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DATA ARTICLE

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SAviTraits 1.0: Seasonally varying dietary attributes for birds

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Abstract

Motivation: Trait-based studies remain limited by the quality and scope of the underlying trait data available. Most of the existing trait databases treat species traits as fixed across time, with any potential temporal variation in the measured traits being unavailable. This is despite the fact that many species are well known to show plasticity in their trait characteristics over the course of the year. This data paper describes a compilation of species-specific dietary preferences and their known intra-annual variation for over 10,000 of the world's extant bird species (SAviTraits 1.0). Information on dietary preferences was obtained from the Cornell Lab of Ornithology Birds of the World (BOW) online database. Textual descriptions of species' dietary preferences were translated into semi-quantitative information denoting the proportion of dietary categories utilized by each species. Temporal variation in dietary attributes was captured at a monthly temporal resolution. We describe the methods for data discovery and translation and present tools for summarizing the annual variability of avian dietary preferences. Altogether, we were able to document a seasonal variability in dietary attributes for a total of 1031 species (ca. 10%). For the remaining species, the dietary attributes were either temporally stationary or the information on temporal variability of the diet was not available.

Main Types of Variable Contained: Temporally-varying dietary traits for birds.

Spatial Location and Grain: N/A.

Time Period and Grain: Variation in diet was captured at a monthly temporal resolution.

Major Taxa and Level of Measurement: Birds, species level.

Software Format: .csv/.rds

KEYWORDS
avian diet, avian traits, birds, diet, temporal non-stationarity, temporal variability

1 | INTRODUCTION

Trait-based studies have grown rapidly in popularity, but they remain limited by the quality and scope of the underlying trait data available (e.g. Kohli & Jarzyna, 2021). A common limitation of existing trait databases is that they treat species traits as fixed across time, with any potential temporal variation in the measured traits being unavailable. This is despite the fact that many species are well known to show plasticity in their trait characteristics over the course of the year. For example, some resident bird species that are arboreal feeders in the breeding season become predominantly ground foragers in the wintering season (Pfeifer et al., 2018). An example species displaying such flexible foraging behaviour is Northern cardinal (*Cardinalis cardinalis*), which forages for insects and fruit in the canopy during the breeding season and on ground for seeds during winter (Dow, 1969). Likewise, avian foraging behaviour and digestive physiology are known to be plastic, which allows birds that are typically granivores or frugivores during the winter months (e.g. American robin, *Turdus migratorius*) to shift to an insect-based diet during the breeding season (Levey & Karasov, 1989). Finally, bird species' associations with land cover change across seasons and with resource availability (Zuckerberg et al., 2016), which might in turn affect their foraging and dietary preferences. This kind of well-documented natural history knowledge remains missing from widely used trait databases for birds and other taxonomic groups.

An organism's diet often reflects its functional role in an ecosystem (Junker et al., 2019; Kissling et al., 2012). But despite widespread recognition of seasonality in avian dietary traits (Levey & Karasov, 1989), available trait compilations for the world's bird species do not yet reflect potential temporal variability in dietary characteristics. For example, EltonTraits 1.0 (Wilman et al., 2014) is currently the most widely used reference for accessing semi-quantitative data on avian diets. EltonTraits specifies the diet of the American robin (*Turdus migratorius*) to be 50% invertebrates and 50% fruit, even though *T. migratorius* feeds primarily on insects during the spring migration and breeding season and primarily on fruit during winter. Likewise, the AvoNet database (Tobias et al., 2022) provides an incredibly detailed picture of continuous trait variation for avian morphological traits, but its account of dietary trait characteristics remains fairly coarse and static across seasons. Finally, the Avian Diet Database (Hurlbert et al., 2021) includes >70,000 records on species diets that, in principle, allow quantifying seasonal variation in diet. However, its current focus is only on ca. 750 species of North America. The effects of not incorporating seasonality into subsequent trait-based species or community analyses on our understanding of avian ecology remain unknown.

SAviTraits 1.0 fills this gap by providing information on temporal variation in dietary characteristics across the world's 10,672 species of birds. SAviTraits 1.0 uses dietary categories described by EltonTraits 1.0 (Wilman et al., 2014) and contains information on the proportional use of each dietary category for each month of the year. Ultimately, we expect these data will provide important and overlooked information on how dietary trait characteristics change across seasons, with applications to the most pressing questions in ecology and evolution.

