



**Mapping Standards and Data Quality
for the IUCN Red List Categories and Criteria**

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Prepared by Red List Technical Working Group

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1 Spatial data and the IUCN Red List

Spatial data are a key component of the IUCN Red List from the criteria that measure species distributions to spatial filtering on the Red List website, and detailed analysis of distribution maps to support conservation. This document provides an overview of the different elements of spatial data on the Red List and outlines what kinds of spatial data Red List assessors are required to provide with each assessment, along with relevant formats and standards, with a particular focus on the distribution map.

1.1 Why spatial data are required

Spatial data are some of the most highly sought-after data on the IUCN Red List as they are crucial information for conservation planning. Each assessment should provide spatial data in some form.

Spatial data are essential for supporting assessments done under IUCN Red List Criteria B and D2 (and arguably also for demonstrating that the thresholds for these criteria are not met).

All Assessors should produce the most accurate depiction of a taxon's distribution based on their knowledge and the available data, in a format that is considered most appropriate for that taxon to inform conservation action. This is used to generate the maps displayed on the IUCN Red List website.

1.2 Reasons for a distribution map

A key component of spatial data is the distribution map (see section 2.3), which is a depiction of a taxon's distribution for communication and/or conservation planning purposes; it may not equate to either the spread of extinction risk (i.e., extent of occurrence) or the occupied range area (i.e., area of occupancy) as defined by the IUCN Red List Categories and Criteria.

There are three main reasons for creating a distribution map for taxa being assessed for the IUCN Red List:

- **Informing Red List assessments:** Distribution maps can help to inform Red List assessments by supporting calculations of some parameters used in the assessment process, such as the extent of occurrence (EOO).

- **Helping to identify conservation priorities:** Spatial data can be used for analyses, which can inform conservation planning and policy, identify priority areas for conservation, identify gaps in scientific knowledge, and help inform business decisions (e.g., where not to expand development).
- **Visual representation:** A distribution map provides a visual representation of a taxon's distribution. By combining spatial data for many taxa and analysing these alongside other Red List data (e.g., Red List Category), informative maps can be prepared to, for example, highlight areas with high numbers of threatened species.

2 What distribution data are needed for Red List assessments?

Spatial data are required to support all new IUCN Red List assessments, except for taxa of unknown provenance (e.g., some Data Deficient taxa) (see [Annex 1 of the Rules of Procedure](#)). Spatial information can be grouped into three elements:

1. Textual description of the distribution (Geographic Range Information).
2. Countries of occurrence (COO), coded by presence, origin and seasonality.
3. A distribution map that represents the best available depiction of the historical, present and projected distribution of a taxon – also coded by presence, origin and seasonality.

2.1 Textual description and SIS

A concise narrative of currently available information on the geographic range of the taxon is required supporting information for all taxa that are not assessed as Least Concern (Table 2 of [Annex 1 of the Rules of Procedure](#)). For taxa that are particularly sensitive to collecting or hunting, it is prudent to avoid providing information that allows people to see exactly where the taxon can be found, but a less precise summary should be provided.

It is important to provide documentation in the assessment on how the map was created and the data sources/methods used (in SIS (Species Information Service) this is recorded within the *Geographic Range* text and the *Map Status* fields).

It is mandatory to fill the *Map Status* field in SIS, which can take the values below:

- Done – the map has been completed and will be provided as part of the assessment, and will be published.

- Missing – the map is missing and needs to be located. A submitted assessment with this status will not be published.
- Incomplete – the map will be provided, but it is known not to be complete e.g. there wasn't enough information to map certain part of the range. It will be published. A reason will need to be provided in the justification box in SIS.
- Not Possible – making a distribution map for the species is not possible e.g. distribution is only known at coarse country level, or for Data Deficient species where distribution is not known. A reason will need to be provided in the justification box in SIS. A submitted assessment with this status can be published without a map.

See the [Supporting Information](#) guidance document on the IUCN Red List website for more information.

2.2 Countries of occurrence (COO)

The countries where the taxon occurs must be entered into SIS, with the appropriate distribution codes for Presence, Origin and Seasonality (see [section 5.0](#) for an explanation of the Presence, Origin and Seasonality codes). Assessors need to ensure that the Countries of Occurrence (COO) on the spatial map are consistent with those listed in SIS. In future, there may be some functionality to help automate this process – but it will still be the Assessor's responsibility to ensure that the COO in SIS correspond to those on the spatial map. See [section 6.0](#) (Spatial information in SIS) for more information.

