

## ***Ecological Archives E095-178-D1***

**Hamish Wilman, Jonathan Belmaker, Jennifer Simpson, Carolina de la Rosa, Marcelo M. Rivadeneira, and Walter Jetz. 2014. EltonTraits 1.0: Species-level foraging attributes of the world's birds and mammals. *Ecology* 95:2027.**

**<http://dx.doi.org/10.1890/13-1917.1>**

### **INTRODUCTION**

Attributes such as diet, foraging strata, foraging time and body size strongly characterize the "Eltonian" niches of species. Birds and mammals are particularly renowned for their significant functional variation. They are also very well recorded, now enabling a first global compilation of species ecological foraging characteristics determining their role and function in ecosystems. Here we present a species-level, consistently sourced and interpreted, and transparent estimate of key ecological attributes relevant for the "Eltonian" niches for all 9,993 and 5,400 extant bird and mammal species derived from the literature.

Traits include those that in combination allow a first-order assessment of species' similarity in "ecological niches" or the overlap in their functional role. The standardized interpretation and adherence to source information and clear documentation aims to provide a replicable and transparent basis for research. Ten diet types were characterized with estimates of their relative importance to facilitate the ecological distinction of species. The trait variables in the dataset should support hypothesis testing or applied inference in ecology, conservation and evolution. Obvious limitations of this dataset due to its broad categories, uncertainties in original sources and transcription, and its species level nature (not accounting for population level variation) remain. It is hoped that this data publication will stimulate collaborative improvement and extension of these data and facilitate discovery of new potential uses.

### **METADATA**

#### **CLASS I. DATA SET DESCRIPTORS**

**A. Data set identity:** EltonTraits 1.0: Species-level foraging attributes of the world's birds and mammals

**B. Data set identification code:**

- (1) BirdFuncDat.txt
- (2) MamFuncDat.txt
- (3) BirdFuncDatSources.txt
- (4) MamFuncDatSources.txt

#### **C. Data set description**

**Summary:** The data set includes information on key characteristics of the foraging ecology of all 15,393 extant bird and mammal species. Variables include relevance of select diet types and foraging strata, body size, and activity time.

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University, 165 Prospect Street, New Haven CT 06511, USA. Jonathan Belmaker, Ecology and Evolutionary Biology Department, Yale University, 165 Prospect Street, New Haven CT 06511, USA and Department of Zoology, George S. Wise Faculty of Life Sciences, Tel Aviv University, Tel Aviv, 69978, Israel. Jennifer Simpson, Ecology and Evolutionary Biology Department, Yale University, 165 Prospect Street, New Haven CT 06511, USA and Scientific Technologies Corporation, 4400 E. Broadway Blvd Suite 705, Tucson AZ 85711. Carolina de la Rosa, Ecology and Evolutionary Biology Department, Yale University, 165 Prospect Street, New Haven CT 06511, USA. Marcelo M. Rivadeneira. Centro de Estudios Avanzados en Zonas Aridas (CEAZA) and Universidad Católica del Norte, Av. Ossandón 877, C.P. 178168, Coquimbo, Chile. Walter Jetz, Ecology and Evolutionary Biology Department, Yale University, 165 Prospect Street, New Haven CT 06511, USA.

Queries regarding the data set should be directed to Walter Jetz ([walter.jetz@yale.edu](mailto:walter.jetz@yale.edu)).

**Abstract:** Species are characterized by physiological, behavioral, and ecological attributes that are all subject to varying evolutionary and ecological constraints and jointly determine their role and function in ecosystems. Attributes such as diet, foraging strata, foraging time, and body size, in particular, determine a large portion of the “Eltonian” niches of species. Here we present a global species-level compilation of these key attributes for all 9993 and 5400 extant bird and mammal species derived from key literature sources. Global handbooks and monographs allowed the consistent sourcing of attributes for most species. For diet and foraging stratum we followed a defined protocol to translate the verbal descriptions into standardized, semiquantitative information about relative importance of different categories. Together with body size (continuous) and activity time (categorical) this enables a much finer distinction of species’ foraging ecology than typical categorical guild assignments allow. Attributes lacking information for specific species were flagged, and interpolated values based on taxonomy were provided instead. The presented data set is limited by, among others, these select cases missing observed data, by errors and uncertainty in the expert assessment as presented in the literature, and by the lack of intraspecific information. However, the standardized and transparent nature and complete global coverage of the data set should support an array of potential studies in biogeography, community ecology, macroevolution, global change biology, and conservation. Potential uses include comparative work involving these traits as focal or secondary variables, ecological research on the trait or trophic structure of communities, or conservation science concerned with the loss of function among species or in ecosystems in a changing world. We hope that this publication will spur the sharing, collaborative curation, and extension of data to the benefit of a more integrative, rigorous, and global biodiversity science.