2 | METHODS

2.1 | Data sources

We used the Cornell Lab of Ornithology Birds of the World (BOW; Billerman et al., 2022; available online, https://birdsoftheworld.org/bow/home) as the primary source of information on species' dietary characteristics. BOW was originally amassed from four major works of ornithology: *Birds of North America*, *The Handbook of Birds of the World*, *Neotropical Birds*, and *Bird Families of the World*, and incorporates information from both the primary and secondary literature and expert knowledge to provide textual descriptions of dietary and foraging characteristics. For each species, we focused our search primarily on the BOW section entitled 'Diet and Foraging' and subsections 'Feeding' (further subsection of 'Main foods taken') and 'Diet'. Further subsections of 'Major food items' and 'Quantitative analysis' were utilized when available. In many cases (e.g. for rare or understudied species), the above subsections were not available, in which case reading more general sections of the species description was required.

2.2 | Bird taxonomy

Bird taxonomy in SAviTraits 1.0 follows the eBird/Clements Checklist v2022 (Clements, 2022), which is consistent with the taxonomy used by the BOW. Because the users of the SAviTraits 1.0 might want to make direct comparisons with dietary characteristics from EltonTraits 1.0 (Wilman et al., 2014) or with avian phylogeny (birdtree.org; Jetz et al., 2012), we additionally provide a taxonomic crosswalk to BirdLife v3, the primary taxonomy used by Wilman et al. (2014) and Jetz et al. (2012), as well as to BirdLife v7, IOC World Bird List v13.1, and eBird/Clements Checklist v2021 taxonomies.

2.3 | Dietary categories

We followed the same ten dietary categories outlined in EltonTraits 1.0 (Wilman et al., 2014). These categories are (Table 1): (1) invertebrates, Inv; (2) mammals and birds, Vend; (3) reptiles, snakes, amphibians, salamanders, Vect; (4) fish, Vfish; (5) vertebrates unknown, Vunk; (6) carrion, Scav; (7) fruits, Fruit; (8) nectar, Nect; (9) seeds, Seed; (10) other plant matter, PlantO. Categories 2 through 5 together constitute a larger category of vertebrates, A; categories 7 through 10 together constitute a larger category of plants, PlantAll.

2.4 | Translating diet information from text

Diet descriptions in BOW are mostly textual descriptions, although quantitative information is commonly available for well-studied species. The textual descriptions are often specific enough to allow a coarse approximation of dietary preferences (Wilman et al., 2014). For each species and each month of the year, we recorded the estimated percentage of each dietary category (see the 'Dietary categories' section) in 10% intervals and recorded these as integers from 0 to 100 (Wilman et al., 2014). We used 10% intervals because it was a close match with the resolution obtainable from the textual descriptions of dietary characteristics in BOW. Each score represents the estimated relative usage of a given diet category (i.e. varying from 0% to 100% in 10% intervals), and the values of all diet categories sum to 100 (i.e. 100%; Wilman et al., 2014). An exception to the above rules was made in certain cases for the four vertebrate categories (Vend, Vect, Vfish, Vunk) and the four plant categories (Fruit, Nect, Seed, and PlantO), which could take values in 5% increments

TABLE 1 Descriptions for each dietary category (following Wilman et al., 2014).

Diet category	Diet subcategory	Description of diet category	Notes
Invertebrate	Invertebrate (Inv)	Percent use of: invertebrates-general, aquatic invertebrates, shrimp, krill, squid, crustacaeans, molluscs, cephalapod, polychaetes, gastropods, orthoptera, terrestrial invertebrates, ground insects, insect larvae, worms, orthopterans, flying insects	Estimated proportional use, in 10% increments
Vertebrate (VA)	Endotherm (Vend)	Percent use of: mammals, birds	Estimated proportional use, in 5% increments
	Ectotherm (Vect)	Percent use of: reptiles, snakes, amphibians, salamanders	Estimated proportional use, in 5% increments
	Fish (Vfish)	Percent use of: Fish	Estimated proportional use, in 5% increments
	Unknown (Vunk)	Percent use of: vertebrates-general or unknown	Estimated proportional use, in 5% increments
Scavenger	Scavenger (Scav)	Percent use of: scavenge, garbage, offal, carcasses, trawlers, carrion	Estimated proportional use, in 10% increments
Plant (PlantAll)	Fruit (Fruit)	Percent use of: fruit, drupes, flowers and flower petals	Estimated proportional use, in 5% increments
	Nectar (Nect)	Percent use of: nectar, pollen, plant exudates, gums	Estimated proportional use, in 5% increments
	Seed (Seed)	Percent use of: seed, maize, nuts, spores, wheat, grains	Estimated proportional use, in 5% increments
	Other (PlantO)	Percent use of: other plant material, grass, ground vegetation, seedlings, weeds, lichen, moss, small plants, reeds, cultivated crops, forbs, vegetables, fungi, roots, tubers, legumes, bulbs, leaves, above ground vegetation, twigs, bark, shrubs, herbs, shoots, aquatic vegetation, aquatic plants	Estimated proportional use, in 5% increments

when appropriate. For example, a species may consume 40% of total plant material, but this proportion of the species' diet could then be further delimited into 25% (a score of 25) fruit and 15% (a score of 15) seeds. Still, in all cases, the primary diet categories (Inv, Vall, Scav, PlantAll) hold integer values that sum to 100.

