USER GUIDE TO THE MOSAIC LIFE HISTORY DATABASE

A Companion to COM(P)ADRE and PADRINO/A demographic databases

Working document – 07 March 2022

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C. Movement traits

User guide version information

Version 1.0.0

Release date: 7 March 2022

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General Instructions

Database Organization

The data associated with MOSAIC are provided in a single R data (extension.Rdata) and as a comma separated value (.csv) file format. The code for downloading the data can be located from the mosaic portal (https://mosaicdatabase.web.ox.ac.uk/download-database) In addition, these files are accompanied by R scripts and a nexus phylogeny available in the Supplementary Information of the manuscript introducing MOSAIC, and in our GitHub repository (https://github.com/mosaicdatabase/mosaicdatabase)

MOSAIC_v_1_0_0.RData: Contains basic information regarding the source of publication, as well as ecological, biogeographic, and taxonomic details of the demographic study for each study species, the demographic information (i.e., the matrix population model) and metadata.

Database Design

In developing the MOSAIC database, we balance level of detail with accessibility. A highly detailed, comprehensive profile of life history traits for species in COM(P)ADRE and PADRINO/A, if possible to collect, would be difficult to navigate. So rather than collating a wealth of information in many different formats, we designed this dataset to highlight a smaller collection of traits in a single format which is of most interest, and expressed, by COM(P)ADRE and PADRINO/A users. In MOSAIC's future updates, we plan to add additional detail and additional fields, but we initially took a limited approach and plan to keep the design minimal. If there are life history traits, alternative formats for existing variables, or other features you would like to see added to MOSAIC, please suggest them to us at: mosaicdatabase@biology.ox.ac.uk

Understanding the diverse needs of users, we include in this guidance document additional direction on obtaining information on the variables we report in more detail. In this guide, we also highlight the scope of use, and caution against the most foreseeable abuses of data. We ask that all users approach this dataset with a caution and pay close attention to what variables and their statistical expression reflect.

The Meanings of NA and NDY in MOSAIC

NA in the MOSAIC data generally means that the data are not applicable. An example of where the data are not applicable is volancy within plants, as this trait does not occur in plants. NDY in the MOSAIC data means that the data have not yet been digitized. NF in the MOSAIC data means that the data are not available to date as no affirmative records were found upon review.