**D. Key words:** *bird; body size; diet; eco-informatics; foraging; function; mammal; mass; niche; stratum; traits; vertebrate.*

## CLASS II. RESEARCH ORIGIN DESCRIPTORS

### A. Overall project description

**Identity:** Integrating the global dimensions of terrestrial vertebrate biodiversity

**Originators:** Walter Jetz , Ecology and Evolutionary Biology Department, Yale University , 165 Prospect Street, New Haven CT 06511, USA

**Period of Study:** 2000 – ongoing.

**Objectives:** To enable an integrated and global understanding of the spatial, environmental, trait and phylogenetic dimensions of terrestrial vertebrates.

**Sources of funding:** University of California San Diego, Yale University, NSF BCS-1037902, DBI-0960550, DEB-1026764.

## B. Specific subproject description

**Taxonomy:** The bird taxonomy used is the same as in ([Jetz et al. 2012](#)). Specifically, it broadly follows the Birdlife V3 world list (June 2010, 9,895 extant species recognized). But we do not recognize nine species (*Anodorhynchus glaucus*, *Gallinula pacifica*, *Gallirallus lafresnayanus*, *Oceanodroma macrodactyla*, *Ophrysia superciliosa*, *Rhodonessa caryophyllacea*, *Siphonorhis americana*, *Tadorna cristata*, *Vanellus macropterus*) that are widely considered extinct and three (*Heliangelus zusii*, *Atlapetes blancae*, *Upupa marginata*) that are considered not valid by most authorities (resulting in 9,882 accepted species). In addition to Birdlife V3 we recognize 111 species that are considered valid by Handbook of the Birds of the World ([del Hoyo et al. 1992-2011](#)) and/or Birds of the Western Palearctic ([Cramp et al. 1978-1994](#)) and/or Birds of Africa ([Urban et al. 1986-2000](#)) and that are also recognized by IOC world list V2.7 (DEC 29, 2010), resulting in a total of 9,993 recognized species. For mammals we used an updated taxonomy following ([Wilson and Reeder 2005](#)) resulting in 5400 species.

**Data sources:** For every species the variable-specific source is referenced in the dataset. Avian diet, foraging and activity time information was mostly taken from The Handbook of the Birds of the World ([del Hoyo et al. 1992-2011](#)). The Handbook is composed of 16 volumes covering all of world's extant bird species (except recent descriptions and discoveries). For a number of species, especially those contained in volume 16 (which was not available at the start of the project), we utilized a range of other bird guides, handbooks, and primary literature.

For the mammal diets we utilized Walker's Mammals of the World ([Nowak 1999](#)) as our main reference. Walker's Mammals is the most comprehensive collection of mammal information currently available. For species, or groups of species, where Walker's Mammals was lacking data we used various other sources, both books and primary literature.

**Translation of foraging descriptions:** For diet and foraging stratum our goal was to translate information about the relative use of different categories into data that is as quantitative as possible. Expert descriptions in the literature are rarely expressed quantitatively in terms of proportional usage of a given diet or stratum. However, descriptions are usually specific enough for a coarse proportional assignment. We standardized the interpretation of certain words and the usage quantities they represented to ensure a uniform translation throughout. For each category of food or stratum we recorded the estimated percent relevance in 10% steps and recorded as integers from 0 to 10. Each score times 10 represents the estimated relative usage of a given category (i.e. varying from 0% to 100% in 10% intervals), and the values of all categories in a given variable (diet or foraging stratum) sum to 10 (i.e. 100%).