In keeping with Wilman et al. (2014), we standardized the interpretation of certain words and the proportions of the diet that they represent to ensure a uniform translation across species. We used the general guidelines on translating the descriptive text into a dietary score provided by Wilman et al. (2014). Examples of the common terms and their translation into standardized numerical values include but are not limited to: (i) 'East *mostly* seeds' would receive a score of 6 or greater; (iii) '*Sometimes* eats seeds' would receive a score of 1 or 2; (iii) '*Occasionally* eats seeds' would receive a score of 1 at most.

Often, however, translating text into a dietary score was context-dependent, and the relevant scores were adjusted in lieu of all information obtained from the full diet description. Following Wilman et al. (2014), if many diet items were listed as being significant to the diet, the score of each was decreased. If the species was described to eat *mostly* seeds and *sometimes* insects and leaves, then 'seeds' dietary category was assigned a score of 6 and 'invertebrates' and 'other plant matter' categories each received a score of 2. If there had only been one diet listed after the *sometimes*, 'seeds' would receive a score of 8 and the secondary diet a score of 2. In cases where comparative words were not used in the description, the first category listed was given the highest score, the second category was given the second highest score, and so on (Wilman et al., 2014). This was possible because Wilman et al. (2014) showed that authors almost always list the most important categories first, and subsequent categories are sorted by order of importance.

Here, we provide several examples of further context dependence. Each description varies in its use of the modifiers (i.e. *mostly* and *occasionally*), which has important implications for the translation of the data. The dietary scores are shown in parentheses. (i) '*Mostly* fruits (6), also seeds (2) and arthropods (2)' was quanitifed as such because *mostly* is always assigned a minimum value of 6 and there is no indication whether seeds or arthropods (invertebrates) are preferred and thus both diet categories receive a score of 2; (ii) '*Mostly* fruits (7), also seeds (2) and *occasionally* arthropods (1)' was scored as such because *mostly* is always assigned a minimum value of 6, and *occasionally* is always assigned a maximum value of 1. Furthermore, *occasionally* also implies that arthropods (invertebrates) are less often consumed than seeds; thus, we score seeds higher than arthropods; (iii) 'Fruits (6), also seeds (3) and *occasionally* arthropods (1)' was quanitifed as such because *occasionally* is always assigned a maximum value of 1. Furthermore, though the lack of the *mostly* modifier on fruits makes it less clear how to attribute percentages to fruits versus seeds, we interpret the use of the word *also* as meaningful and indicative of a secondary dietary source that is less important than the first one mentioned; hence, fruits remain more heavily weighted; (iv) 'Fruits (6), also seeds (2) and arthropods (2)' was scored as such because *occasionally* dropped from arthropods, and we thus weight seeds and arthropods equally; (v) 'Fruits (6) from species A, B, C, and D, also seeds (2) and arthropods (2)' was quanitifed as such because *occasionally* is dropped from arthropods, and we thus weight seeds and arthropods equally. (vi) 'Fruits (4), seeds (3), and arthropods (3)' was scored as such because fruits are listed first and are thus likely the most important diet item, but the lack of word *also* is indicative of the lower proportion of fruits than in previous examples.

In rare cases, we purposefully excluded some dietary designations as not to artificially overweight any categories. This exclusion was necessary in some cases due to the 10% rule used to assign dietary preferences. For example, the dietary description for *T. migratorius* indicates that invertebrates and fruits are the major components of the diet but that 'other unusual food items consumed include fish, small snakes, shrews, damselfly nymphs, frogs and skinks'. Such phrasing suggests that fish and vertebrates constitute much <10% of the diet, and likely <1% of the diet. Additionally, we note that very few, if any, dietary descriptions explicitly mentioned the exclusion of a particular diet (i.e. phrases such as 'does not eat insects', etc., were extremely rare). Consequently, we assumed that if a diet was not explicitly mentioned (whether in a general sense or within a specific time period), the dietary item was not considered a part of the diet.

2.5 | Species with no diet information

For some rare species, no data on dietary characteristics were available. In some cases, statements equating their diet to that of a closely related species were included in the species description. For example, a diet description for Yellow-throated Mountain Greenbul (*Arizelocichla chlorigula*) reads as follows: 'Seemingly no published information, but diet and foraging behavior both probably similar to those of better-known members of *A. nigriceps* species complex'. In such cases, we assigned *A. chlorigula* the same dietary characteristics as those of *A. nigriceps*. In other cases where no information was available at all, we assigned a species in question the dietary characteristics of its sister species, defined as the closest relative according to Jetz et al. (2012). Together, data on dietary characteristics were not available for a total of 172 species.