Disclaimer

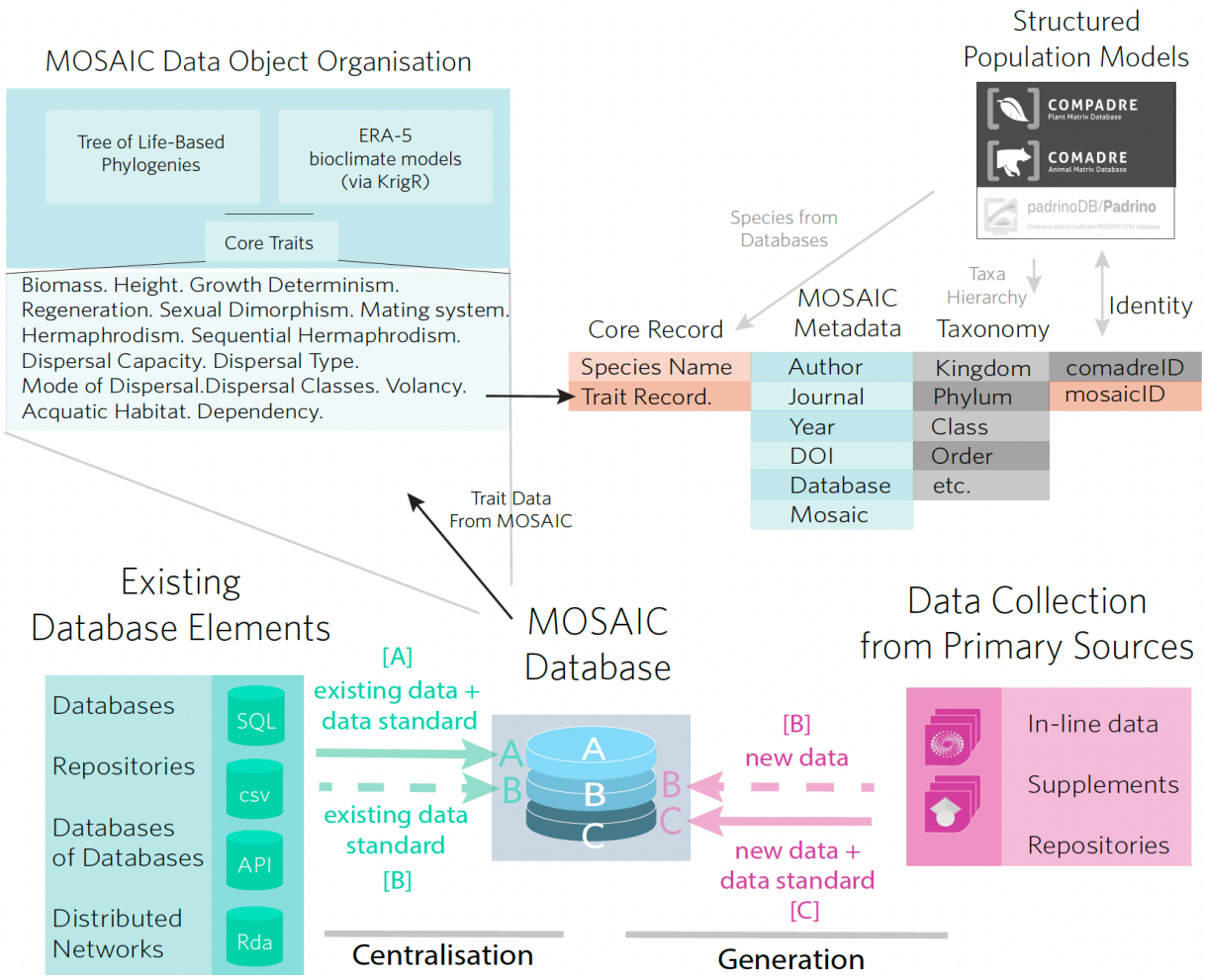
The MOSAIC digitization team does its best to ensure data accuracy, and every piece of information goes through multiple error-checks prior to its release in www. mosaicdatabase.web.ox.ac.uk. However, we claim no responsibility for any damage that may arise from using MOSAIC. A list of error checks and potential issues in the use and interpretation of the database are described in the main manuscript. The end user is ultimately responsible for his/her interpretations of the data.

What is new in this version?

Version 1.0.0

- The first version of the database. No updates.

DIAGRAM OF THE MOSAIC DATABASE ARCHITECTURE



Variables in MOSAIC

The MOSAIC database is constructed of objects containing life history information across variables and organized into themes to aid in navigation. The metadata object is the object containing information about every study for which data is stored in the MOSAIC database. Every variable containing a value in the MOSAIC database will have corresponding metadata.

Associated with every data record is a value and its corresponding metadata. The metadata details data providence and relationships to existing databases. The fields within metadata are detailed below:

Format Guide

[Index] *Variable Name*

Definition: [Definition of the variable]

Possible values, [cat. = categorical/discrete; cont. = continuous], [r variable class: character, numeric, integer, complex, or logical.]

- <XX> [variable with two digits]
  XXX – XXX [discrete variable name] – [discrete variable definition]
  <...>XXX<...> [discrete variable with additional content on either side]
- Units: [unit of measure (integer, percent, ratio, mm, km^2, g, etc.)]
- Precision: [for continuous variables: scientific notation of the precision of the measure - e.g., $1e^1$ for km = precise to the tens of km (3270 km), no decimal; $1e^{-1}$ for temperature = precise to the tenth of a degree (10.4 °C)]
- Error boundaries: [for continuous variables: boundaries beyond which values are errors]

Usage Notes: [Notes on boundaries of use – note that this is non-exhaustive and highlights major potential errors]

Additional Information: [Guidance on databases containing more detailed information]

Source Data: [Datasets from which information was gathered; note that this will not include individual papers unless the papers are associated with a larger dataset/database. This category reflects databases.]

Last updated: [Date that information was retrieved from other databases or searches]

A1 *Species Accepted*

Definition: Currently accepted latin name.