To minimize inconsistencies between SIS and the distribution map, it is also crucial to make sure that the appropriate recommended country basemap dataset is used (this is available from the [IUCN Spatial Data Resources](#) page on the IUCN Red List website).

2.3 Distribution map

We encourage Assessors to provide the best possible map they can make (i.e., as accurate as possible considering the available data) to better support/inform conservation planning and actions. To ensure efficiency and ease of data management, it is preferable to submit the representation of the geographic range (i.e., distribution map data) in the following formats (can be one or a mixture of the below formats):

- 1) **Occurrence Data (Point/s):** The historical, present and projected occurrence of a taxon is referenced by a set of coordinates known as a point locality.
- 2) **Polygon Data:** The historical, present and possible distribution of a taxon's occurrences is referenced by a polygon or set of polygons.

- 3) **Basins:** The historical, present and possible distribution of a taxon’s occurrences is referenced by a basin (HydroBASINS) or a set of basins. Basins is used as a short term for HydroBASINS – more information can be found [here](#).

The recommended projection is [WGS84](#) (World Geodetic Survey 1984).

The distribution map (commonly referred to as “limits of distribution” or “field guide” map) aims to provide the current known distribution of a taxon within its native, historical and introduced range. The limits of distribution are determined by using known occurrences of the taxon, along with knowledge of habitat, elevation limits, and other expert knowledge of the taxon and its range. In most cases the distribution is depicted as polygons. Essentially, a polygon displays the limits of a taxon’s distribution, and is intended to communicate that the taxon probably only occurs within the polygon, but it does not mean that it is distributed equally within that polygon or occurs everywhere within that polygon.

Options 1,2 and 3 above are not mutually exclusive; an assessment can be supported by a combination of occurrence data and polygons. Independent of method used, a minimum set of attribute data (metadata) should be provided; the attribute information is described further in [section 4.0](#).

3 Taxon and system differences

Table 1 shows the preferred approaches (i.e., polygons, basins, points) for different taxonomic groups and systems. These are not intended to be strict rules; for any deviations, please contact the GIS team within the [IUCN Red List Unit](#).

Table 1: Preferred approaches by taxa and by system.

Group	Terrestrial	Inland Water**	Marine
Mammals	Points Polygons	Polygon informed by basin	Points; Polygons
Birds	Points; Polygons	Polygon informed by basin	Points; Polygons
Amphibians	Points; Polygons	Polygon informed by basin	N/A
Reptiles	Points; Polygons	Polygon informed by basin	Points; Polygons
Fishes	N/A	Points; Basins	Points; Polygons
Molluscs	Points; Polygons	Points; Basins	Points; Polygons
Odonata and ecological equivalents	Basins	Points; Basins	Points; Polygons
Crustaceans	Points; Polygons	Points; Basins	Points; Polygons
All other invertebrates	Points; Polygons	Points; Basins	Points; Polygons

Plants*	Points; Polygons	Points; Basins	Points; Polygons
Fungi	Points; Polygons	N/A	N/A

* For plants, most experts collect point locality data but do not produce polygon maps (with some exceptions, e.g., cacti). For assessments that are accompanied by points only, it is recommended that a Minimum Convex Polygon (MCP) map (equivalent to the maximum EOO as defined in this document) is produced, where possible and appropriate, for display on the IUCN Red List website along with the points, and which could also be used for analysis purposes.

** “Inland Water” includes taxa occurring in freshwater, brackish and estuarine habitats. Wherever it applies, points should be provided if more specific location of the taxa within the basin is known.

3.1 Terrestrial and marine taxa

A taxon’s distribution can be provided either as point or polygon data. For polygon, areas of unsuitable habitat, climate or physical geography (e.g. altitude, bathymetry, hydrology) should be removed to provide a refined range.

3.2 Inland water taxa (Freshwater)

The distribution map of inland water taxa is highly recommended to be made using the official HydroBASINS sub-basin layer, available from the [IUCN Spatial Data Resources page](#) on the IUCN Red List website. HydroBASINS are available in different resolutions (size of sub-basins), with the smaller sub-basins (e.g., levels 10 and 12) being nested within larger sub-basins (e.g., level 8). The appropriate resolution to use will depend on the level of knowledge of the taxon as well as size of its distribution range.