2.6 | Translating seasonal variability

We captured temporal variability at a monthly temporal resolution. For some species, the specific months associated with breeding, non-breeding, and migration seasons were available from BOW (i.e. 'Breeding' section of species descriptions), allowing translation of seasonal dietary information at a monthly resolution. In other cases where monthly information was not available, we used standardized terms and phrases to indicate different seasons of the year. For the Northern Hemisphere, we interpreted 'winter' as December, January and February; 'spring' as March, April, and May; 'summer' as June, July and August; and 'fall' as September, October and November. For the Southern Hemisphere, we interpreted 'winter' as June, July and August; 'spring' as September, October and November; 'summer' as December, January and February; and 'fall' as March, April and May. Other terms were also standardized. We interpreted the term 'breeding season' to generally mean 'summer' (June, July and August in the Northern Hemisphere; December, January and February in the Southern Hemisphere), though variation among species might occur. The term 'migration' generally was interpreted as 'spring' and 'fall' (March, April, May, September, October and November), though variation among species might occur and was captured if present. We interpreted 'early season' as 'spring' (March, April and May in the Northern Hemisphere; September, October and November in the Southern Hemisphere) and 'late season' as 'fall' (September, October and November in the Northern Hemisphere; March, April and May in the Southern Hemisphere). Finally, when the term 'wet/dry season' was invoked, we checked the months when wet/dry seasons occurred across the geographic range of the species in question.

It is important to note that even though SAviTraits 1.0 reports dietary variation at a monthly temporal resolution, the dietary designations should be considered to be at a seasonal resolution because, for most species, information on diet in the BOW is expressed seasonally through phrases such as, for example, 'eats insects during the breeding season', 'higher proportion of berries consumed in winter', etc. However, standardizing SAviTraits 1.0 to a seasonal resolution would be challenging because seasons are not consistently defined across species, often because their breeding and non-breeding periods fall at different times of the year. Users of SAviTraits 1.0 should keep this caveat in mind when analysing the data.

In situations where information on temporal variability of the diet was not available at all, or when the description was clear that the diet does not vary through time, all seasons of the year were assigned the same dietary scores. We clearly designated these species in the database as showing no variability to distinguish them from those showing documented seasonal changes in diet.

2.7 | Technical validation

The guidelines outlined here provide a consistent methodology for translating textual dietary descriptions of bird species into semi-quantitative data that can be used for rigorous analyses of avian life history and ecology. However, occasionally subjective decisions had to be made. Cases when descriptions did not clearly fit within the guidelines described above were discussed by all members of the research team to ensure proper and consistent translation.

To further limit translator bias, we checked for consistency between translators by re-analysing subsets of species by multiple translators and checking for agreement between the individual descriptions. Approximately 300 species were re-analysed in this way, and no significant translator bias was detected.

3 | DISTINGUISHING BETWEEN SPECIES THAT ARE DATA DEFICIENT VERSUS THOSE WITH TEMPORALLY STATIONARY DIETS

In the current version of SAviTraits database, it is difficult to differentiate between species that truly display no temporal variation in their diet and those that might be data deficient. To provide the database users with an estimate of the certainty in each species' dietary designation, we report, for each species, the total number of citations that accompanied the species' description, the number of citations explicitly cited within the 'Diet and Foraging' section of the species' description, and the length (in words) of the diet description. The goal of including information on dietary citations is to approximate the level of effort expanded to collect dietary attributes, as the sampling effort likely affects the reported variability in dietary characteristics. While potentially a better estimate of effort would be the sample size used to make dietary designations in each of the citations, assessing this was not logistically feasible as, on average, 47 total citations accompanied each species. We additionally provide three rank measures: (i) the percentile that a given species falls into given the total number of citations that accompanied that species' description, (ii) the percentile that a given species falls into given the number of citations explicitly cited within the 'Diet and Foraging' section of that species' description, and (iii) the percentile a given species falls into given the length of its diet description. Those rank measures are bounded by 0 and 1, where 0.5 indicates that a given species lies in the middle in terms of the effort (total number of citations, number of citations within the 'Diet and Foraging' section, or diet

TABLE 2 Descriptions of the fields in the SAviTraits_1-0_1.csv database file.

Field	Description
Species_Scientific_Name	Scientific species name, using eBird/Clements Checklist v2022 taxonomic authority (used by SAviTraits 1.0)
Diet_Cat	Diet category (see Table 1)
Diet_Sub_Cat	Diet subcategory (see Table 1)
Jan–Dec	Species' diet in each month, January through December
Diet_Variability	Binary indicator of whether diet varies across seasons: Yes, No
Recorded_By	Name of primary transcriber of diet data; RJM: Reymond J. Miyajima; NAS: Natalie A. Sebunia; MML: Molly M. Lynch
Diet_Comments	Additional comments regarding diet
Other_Comments	Any additional comments

TABLE 3 Descriptions of the fields in the SAviTraits_1-0_2.csv and SAviTraits_1-0_2_citations.rds database files.