Possible values, cat., factor

- <Genus_species> - e.g., Taraxacum_officinale

Usage Notes: NA

Additional Information: NA

Source Data: This information is obtained from The Encyclopaedia of Life

Last updated: 24 January 2022

A2 *Kingdom*

Definition: Kingdom to which species belongs

Possible values, cat., factor

- <kingdom> - e.g., Plantae, Fungi, Rhodophyta, Chromista (yes, MOSAIC includes fungi and algae as well as plants)

Usage Notes: NA

Additional Information: NA

Source Data: The Encyclopaedia of Life

Last updated: 24 January 2022

B1 *Authors*

Definition: Surname (family name) of all authors

Possible values, NA, character

- <name(s)> - Separated with ";" e.g., "Smith; Jones"

Usage Notes: NA

Additional Information: NA

Source Data: NA

Last updated: 24 January 2022

B2 *Journal Name*

Definition: The document from which data were sourced.

Possible values, cat., factor

- <abbreviated journal name> - Where the data come from a scientific journal article, the abbreviated journal name is given. We use the standard abbreviation of the journal compliant with the ISO-4 standard.
- Book - Records are from a book, or book chapter
- PhD thesis - Records are from a doctoral thesis
- MSc thesis - Records are from a masters thesis
- Report - Records are from a report
- Conference talk - Records are from a conference talk
- Conference poster - Records are from a conference poster

Usage Notes: NA

Additional Information: NA

Source Data: NA

Last updated: 24 January 2022

B3 *Year Publication*

Definition: Year of publication

Possible values, cont., numerical
- <yyyy> - e.g., 2012

Usage Notes: NA

Additional Information: NA

Source Data: NA

Last updated: 24 January 2022

B4 *DOI/ISBN Number*

Definition: Digital Object Identifier number

Possible values, NA, character
- <XXXXXXXXXXXXXX> - e.g., doi.org/10.1073/pnas.1506215112

Usage Notes: NA

Additional Information: NA

Source Data: NA

Last updated: 24 January 2022

PRIMARY Variables

A1 *Biomass*

Call: mosaic@biomass

Definition: Maximum reported mass of adult individual/whole-organism. For plants, only aboveground dry mass is measured. See "Additional information" for additional information on belowground biomass.

Possible values, cont., numerical

- Units: Grams (g)
- Precision: 0.000
- Error Boundaries: 0-150,000,000g
- NF – Body mass reviewed and inconclusive (no affirmative records found upon review)
- NDY – Body mass not digitised yet (yet to be evaluated)
- NA – not applicable

Usage notes: When both male and female data were reported, only the maximum value was considered independently of the gender of the individuals.

Additional Information: Belowground biomass is not reported because information availability is appreciably more limited than for aboveground biomass. The BIEN database includes information on belowground biomass that can be referenced and utilized where of interest.

Source Data: Amniote, TRY database.

Last updated: 24 January 2022

A2 *Height*

Call: mosaic@height

Definition: (Plants) Maximum height of the whole organism/whole individual from surface (i.e. substrate) to tallest vertical extremity.

Possible values, cont., numerical

- Units: centimeters (cm)
- Precision: 0.000
- Error Boundaries: 0-1000cm

Usage notes:

- Depending on the species group, height can have profoundly different meanings. Height corresponds with embolic risk in some woody plants and corresponds with size-based fitness in others.

Additional Information: NA

Source Data: TRY database.

Last updated: 24 January 2022

A3 *Growth Determination*

Call: mosaic@growthdet

Definition: Growth indeterminacy is defined by continuous growth of individuals throughout their lifetimes (measured by mass, length, bone ossification, or other indicators). This field reflects a binary classification of whether an individual is growth (in)determinate.

Possible values, cat, factor

- Growth indeterminate – growth continues throughout an individual's lifespan
- Growth determinate – growth ceases or attenuates to negligibility before the end of an individual's lifespan
- NF - Growth determination reviewed and inconclusive (no affirmative records found upon review)
- NDY - Growth determination not digitised yet (yet to be evaluated)
- NA – Growth determination not applicable to the subject area

Usage notes: Additional classification systems for characterizing growth indeterminacy exist in the literature. Most well recognised is a six-type scheme describing growth and determination by Sebens (1987), which offers detailed characterization of growth patterns. Broad-scale information about growth and age for most species could not be located in the literature, and therefore a simplified schema is used. More resolved classifications might be incorporated into future versions of MOSAIC.