Throughout the references a range of terminology is used to describe the diets of species. Here are some examples of the common terms and their translation into standardized numerical values: - "Eats mostly fruit": score: 6 or greater. - "Sometimes eats fruit"; score: 1 or 2. - "Occasionally eats fruit"; score: 1 at most. We adjusted relevance scores depending on the remainder of the description and context. If many diet items or strata are listed as being significant to the diet, we would decrease the score of each. As another example, if the species is described to eat *mostly* fruit and *sometimes* seeds and leaves, then fruit was assigned a proportion of 6 and seeds and leaves each received 2. If there had only been one diet listed after the sometimes, fruit would receive proportion 8 and the secondary diet 2. Comparison of multiple sources for the same species suggested that authors almost always list the most important categories first with others sorted by order of importance. Thus, in cases where comparative words were not used in the description, we gave more weight to the category that was listed first, then decreasing proportions for those following.

**Data interpolation:** For some species, little to no data is available on feeding ecology. Sometimes, the feeding descriptions indicate similarity to another species in the genus. These species receive the same proportions given to the referenced species. For species completely lacking in data we used genus- or, in very few cases (e.g. monotypic genera), family-typical values. Instead of providing an "expert guess" without clear source, we performed such interpolation consistently for any missing value and clearly marked them in the dataset. For body size we use the geometric average of the relevant taxon. For foraging attributes, we averaged the values of every category (e.g. "fruits") among species in the same genus (or family) with data. The averages were then rounded to integers and thus represented a "typical value" for any data-poor species in the genus. On few occasions the rounding procedure resulted in species diets that did not sum to 10 (100%). In these cases we individually inspected the non-rounded averages, as well as the original proportions, to determine appropriate categories where proportions should be added or subtracted. Body size and foraging attributes are usually evolutionarily highly conserved and for analyses including many species we expect this interpolation to introduce little error, yet facilitate whole assemblage analyses. However, the interpolation should be noted and accounted for in any phylogenetic analyses.

**Other limitations:** Errors in original sources, errors in transcription, inconsistencies in transcription, spatial and temporal intraspecific variation (among and within populations). See, e.g., ([Fitzsimmons 2013](#)) for further discussion of some of these issues.

**Project personnel:** Hamish Wilman, Walter Jetz, Jonathan Belmaker, Jennifer Simpson, Jessica Hagberry, Carolina De la Rosa, Christian Anderson, Marcelo Rivadeneira.

### CLASS III. DATA SET STATUS AND ACCESSIBILITY

#### A. Status

**Latest update:** August 2013. Data compilation is ongoing.

**Latest Archive date:** n/a

**Metadata status:** Metadata are complete and up to date.

**Data verification:** All records were double-checked by either H. Wilman or W. Jetz. All data have been used in various analyses and plots and received additional spot-checking for outliers. The data set will undoubtedly benefit from further quality control and curation, and our goal is to facilitate this process by sharing through this archive and online.

#### B. Accessibility

**Storage location and medium:** The data set is available from the Ecological Society of America's data archives. We plan to also make the data available for download and curation online, please feel free to contact us for any updates.

**Contact person:** Walter Jetz, Yale University ([walter.jetz@yale.edu](mailto:walter.jetz@yale.edu)).

**Copyright restrictions:** None.

**Proprietary restrictions:** None.

**Costs:** None. We request that researchers cite this paper if using the diet, foraging stratum and activity data. When using the body mass data, please separately cite the respective main sources (two existing

digital datasets: Smith et al 2003, Dunning 2007).

## CLASS IV. DATA STRUCTURAL DESCRIPTORS

### A. Data Set File

**Identity:** (1) BirdFuncDat.txt (2) MamFuncDat.txt (3) BirdFuncDatSources.txt  
(4) MamFuncDatSources.txt

**Size:**

- (1) 9,993 records (including header) and 40 fields. Total file size is 2,148 kb.
- (2) 5,401 records (including header) and 27 fields. Total file size is 566 kb.
- (3) 59 records (including header) and 2 fields. Total file size is 8 kb.
- (4) 177 records (including header) and 2 fields. Total file size is 32 kb.