Field	Description
BOW_Code	The reference code for the species on the BOW online handbook
Species_Scientific_Name	Scientific species name, using eBird/Clements Checklist v2022 taxonomic authority (used by SAviTraits 1.0)
Species_Common_Name	The common name listed on the BOW online handbook
Total_Citation_Num	The total number of citations listed in a given species entry
Diet_Information	Logical (TRUE/FALSE) indicating whether there was any information on diet for that species
Diet_Entry_Length	The number of words, excluding citations, in the dietary description. Where 'No information available' was listed, the entry length was assigned zero
Diet_Citation_Num	The number of literary citations listed in the dietary description
Percentile_Total_Citation_Num	Percentile a given species falls into given the total number of citations that accompanied that species description; quantified as rank $(x/(n+1))$, where x is the observation and n is the total number of species
Percentile_Diet_Entry_Length	Percentile a given species falls into given the length of its diet description in words; quantified as rank $(x/(n+1))$, where x is the observation and n is the total number of species
Percentile_Diet_Citation_Num	Percentile a given species falls into given the number of citations explicitly cited within the 'Diet and Foraging' section of the species description; quantified as rank $(x/(n+1))$, where x is the observation and n is the total number of species
Certainty	The level of confidence in a species' dietary designation; calculated as the mean of Percentile_Total_Citation_Num, Percentile_Diet_Citation_Num, and Percentile_Diet_Entry_Length
Additional columns in the SAviTraits_1-0_2_citations.rds file	
All_Citations	Complete list of citations that accompanied the species description
Diet_Description	The dietary description verbatim as it appeared in BOW at the time of the creation of SAviTraits 1.0
Diet_Citations	Complete list of citations explicitly cited within the 'Diet and Foraging' section of the species description

description length, respectively) expanded on studying diet of all species. By creating these rank measures, we ensure that large outliers – for example species with hundreds of citations or very long diet descriptions – almost certainly fall within 0.95 percentile or higher and their contribution to the assemblage-wide mean is not overstated. Finally, for each species, we provide an estimate of the confidence level that we have in its dietary designation, which we calculate as the average of the three rank measures. We suggest that users of SAviTraits 1.0 consider either the estimate of effort (i.e. the number of citations and/or the length of the diet description) or the rank measures and the associated confidence levels in their analyses. Information on the length of the dietary text, the number of citations and the citations for each species were scraped using R (version 4.3; Team, 2014) in an RStudio IDE (version 2023.03.1+446; Team, 2015). Information was scraped using the R packages rvest (version 1.0.3; Wickham & Wickham, 2022), httr (version 1.4.6; Wickham & Wickham, 2023), XML (version 3.99-0.14; Lang & Lang, 2023) and xml2 (version 1.3.4; Wickham et al., 2023a).

4 | DATA RECORDS

The latest official release of SAviTraits 1.0 is available on GitHub (https://github.com/martaajarzyna/SAviTraits_database) and is archived with Zenodo (https://doi.org/10.5281/zenodo.8006811).

TABLE 4 Descriptions of the fields in the SAviTraits_1-0_3.csv database file.

Field	Description
eBird_Clements_v2022	Latin species name following the eBird/Clements Checklist v2022 taxonomic authority (used by SAviTraits 1.0)
eBird_Clements_v2021	Latin species name following the eBird/Clements Checklist v2021 taxonomic authority
BirdLife_v3	Latin species name following the BirdLife v3 taxonomic authority (used by EltonTraits 1.0; Wilman et al., 2014)
BirdLife_v7	Latin species name following the BirdLife v7 taxonomic authority
IOC_v13.1	Latin species name following the IOC World Bird List v13.1