Additional Information: NA

Source Data: 24 January 2022

Last updated: NA

A4 *Regeneration*

Call: mosaic@regen

Definition: Capacity for an individual to regenerate any substantial part of its body, including autotomy. Autotomy is defined as "The voluntary severance by an animal of a part of its body (commonly one of its own limbs), usually to escape capture by a predator that has seized that part. The part then regrows."

Possible values, cat., factor

- Regenerative – individuals are capable of regenerating
- Non-regenerative – individuals do not exhibit the capacity to regenerate tissues
- NF - regenerative abilities reviewed and inconclusive (no affirmative records found upon review)
- NDY - regeneration information not digitised yet (yet to be evaluated)
- NA – regenerative abilities not applicable to the subject area

Usage notes: There are a number of more resolved schemes for detailing whether regenerating different parts of the body. For particular questions pertaining to the nature of injury, the level of recovery, the role of depredation, and the consequences for reproduction, more detail may be appropriate. This dataset covers the most general applications and initially screens for regenerative capability (from poor recovery of appendages to complete regeneration of limbs).

Additional Information: NA

Source Data: NA

Last updated: 24 January 2022

A5 *Sexual Dimorphism*

Call: mosaic@dimorph

Definition: An indicator of whether sexual dimorphism is exhibited in the species. Sexual dimorphism is defined as "the occurrence of morphological differences (other than primary sexual characters) that distinguish males from females of a species of organism." (Oxford Dictionaries of Ecology and Zoology)

Possible values, cat., factor

- Sexually Dimorphic – species is sexually dimorphic
- Sexually Monomorphic – species is sexually monomorphic (i.e. non-dimorphic)
- NF - Sexual dimorphism reviewed and inconclusive (no affirmative records found upon review)
- NDY - Sexual dimorphism not digitised yet (yet to be evaluated)
- NA – Sexual dimorphism not applicable to the subject area

Usage Notes: NA

Additional Information:

Source Data: NA

Last updated: 24 January 2022

B1 *Mating system*

Call: mosaic@matsyst

Definition: System of mating; the organization of sexual interactions of individuals within populations based on sex.

Possible values, cat., factor

- Monogamy – exclusive mating between one male and one female
- Non-monogamy - Non-monogamy was assigned based on genetic or behavioural evidence
- NF - Mating system reviewed and inconclusive (no affirmative records found upon review)
- NDY - Mating system not digitised yet (yet to be evaluated)
- NA – Mating system not applicable to the subject area

Usage notes:

- Metric does not identify size of groups for plural mating systems
- Metric does not identify enforcement mechanisms for different mating systems

Additional Information: NA

Source Data: NA

Last updated: 24 January 2022

B2 *Sexual allocation*

Call: mosaic@hermaph

Definition: Indicator of whether a species exhibits hermaphroditism or monoeicieosity. Hermaphrodism is defined as: “An individual that possesses both male and female sex organs; i.e. it is bisexual.” (Oxford Dictionary of Zoology). Monoeciousness is defined as: “Applied to an organism in which separate male and female organs occur on the same individual (e.g. to a plant which bears male and female reproductive structures in the same flower or separate male and female flowers on the same plant, or to a hermaphrodite animal). Some authors restrict the term botanically to plants with separate male and female flowers; plants which bear male and female reproductive organs in the same flower are then called hermaphrodite.”

Possible values, cat., factor

- Hermaphroditic – species is hermaphroditic
- Monoecious – species is monoecious
- Dioecious or Gonochorous – species is dioecious (Gonochorous was adopted for animals)
- NF - Hermaphroditism reviewed and inconclusive (no affirmative records found upon review)
- NDY - Hermaphroditism not digitised yet (yet to be evaluated)
- NA – Hermaphroditism is not applicable to the subject area

Usage notes:

- NA

Additional Information: NA

Source Data: NA

Last updated: 24 January 2022

B3 *Sequential hermaphroditism*

Call: mosaic@seqhermaph

Definition: Indicator of whether there is a sex switch during the organism's lifespan.

Possible values, cat., factor

- Protogynous – species is protogynous: organisms that are female and at some point in their lifespan change sex to male.
- Protandrous – species is protandrous: organisms that are male and at some point in their lifespan change sex to male.
- NF - Protogyny/Protandry reviewed and inconclusive (no affirmative records found upon review)
- NDY - Protogyny/Protandry not digitised yet (yet to be evaluated)
- NA – Protogyny/Protandry is not applicable to the subject area.