**Format and storage mode:** ASCII text, tab delimited, not compressed.

**Header information:** The first row of the file contains variable names (see below).

**Row information:** Each row represents data for a single species (files (1) and (2)) or reference (files (3) and (4))

**Alphanumeric attributes:** Mixed.

**Special characters/fields:** NA.

**Authentication procedures:** MD5 Checksum for (1) d6197b2cd90ca3ece0a7393abbf8b7fc; for (2) 59c3eee29d3ed0a33a002975a5a8cc75; for (3) e4793ab8baa813bba7d168a3d2d6b6a7; for (4) 0c67fa8bf6b6ccb7a38fc5229f84508b .

### B. Variable information

TABLE 1. Summary of variable information for file (1) – bird data

Variable	Description	Type	Variable codes
SpecID	Jetz Lab Species ID	Integer	NA
PassNonPass	Passeriformes, Nonpasseriformes	Character	NA
IOOrder	IOC V2.7 Checklist Order	Character	NA
BLFamilyLatin	Birdlife V3.0 Checklist Family Latin	Character	NA

BLFamilyEnglish	Birdlife V3.0 Checklist Family English	Character	NA
BLFamSequID	Birdlife V3.0 Checklist Family Sequence	Character	NA
Taxo	Taxonomic authority used for species	Character	BL3: Birdlife V3.0; IOC27: IOC V2.7
Scientific	Species Latin name	Character	NA
English	Species English name	Character	NA
Diet-Inv	Percent use of: Invertebrates-general, aquatic invertebrates, shrimp, krill, squid, crustaceans, molluscs, cephalopod, polychaetes, gastropods, orthoptera, terrestrial Invertebrates, ground insects, insect larvae, worms, orthopterans, flying insects	Integer	estimated % use (categories sum to 100% total)
Diet-Vend	Percent use of: Mammals, Birds	Integer	estimated % use (categories sum to 100% total)
Diet-Vect	Percent use of: Reptiles, snakes, amphibians, salamanders	Integer	estimated % use (categories sum to 100% total)
Diet-Vfish	Percent use of: Fish	Integer	estimated % use (categories sum to 100% total)
Diet-Vunk	Percent use of: Vertebrates- general or unknown	Integer	estimated % use (categories sum to 100%

			total)
Diet-Scav	Percent use of: Scavenge, garbage, offal, carcasses, trawlers, carrion	Integer	estimated % use (categories sum to 100% total)
Diet-Fruit	Percent use of: Fruit, drupes	Integer	estimated % use (categories sum to 100% total)
Diet-Nect	Percent use of: Nectar, pollen, plant exudates, gums	Integer	estimated % use (categories sum to 100% total)
Diet-Seed	Percent use of: Seed, maize, nuts, spores, wheat, grains	Integer	estimated % use (categories sum to 100% total)
Diet-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	Integer	estimated % use (categories sum to 100% total)
Diet-5Cat	Assignment to the dominant among five diet categories based on the summed scores of constituent individual diets.	Character	PlantSeed: Plant and Seeds, FruiNect: Fruits and Nectar, Invertebrate: Invertebrates, VertFishScav: Vertebrates and Fish and Carrion, Omnivore: score of $\leq 50$ in all four categories
Diet-Source	Literature source used	Character	Link to Ref_ID in Table 3

Diet-Certainty	Dietary relevance score reliability	Character	A – Highly certain that the source is reliable and has provided accurate diet information. B – Reasonably confident that source is reliable, however information on relative proportion of each diet category making up the whole diet is possibly uncertain. C – Quality of source diet estimate unclear or inferred from a specific congeneric species with good sources. D1, D2 – Species-level information missing and value is that typical for genus (D1) or family (D2).
Diet-EnteredBy	Name of primary transcriber of diet data		
ForStrat-watbelowsurf	Prevalence of: Foraging below the water surfaces	Integer	estimated % use (categories sum to 100% total)
ForStrat-wataroundsurf	Prevalence of: Foraging on or just (<5 inches) below water surface	Integer	estimated % use (categories sum to 100% total)
ForStrat-ground	Prevalence of: Foraging on ground	Integer	estimated % use (categories sum to 100% total)
ForStrat-understory	Prevalence of: Foraging below 2m in understory in forest, forest edges, bushes or shrubs	Integer	estimated % use (categories sum to 100% total)
ForStrat-midhigh	Prevalence of: Foraging in mid to high levels in trees	Integer	estimated % use (categories sum to 100%