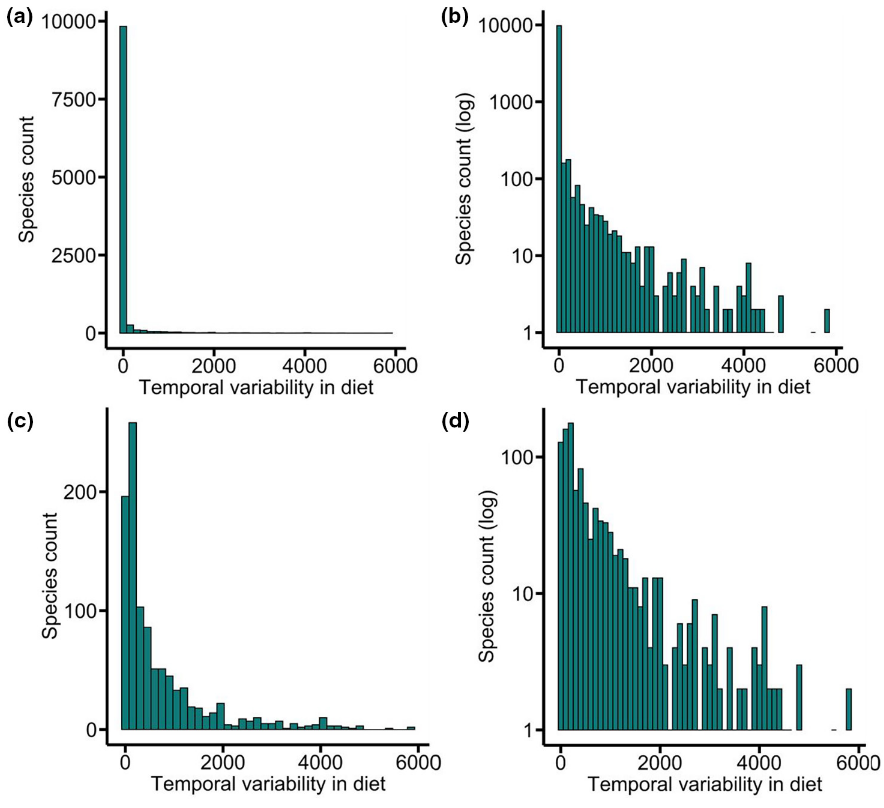

FIGURE 1 Distribution of values of temporal variability in dietary characteristics for (a) 10,672 species of birds, (b) the log-transformed world's 10,672 species of birds, (c) 1031 species (ca. 10%) that showed seasonal variability in dietary characteristics, and (d) log-transformed 1031 species (ca. 10%) that showed seasonal variability in dietary characteristics. Temporal variability in diet is measured as the sum of variance in each dietary category across seasons, with higher values indicating higher temporal variability.

SAviTraits 1.0 consists of three .csv files and one .rds file. The first file, SAviTraits_1-0_1.csv, is the main database file that contains data on temporally varying dietary characteristics for all species of birds (Table 2). The second file, SAviTraits_1-0_2.csv, contains information, for each species, on (i) the total number of citations that accompanied that species' description, (ii) the number of citations explicitly cited within the 'Diet and Foraging' section of that species' description,(iii) the length (in words) of the diet description, (iv) the percentile that a given species falls into given the total number of citations that accompanied that species' desription, (v) the percentile a given species falls into given the number of citations explicitly cited within the 'Diet and Foraging' section of that species' description, (vi) the percentile a given species falls into given the length of its diet description, and (vii) the confidence level in the species' dietary designation (Table 3). The third file, SAviTraits_1-0_2_citations.rds, contains the same information as SAviTraits_1-0_2.csv but additionally lists all the citations and the dietary description verbatim as it appeared in BOW at the time of the creation of SAviTraits 1.0 (Table 3). The fourth file, SAviTraits_1-0_3.csv, is a taxonomic crosswalk that contains a list of all species included in the database using eBird/Clements Checklist v2022 taxonomic authority (used in SAviTrait 1.0) and their respective scientific names in BirdLife v3, BirdLife v7, IOC World Bird List v13.1, and eBird/Clements Checklist v2021 taxonomic authorities (Table 4). Basic data manipulation was performed with dplyr (version 1.1.2; Wickham et al., 2023b) and stringr (version 1.5.0; Wickham, 2022).

Altogether, a total of 1031 species (ca. 10%) showed documented temporal variation in dietary characteristics (Figure 1),

