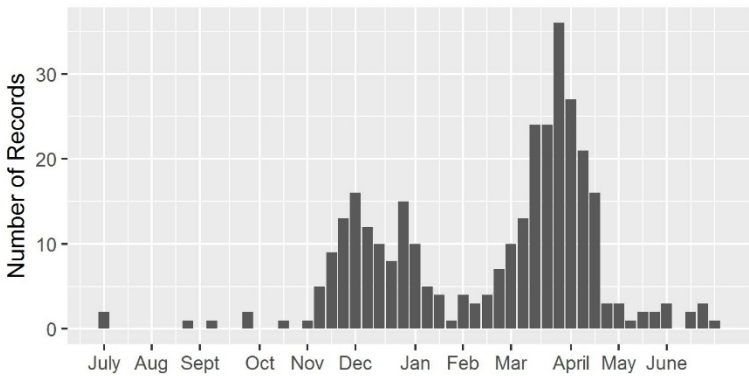
<sup>a</sup> Extreme dates (inclusive of months spanning two consecutive years [e.g., 29 Nov of one year through 22 Feb of the following year])

<sup>b</sup> Identification to a specific species uncertain

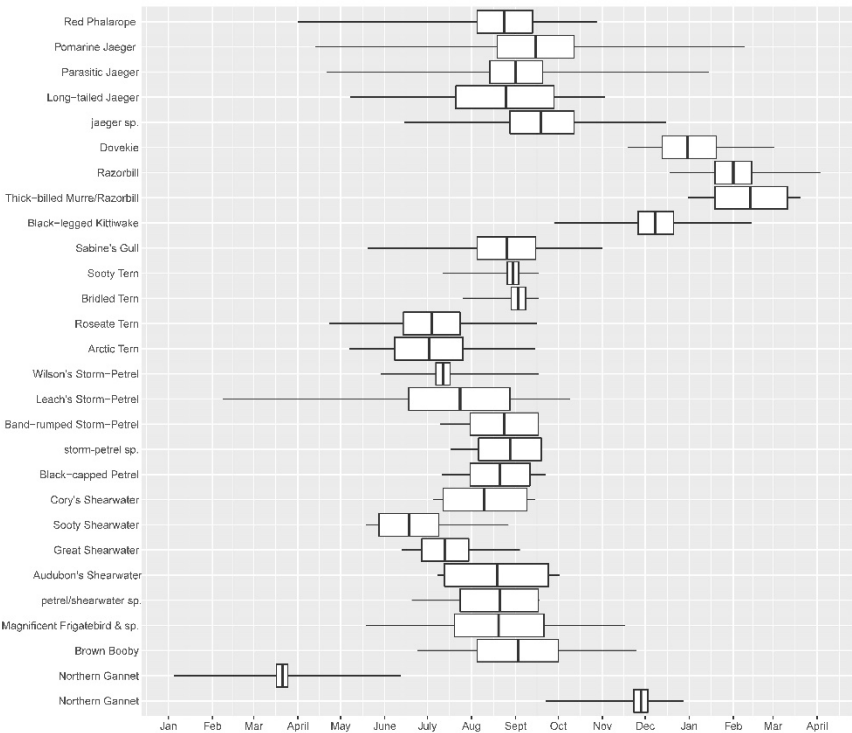
<sup>c</sup> Black Guillemot accredited to one record, others identified as guillemot sp.

<sup>d</sup> Atlantic Puffin accredited to two records, other one identified as puffin sp.

<sup>e</sup> Magnificent Frigatebird accredited to eight records, other identifications uncertain frigatebird sp.