	or high bushes (2m upward), but below canopy		total)
ForStrat-canopy	Prevalence of: Foraging in or just above (from) tree canopy	Integer	estimated % use (categories sum to 100% total)
ForStrat-aerial	Prevalence of: Foraging well above vegetation or any structures	Integer	estimated % use (categories sum to 100% total)
PelagicSpecialist	Foraging predominantly pelagic. Source for all: Handbook of the Birds of the World	Binary	0: no; 1: yes
ForStrat-Source	Source of estimates for foraging stratum	Character	Link to Ref_ID in Table 3
ForStrat-SpecLevel	Indicates whether foraging stratum estimates are based on species-level data	Binary	0: no; 1: yes
ForStrat-EnteredBy	Name of primary transcriber of foraging stratum data	Character	
Nocturnal	Main foraging activity at night. Source for all: Handbook of the Birds of the World	Binary	0: no; 1: yes
BodyMass-Value	Body mass (g). For Source Dunning08: Geometric mean of average values provided for both sexes (Dunning08). For Source GenAvg: genus average as provided by other sources	Floating Point	NA

BodyMass-Source	Source of body mass values.	Character	PrimScale: inferred from select primary sources with mass and length data, and mass-length relationships parameterized at family level. GenAvg: genus average. Other: see comments.
BodyMass-SpecLevel	Indicates whether body mass values are based on species-level data	Binary	1: based on species level data; 0: inferred from genus or family typical values
BodyMass-Comment	Misc. comments	Character	MarceloR: mobilized or calculated from length estimates by Marcelo Rivadeneira
Record-Comment	Indicates whether data record arose from species split	Character	NA

TABLE 2. Summary of variable information for file (2) – mammal data

Variable	Description	Type	Variable codes
MSW3_ID	Jetz Lab Species ID	Integer	NA
Scientific	MSW3 Species Latin name	Character	NA
MSWFamilyLatin	MSW3 Checklist Family Latin	Character	NA
Diet-Inv	Percent use of: Invertebrates-general,	Integer	estimated % use (categories sum to 100%)

	aquatic invertebrates, shrimp, krill, squid, crustaceans, molluscs, cephalopod, polychaetes, gastropods, orthoptera, terrestrial Invertebrates, ground insects, insect larvae, worms, orthopterans, flying insects		total)
Diet-Vend	Percent use of: Mammals, Birds	Integer	estimated % use (categories sum to 100% total)
Diet-Vect	Percent use of: Reptiles, snakes, amphibians, salamanders	Integer	estimated % use (categories sum to 100% total)
Diet-Vfish	Percent use of: Fish	Integer	estimated % use (categories sum to 100% total)
Diet-Vunk	Percent use of: Vertebrates-general or unknown	Integer	estimated % use (categories sum to 100% total)
Diet-Scav	Percent use of: Scavenge, garbage, offal, carcasses, trawlers, carrion	Integer	estimated % use (categories sum to 100% total)
Diet-Fruit	Percent use of: Fruit, drupes	Integer	estimated % use (categories sum to 100% total)
Diet-Nect	Percent use of: Nectar, pollen, plant exudates, gums	Integer	estimated % use (categories sum to 100% total)
Diet-Seed	Percent use of: Seed, maize, nuts, spores,	Integer	estimated % use (categories sum to 100%