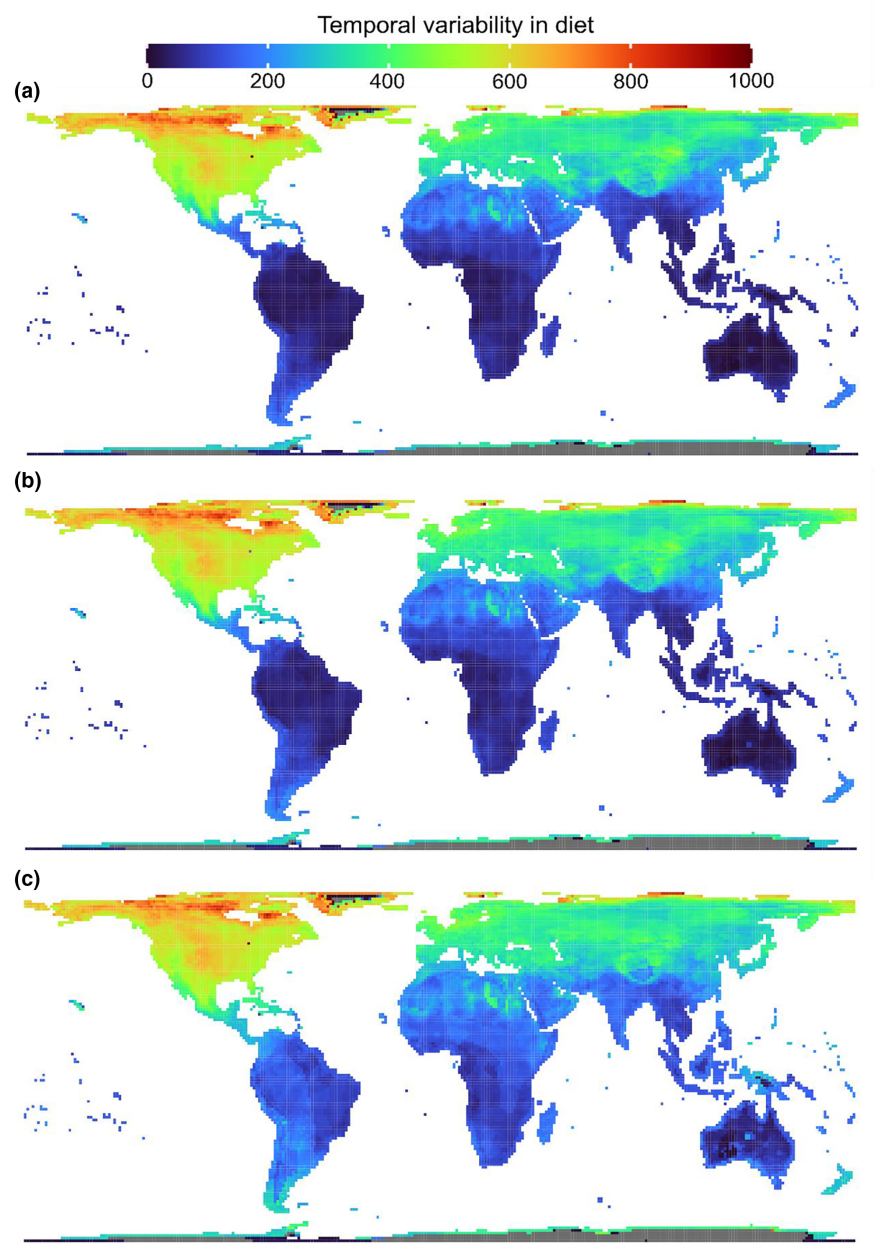

FIGURE 2 Spatial variation in average assemblage-level temporal variability in dietary characteristics quantified using (a) raw data, (b) data corrected for the level of confidence, and (c) raw data for species' with confidence level ≥0.75 only. Raw assemblage-level temporal variability in diet in (a) is measured as the species-specific sum of variance in each dietary category across time, averaged across all species occurring in each 110 × 110 km grid cell. Effort-corrected assemblage-level temporal variability in (b) is measured as weighted average across all species' temporal dietary variability, where weights are levels of confidence in species' dietary designation (see text for details). Raw assemblage-level temporal variability in diet in (c) is measured as the species-specific sum of variance in each dietary category across time, averaged across species occurring in each 110 × 110 km grid cell that have a level of confidence ≥0.75. Higher values indicate higher assemblage-level temporal variability in diet. We used the IUCN range maps to denote each species' presence or absence in each 110 × 110 km grid cell; full geographic range (i.e. breeding and non-breeding range) was used for each species. Grey areas in interior Greenland and interior Antarctica signify locations where avian species richness is zero.