Usage notes: NA

Additional Information: Note that is not rare flowers present protogyny/protandry but this was not considered in Mosaic so far

Source Data: NA

Last updated: 24 January 2022

C1 *Dispersal Capability*

Call: mosaic@dispcap

Definition: An indicator for whether or not a species exhibits dispersal behaviour or at any stage in its life cycle. Where dispersing, a categorical description of whether dispersal is natal or breeding or otherwise. Dispersal is defined as "The tendency of an organism to move away, either from its birth site (natal dispersal) or breeding site (breeding dispersal): the opposite of philopatry." (Oxford Dictionary of Zoology).

Possible values: cat., factor

- Dispersing – Exhibits at least one age-/stage-class which disperses; natal or breeding components unknown.
- Natal Dispersal – Permanent dispersal of at least one age-/stage-class
- Breeding Dispersal – Dispersal of adults between breeding attempts in at least one age-/stage-class
- Multi-Dispersal – Both natal and breeding dispersal reported in the species; see DispClasses for more information
- Non-Dispersing – Species observed to have no dispersal traits/behaviour
- NF - dispersal capability reviewed and inconclusive (no affirmative records found upon review)
- NDY – dispersal capability unknown/not yet evaluated
- NA – not applicable

Usage Notes: NA

Additional Information: NA

Source Data: NA

Last updated: 24 January 2022

C2 *Type of Dispersal*

Call: mosaic@disptype

Definition: An indication of whether dispersal is a passive (requires assistance) or active (no assistance) event. See DispClasses for more information.

Possible values: cat., factor

- Active – organism utilises its own morphology for the dispersal event
- Passive – organism is unable to disperse through their own means and require an external factor
- Active and Passive – organism is able to disperse with assistance but can also use external factors. Active and passive dispersal can occur within the same life stage or can occur in different life stages.
- NF – type of dispersal reviewed and inconclusive (no affirmative records found upon review)
- NDY – type of dispersal unknown/not yet evaluated
- NA – not applicable

Usage Notes: NA

Additional Information: NA

Source Data: NA

Last updated: 24 January 2022

C3 *Mode of Dispersal*

Call: mosaic@modedisp

Definition: An indicator of the mode of dispersal of the species (plant and animal specific terminology).

Possible values: cat., factor

- Motile – the dispersal of animal species without assistance
- Phoretic – the dispersal of animal species by attaching to another animal
- Water currents – the dispersal of animal species by water
- Motile and water currents – animal species that disperse without assistance and by water, both forms of dispersal can occur within the same life stage or can occur in different life stages
- Anemochory – the dispersal of plant seeds by wind
- Anthropochory – the dispersal of plant seeds by humans
- Autochory – the dispersal of plant seeds without assistance from an external vector (e.g., by gravity or ballistic dispersal)
- Hydrochory – the dispersal of plant seeds by water
- Zoochory – the dispersal of plant seeds by animals
- Anemochory and Anthropochory – plant seeds can be dispersed by wind and humans
- Anemochory and Autochory – plant seeds can be dispersed by wind and without the help of an external vector
- Anemochory and Hydrochory – plant seeds can be dispersed by wind and water
- Anemochory and Zoochory – plant seeds can be dispersed by wind and animals
- Autochory and Hydrochory – plant seeds can be dispersed without the help of an external vector and by water
- Autochory and Zoochory – plant seeds can be dispersed without the help of an external vector and by animals
- Hydrochory and Zoochory – plant seeds can be dispersed by water and animals
- Autochory, Anthropochory and Zoochory – plant seeds can be dispersed without the help of an external vector, by humans and by animals
- NF – mode of dispersal reviewed and inconclusive (no affirmative records found upon review)
- NDY – mode of dispersal unknown/not yet evaluated
- NA – not applicable

Usage Notes: Plant seed dispersal modes can be subdivided into further categories, however we collated lower order categories into the higher order categories identified here

Additional Information: NA

Source Data: NA

Last updated: 24 January 2022

C4 *Dispersal Class*

Call: mosaic@dispclass

Definition: Age- or stage-classes of the species that are capable of dispersal.