For inland water taxa, as with other groups, the distribution map should represent the best possible representation of the distribution. For those inland water taxa with distributions more restricted than the finest scale HydroBASINS layer (e.g., the location of a cave or small wetland to which a taxon is restricted), the range should be mapped as a polygon reflecting the specific distribution, rather than generalising to the finest scale HydroBASIN layer. By using a coarser HydroBASIN layer, (e.g., where a taxon only occurs at an edge of the basin or only in a main channel), this will inflate the MCP (see EOO description below).

If point data are being provided for inland water taxa, assessors are strongly encouraged to provide the corresponding HydroBASINS data as well. HydroBASINS data are used in multiple projects coordinated by the IUCN Freshwater Biodiversity Unit and providing these data will ensure the maps are included as part of large scale analyses using this type of spatial data.

More detailed information about mapping of inland water taxa can be found on the [IUCN Spatial Data Resources page](#) on the IUCN Red List website.

4 Attributes for distribution maps

For the distribution map, there is a list of data attributes which must be recorded for both polygon and point data. These attributes help describe the taxon's distribution. Please refer to the standards for Points and Polygons on the [Spatial Resources Page](#) of the IUCN Red List website.

[Tables 2](#) and [3](#) list the standard attributes for spatial data; the codes used to indicate Presence, Origin and Seasonality. These codes are also used to create legends for the distribution map (see [section 9.2](#)).

Please note that only the Required and Recommended fields are displayed in [Tables 2](#) and [3](#) – more information on these can be found on the [Spatial Resources Page](#).

The spatial attributes field names are limited to 10 characters in order to match the Shapefile format (i.e. the Shapefile format does not allow field lengths of greater than 10 characters).

4.1 Polygon and point data

4.1.1 Required polygon and point attributes

[Table 2](#) lists the Required attributes for polygon and point data. Note that some of these attributes are taxon dependent: these are the attributes described as “[Required (if relevant)]” in the Description column. For example, polygon depicting the distribution of a subspecies (e.g., *Panthera leo ssp. persica*) the subspecies attribute field must be completed.

Table 2: Required attributes for polygons and points (see * which indicates which fields apply to polygons or points)

Field	Description	Notes	Polygons /Basins	Points
ID_NO	Unique ID for the Taxon	Species taxon ID in SIS	√	√
<i>HYBAS_ID</i>	HydroBASIN ID *	Only required if HydroBASINS have been used for mapping the data	√	
BINOMIAL	Scientific name of the species	This must match the corresponding field in SIS	√	√
PRESENCE	Is/Was the species in this area	See Presence coding	√	√
ORIGIN	Why/ How the species is in this area	See Origin coding (default is “1” if not indicated)	√	√

SEASONAL	What is the seasonal presence of the species in the area	See seasonal coding (default is "1" if not indicated)	√	√
COMPILER	Name of the individual/s or institution responsible for generating the taxon distribution, if not IUCN.	Names should be given in full (e.g., John Smith; NatureServe; World Conservation Monitoring Centre, etc). If not indicated, this will default to "IUCN"	√	√
YEAR	Year in which the taxon distribution was mapped or compiled, or modified	If not indicated, this will default to the current year	√	√
CITATION	Individual/s or institution responsible for providing the data	This must be the same throughout the file, and is how the data points will be credited on the IUCN Red List. If not indicated, this will default to "IUCN (International Union for Conservation of Nature)"	√	√
DEC_LAT	The graphical latitude in decimal degrees, e.g. -41.097	Positive values are North of the equator; negative values are South of it. Legal values lie between -90 and 90.		√
DEC_LONG	The geographical longitude in decimal degrees, e.g. -121.25	Positive values are East of the Greenwich Meridian; negative values are West of it. Legal values lie between -180 and 180		√
SPATIALREF	The ellipsoid, geodetic datum or spatial reference system (SRS) upon which the geographic coordinates given in dec_lat and dec_long as based. Data is preferred in WGS84. If Blank, will default to WGS84	For e.g., EPSG:4326; WGS84; NAD27; Campo Inchauspe; European 1950; Clarke 1866.		√
SUBSPECIES	Subspecies Name/Epithet [Required if relevant]	Only if assessed at the subspecies level. This must then match the corresponding field in SIS. For e.g., " <i>Panthera leo ssp. persica</i> "	√	√
SUBPOP	Subpopulation Name/Epithet [Required if relevant]	Only if assessed at the subpopulation level, for e.g., " <i>Chelonia mydas</i> Hawaiian subpopulation"	√	√
DATA_SENS	Flags up whether or not the polygon distribution/data point is sensitive. This is most likely to be the case if the	Yes or No field. If "Yes", then the field "Sens_comm" should be completed	√	√

	polygons or points effectively correspond to individual localities. [Required if data is sensitive]			
SENS_COMM	Comments on why the data are considered sensitive [Required if DATA_SENS is 'Yes']	Max 255 characters.	√	√