**Figure 2. Northern Gannet seven-day record totals (n = 325) for Chesapeake Bay and its tributaries.**



**Figure 3. Pelagic species and grouped-species chronologies for Chesapeake Bay and its tributaries. Horizontal lines denote periods containing 95% of the records, vertical lines denote mean dates, and boxes indicate 95% confidence intervals.**

## DISCUSSION

This study provides the first comprehensive examination of pelagic bird species chronology and distribution for the Virginia portion of Chesapeake Bay and its tributaries in over a decade and the Maryland/District of Columbia portion in over 60 years. The study found plentiful records throughout the Bay during all months of the year for some species, while others are known by less than 10 records and/or restricted to the Bay's interface with the Atlantic Ocean. Most records occur in the last half of the year particularly in months with tropical storms.

Northern Gannet is the most frequently occurring and wide-spread pelagic species in Chesapeake Bay and its tributaries with records from every month of the year and a distribution ranging to Sassafras River (Armistead 1991, Ringler 1991) near the head of the Bay, while extending up major tributaries to locations such as Williamsburg, Virginia (Iloff 1996), Washington, DC (Atwood 2005), and Cambridge, Maryland (Ringler 2003). Flocks sometimes range into the thousands (Iloff 2001, 2002) in portions of the Chesapeake Bay below the mouth of the Potomac River. However, gannet records are clustered in two separate times of the year (early March–mid-April and again in mid-November–late December) suggesting migrants passing this latitude to and from northern nesting areas. Despite accounting for this behavior by splitting the gannet data in two seasonal periods for analysis, consideration should be given when interpreting these results as both these periods may contain a small number of winter or summer vagrants.

Similarly, records used in the annual chronology given here for some other pelagic species may include less obvious north and south migrants, e.g., cyclic lemmings provide the primary food source for Pomarine Jaeger in arctic nesting areas while in years of rodent scarcity, early arriving jaegers sense the shortage, forego nesting, and immediately disperse or return south (Harrison 1983). Other overlapping incidences may involve late north and early south migrating Wilson's and Leach's Storm-Petrels, Roseate and Arctic Terns, and jaegers that all nest in the eastern Canadian Maritimes.

Wilson's Storm-Petrel is the second most frequently occurring pelagic species in Chesapeake Bay and its tributaries with most records in mid-June–late-July (Bazuin 1992). Their records range north to Eastern Bay (Sharp 1971), west to Alexandria on the Potomac River (Ringler 2004) and east to inside the mouth of the Nanticoke River off of Tangier Sound (Day 2005). Records are most frequent from the mouth of the Potomac River and the southern Tangier and Pocomoke Sounds south to the mouth of the Chesapeake Bay. Records indicate storm-petrels appear to favor the west side of this portion of Chesapeake Bay

especially in area of Mobjack Bay where flocks of hundreds have been recorded (English 1933, Scott and Cutler 1974, Ake et al. 1975).

Records indicate pelagic species that inhabit more northerly latitudes usually enter the Chesapeake Bay and its tributaries in only the coldest months, e.g., Great Skua, all the alcids, Black-legged Kittiwake, and Northern Fulmar. Records of more southerly inhabiting species show ingress primarily during tropical storms passing north along the Atlantic Coast during the warmest months, e.g., jaegers, Sooty Tern, Bridled Tern, storm-petrels, petrels, shearwaters, and frigatebirds. Records of other pelagic species appear to not be as strongly influenced by climatic conditions and may occur at various intervals or anytime during the year, e.g., Red Phalarope, Sabine's Gull, Wilson's Storm-Petrel, and Northern Gannet. Additionally, published literature indicates there have been sporadic influxes of an individual pelagic species (Murphy and Vogt 1933, Lincoln 1934). Prevailing onshore east winds and/or ocean currents, unusual freeze-ups at more northern latitudes, oceanic storms, or shortages of marine organisms may be associated with the sporadic influxes.

Record locations indicate Chesapeake Bay tributaries with the highest diversity of pelagic species are respectively the Potomac River, James River, and Tangier/Pocomoke Sounds. These findings may be associated with the proximity of those bodies of water to the Bay's interface with the Atlantic Ocean, their size as a large waterway attractant, and/or highly developed and populated shorelines with abundant observers. Unexplained, however, is the occurrence of pelagic species 48 km (30 mi) upstream above Washington, DC on the Potomac River.