	wheat, grains		total)
Diet-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	Integer	estimated % use (categories sum to 100% total)
Diet-Source	Reference ID. Refer to Mammal Reference Table for full list of references	Character	Link to Ref_ID in Table 4
Diet-Certainty	Estimated reliability of relative diet scores	Character	ABC – Highly, reasonably or somewhat certain that the source is reliable. In some cases the estimate may come from a specific congeneric species that is expert-judged to be ecologically very similar. D1, D2 – Species-level information missing and value is that typical for genus (D1) or family (D2).
ForStrat-Value	Assignment to one of five (possibly ordinal when excluding marine species) foraging stratum categories. Source for all: Nowak (1999).	Character / Ordinal	M - marine, G - ground level, including aquatic foraging (see ForStrat-Comment), S- scansorial, Ar - arboreal, A- aerial.
ForStrat-Certainty	Estimated reliability of foraging stratum	Character	A - Certain that the source is reliable and has

	assignment		provided accurate foraging stratum information. B – Assignment uncertain.
ForStrat-Comment	Any comments	Character	NA
Activity-Nocturnal	Foraging activity at night	Binary	0: no; 1: yes
Activity-Crepuscular	Foraging activity at twilight.	Binary	0: no; 1: yes
Activity-Diurnal	Foraging activity at day	Binary	0: no; 1: yes
Activity-Source	Literature source of activity cycle estimate	Character	Link to Ref_ID in Table 4
Activity-Certainty	Estimated reliability of activity cycle estimates	Character	ABC – Highly, reasonably or somewhat certain that the source is reliable. In some cases the estimate may come from a specific congeneric species that is expert-judged to be ecologically very similar. D1, D2 – Species-level information missing and value is that typical for genus (D1) or family (D2).
BodyMass-Value	(Average) Adult body mass (g)	Floating Point	NA
BodyMass-Source	Literature source used	Character	Link to Ref_ID in Table 4
BodyMass-SpecLevel	Indicates whether body mass values are based on	Integer	1: based on species level data; 0: inferred from

	species-level data		genus or family typical values; 2: Based on phylogenetically imputed values (see Ref_178 for details and variance measures)
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TABLE 3. Summary of variable information for file (3) – bird data sources

Variable	Description	Type	Variable codes
Ref_ID	Reference ID	Character	NA
Full Reference	Full reference details	Character	NA

TABLE 4. Summary of variable information for file (4) – mammal data sources.

Variable	Description	Type	Variable codes
Ref_ID	Reference ID	Character	NA
Full Reference	Full reference details	Character	NA

**CLASS V. SUPPLEMENTAL DESCRIPTORS****A. Data acquisition**

See Class II, Section B.

**B. Quality assurance/quality control procedures:** See comments above (Class II, Section B; Class III, Section A).

**C. Related material:** N/A.

**D. Computer programs and data processing algorithms:**

**E. Archiving:** We hope to update data files and metadata periodically at Ecological Archives and at a dedicated website.

**F. Literature cited:**

Publications from which data were obtained are stated in the respective fields of the data file.

**G. Publications using the data set:**

Belmaker, J., C. H. Sekercioglu, and W. Jetz. 2012. Global patterns of specialization and coexistence in bird assemblages. *Journal of Biogeography* 39: 193–120.

Belmaker, J. and W. Jetz. 2013. Spatial Scaling of Functional Structure in Bird and Mammal Assemblages. *The American Naturalist* 181:464-478.

Boyer, A. and W. Jetz Boyer, A. G. and W. Jetz. 2014. Extinctions and the loss of ecological function in island bird communities. *Global Ecology and Biogeography* 23:679-688.

Barbet-Massin, M. and W. Jetz (manuscript): Global turnover and loss of ecological function in avian assemblages under climate change.

**H. History of data set usage**

**Data request history:** N/A

**Data set update history:** N/A.

**Review history:** N/A.

**Questions and comments from secondary users:** N/A

**ACKNOWLEDGMENTS**

We sincerely thank the many authors of the literature sources consulted for this database. Without their careful work, the compilation of this data set would have been either impossible or meaningless. In addition, we would like to thank Tien Ming Lee, Frank LaSorte, and Clinton Edwards for their valuable feedback and ideas on how to make this data collection effort more valuable to the scientific community at large. Finally, we acknowledge financial support for this data compilation from University of California San Diego, Yale University, and NSF BCS-1037902, DBI-0960550, DEB-1026764.

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