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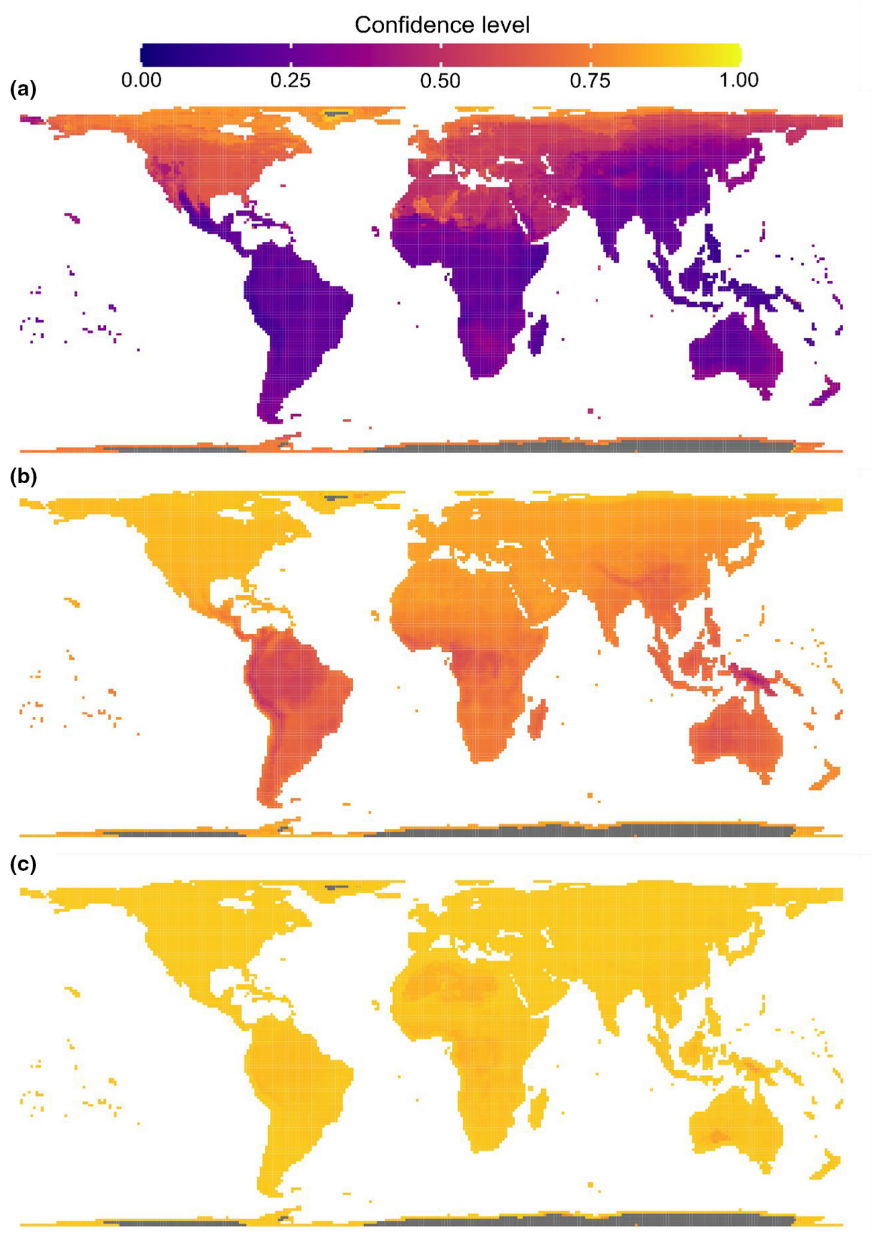

FIGURE 3 Spatial variation in assemblage-level confidence levels in the designations of temporal variability in species dietary attributes. Confidence levels for each species were quantified as the average of the percentile that a given species falls into, given the number of citations that were considered when making its dietary designation and the percentile a given species falls into given the length of its diet description (see text for details). (a–c) show the lower quantile (0.025), the median (0.50), and the upper quantile (0.975) of the confidence levels, respectively, for all species occurring in each 110×110 km grid cell. Higher values indicate higher confidence level. We used the IUCN range maps to denote each species' presence or absence in each 110×110 km grid cell; a full geographic range (i.e. breeding and non-breeding range) was used for each species. Grey areas in interior Greenland and interior Antarctica signify locations where avian species richness is zero.

while the remainder either showed temporal stationarity in diet (at least, at the dietary resolution considered here) or lacked information on temporal variability of diet. The information on diet change, and associated data on effort or level of confidence, can be used in conjunction with distributional data for each species (e.g. species range maps) to investigate temporal variability in dietary attributes at the assemblage level (Figures 2 and 3). As an example, we show that temporal variability in diet, both raw and corrected for the level of confidence, is highest for assemblages in North America, Europe, and Asia, though other regions such as, for example parts of northern Africa and New Zealand, also harbour species with highly variable diets (Figure 2). This spatial pattern remains largely the same even when only species with high level of confidence (>=0.75) in their dietary designations are retained (Figure 2c). Species with range boundaries in North America, Europe, northern Asia, and northern Africa have on average highest levels of confidence in the dietary designations (Figure 3). SAviTraits 1.0 provides important and overlooked information on how species dietary attributes change across the year and can be used to help answer a number of outstanding ecological questions including, but not limited to, assembly of bird communities across space and time, bird functional diversity dynamics, and the impacts of anthropogenic stressors on bird diversity. All data visualization were created with ggplot2 (version 3.4.2; Wickham et al., 2016).

AUTHOR CONTRIBUTIONS

Marta A. Jarzyna conceived the idea. **Stephen J. Murphy**, **André M. Bellvé**, **Reymond J. Miyajima**, **Natalie A. Sebunia**, **Molly M. Lynch** did data discovery and translation. **Stephen J. Murphy** and **Marta**

A. Jarzyna wrote the first draft of the manuscript, with all authors contributing to manuscript revisions.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Data R code with basic functions for exploration of SAviTraits 1.0 can be accessed via GitHub (https://github.com/martaajarzyna/SAviTraits_database) and is archived with Zenodo (10.5281/zenodo.8006811).

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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