Possible values: cat., factor

- Adult – dispersal stage is an individual that has reached maturity, we include sub-adults into this category
- Egg – dispersal stage is a vessel within which an embryo develops and is expelled by an adult allowing for dispersal
- Fertile material – dispersal stage is a part of an individual, or in some cases a complete individual, that contains fertile material (e.g., the alga *Fucus vesiculosus*; detached floating material/individual that contains gametes)
- Gamete – dispersal stage is the reproductive cell not within a vessel
- Juvenile – dispersal stage is an individual that has not reached maturity
- Larval – dispersal in a specific juvenile stage restricted to non-mammal species, species can have multiple larval stages
- Seed – dispersal stage is fertilized, specific to plant species and, in our definition, references seeds and/or fruits that are dispersed
- Sperm – dispersal stage is the male gamete
- Spore – dispersal stage is a single cell that only contains half of the chromosome of the adult, can produce eggs or sperm
- Sporophyte – dispersal stage is a nonsexual phase of a species producing two diploid spores
- Zoospore – dispersal stage is a motile asexual spore
- Zygote – dispersal stage is a fused male and female gamete
- Adult and Juvenile – dispersal stage can be both the adult and juvenile stage
- Egg and Larval – dispersal stage can be both the egg and larval stage
- Gamete and Spore – dispersal stage can be both the gamete and spore
- Zoospore, Sperm and Sporophyte – dispersal stage can be a zoospore, sperm or sporophyte
- NF – dispersal class reviewed and inconclusive (no affirmative records found upon review)
- NDY – dispersal class unknown/not yet evaluated
- NA – not applicable

Usage Notes: Dispersal can occur in more than one age- or stage- class, where this occurs it is noted as such within the database

Additional Information: NA

Source Data: NA

Last updated: 24 January 2022

C5 *Volancy*

Call: mosaic@volancy

Definition: An indicator of whether a species is volant or non-volant (i.e., able to fly or not).

Possible values, cat., factor

- Volant – the species is volant
  (Most Birds (Class Aves), all Bats (Order Chiroptera), and some invertebrate species)
- Non-volant – the species is non-volant
- Semi-volant – the species has gliding abilities
  (e.g., Gliding lizards (*Draco* spp.); flying squirrels such as the Northern flying squirrel (*Glaucomys sabrinus*); flying fish (Exocoetidae); gliding frogs such as Wallace's flying frog (*Rhacophorus nigropalmatus*); and gliding ants such as *Cephalotes atratus*).
- NF – volancy reviewed and inconclusive (no affirmative records found upon review)
- NDY – volancy unknown/not yet evaluated
- NA – not applicable

Usage Notes: NA

Additional Information: NA

Source Data: NA

Last updated: 24 January 2022

C6 *Aquatic Habitat Dependency*

Call: mosaic@aquadep

Definition: An indicator of the acquaitc habitat dependency of a species.

Possible values, cat., factor

- Anadromous—Species exhibits behavior of most of the lifecycle occurs in the sea/marine environment, but then migrate to fresh water to spawn (e.g. salmon and lamprey)
- Catadromous— Species exhibits migratory behavior in which most of the lifecycle occurs in fresh water but that migrate to the sea in order to breed there (e.g. *Anguilla anguilla* (common eel) which breeds in the Sargasso Sea)
- Potamodromous—Species exhibit large migrations exclusively in freshwaters.
- Estuarine/Brackish—Species habitat is estuarian waters (interface of freshwater and marine).
- Freshwater, Lentic—Species habitat is freshwater habitat characterized by calm or standing water r (e.g. lakes, ponds, swamps, and bogs).
- Freshwater, Lotic—Species habitat is freshwater habitat characterized by running water, e.g. springs, rivers, and streams.
- Freshwater, Mixed–Species habitat is a mixture of lentic and lotic environments.
- Marine—Species habitat is oceanic.
- Ontogenically Dependent—Species is ontogenetically/developmentally dependent on water (e.g., amphibians).
- Terrestrial, Facultative Freshwater Dependent—Species is dependent on water periodically
- Terrestrial, Facultative Marine Water Dependent—Species is dependent on marine environments periodically
- Terrestrial, Obligative Freshwater Dependent—Species is dependent on freshwater to carry out lifecycle
- Terrestrial, Obligative Marine Water Dependent –Species is dependent on marine water to carry out lifecycle
- Terrestrial, Water habitat independent—Species can carry out its lifecycle in the absence of surface water

Usage Notes: NA

Additional Information: NA

Source Data: NA

Last updated: 24 January 2022