Many factors may contribute to arduous, perplexing, or dubious pelagic species identification. Limited public access to strategic land projections into Chesapeake Bay and its tributaries, viewing compromised by unstable footing due to boat movement, a brief viewing period of seldom-seen species at long distances in unfavorable light, or adverse weather conditions are some restraints. Additionally, rapid flight of fast-moving birds, plumages restricted to subdued black-brown-grey-white color patterns, many species difficult to separate from similar looking species, and lack of contemporary regional identification field guides containing all possible pelagic species that could occur confound species identification.

It should be noted the database may contain published records of documentation that are lacking or have questionable identification descriptions; no witness observer, no peer or records committee review of the record; and/or erroneous and conflicting dates or locations (see database examples in Methods). Many records published prior to formation of the records committees in the 1980s have been reviewed and accepted by the committees, while other records contained in

published reports may be forever unsuitable for review. The published regional records committees' identification decisions are included in Table 4 to reflect an approximate proportion of each pelagic species records that have been confirmed or refuted by peer review. In this paper, we have attempted to minimize some of these potential identification discrepancies and/or misleading chronologies by creating subsets of similar-looking species (i.e., jaegers, alcids, storm-petrels, petrel/shearwaters, and frigatebirds) for analysis. The resulting lumped chronologies may then be compared for variance with that given for a specific individual species in that group (Figure 3).

In conclusion, this is the first available comprehensive analysis of pelagic bird species chronology and distribution for the Chesapeake Bay and its tributaries despite possible definitive discrepancies and/or small sample size for some species in the records. Additionally, it is the first-time that pelagic species chronology or distribution has been addressed in the Virginia jurisdiction in over a decade and in the Maryland/District of Columbia portion in over six decades. This important baseline information may be of value to future studies in understanding pelagic species occurrence, chronologies and distribution in Chesapeake Bay and its tributaries.

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Sandy Point State Park at the base of the Chesapeake Bay Bridge; and Eirik A. T. Blom and Eugene J. Scarpulla at the head of the Chesapeake Bay.

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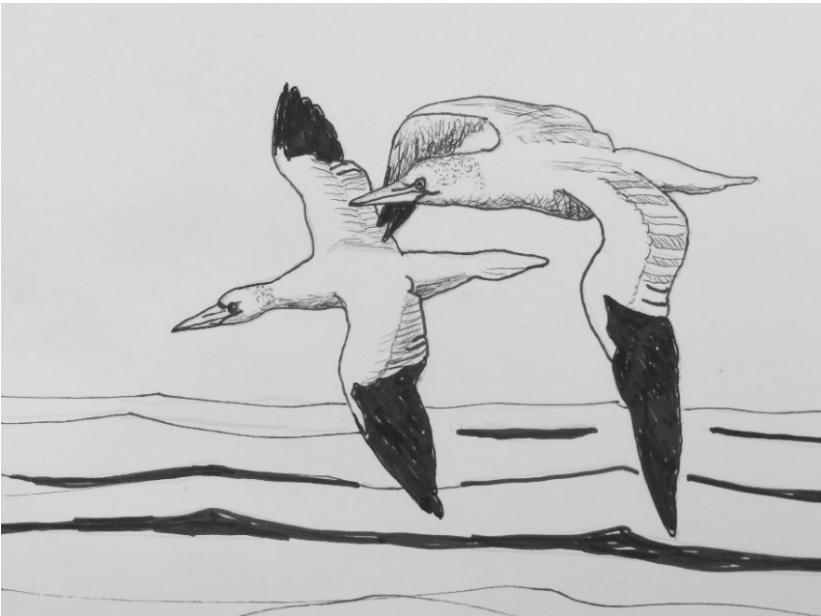
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**Northern Gannet sketch by Diane Ford**

Pen and ink. Middle of the Chesapeake Bay (on a trip to Smith Island, Somerset County, Maryland), 17 April 2011.