- HydroBASINS: If basins have been used to provide distribution data then the HYBAS_ID, which is the unique identifier of that HydroBASIN where the taxon has been mapped, should also be provided

4.1.2 Recommended polygon and point attributes

The Recommended attributes are listed in Table 3. Although they are not absolutely required, these attributes should be recorded whenever this information is available, so we encourage effort being made to enter the relevant information into these fields as much as possible.

Table 3: Recommended attributes for polygons and points

Field	Definition	Notes	Polygon/ Basin	Point
EVENT_YEAR	The four-digit year in which the Event (object or observation) occurred -	For e.g., 2008		
SOURCE	Provide source of distribution range / point data	Relates to the primary source used to compile each polygon or point, especially in a recently published range map, or a set of point data. If compiled in a workshop, or compiled from numerous sources, then field may be left empty. References should be in the format "AuthorX and AuthorY, date" and the reference should be in the corresponding IUCN Red List assessment [max 255 characters]		
CATALOG_NO	An identifier (preferably unique) for the record within the data set or collection	Name of the museum or herbarium and the specimen number		√

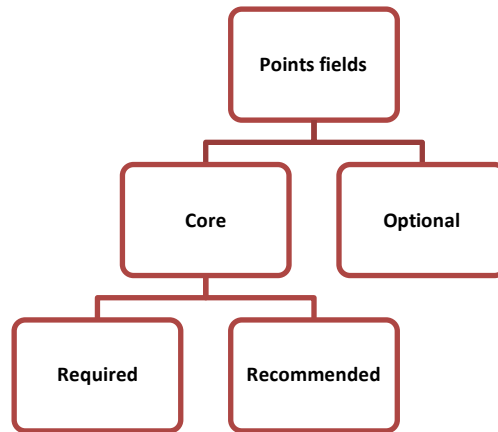
DIST_COMM	Distribution comments that refer directly to the polygon or point	Examples include whether the polygon represents the type locality, names of protected areas or geographical features, and so forth. May also include specific notes on presence, origin or seasonality [max 255 characters]	√	√
ISLAND	Name of the island where the polygon or point is on	This relates mainly to very small islands or atolls (e.g. Midway Atoll; Meemu Atoll; Bohol)	√	√
TAX_COMM	Taxonomic comments that refer directly to the polygon. Includes notes on polygons pertaining to subspecies, varieties or subpopulations.	Max 255 characters	√	√
BasisOfRec	The specific nature of the data record. (<i>See IUCN Standard Attributes for Point Locality Data</i>)	PreservedSpecimen, FossilSpecimen, LivingSpecimen, HumanObservation, MachineObservation, StillImage, MovingImage SoundRecording		√

Notes:

- 1) For entries in the **Source** attribute field that approach the 255 character limit, apply standard abbreviations and then define these within the reference list within SIS.
- 2) If the spatial data is sensitive, please fill the DATA_SENS and SENS_COMM fields

4.2 Point data

Point data fields/attributes are divided into two groups: core and optional. Within core there are two divisions: required and recommended. Recommended data may be required if relevant to the spatial data.



We strongly encourage point data to be provided if they are available, together with the polygon data, or by themselves, and they should follow the point standards defined in [Tables 2](#) and [3](#). In spatial analyses (e.g., overlays) involving a mixture of point and polygon data for different species, methods would have to:

1. Use MCP (EOO) rather than mapped range (equating to degradation of the data for taxa mapped as polygons); or
2. Exclude the points; or
3. Accept that the results will not be entirely comparable between taxa mapped using polygons and those mapped using points.

4.2.1 Optional point data

Optional attributes may be used and some are taxon dependent. The list of optional attributes can be found in the [IUCN Standard Attributes for Point Locality Data](#) (see the [IUCN Spatial Data Resources page](#) on the IUCN Red List website).

NOTE: Please make sure to use the Points and Polygons standard file on the Spatial Data Resources page as this will be updated with the most recent information, and also a log to indicate what has changed.

5 Coding of Presence, Origin and Seasonality for distribution maps

Every polygon and point occurrence in the distribution map requires Presence, Origin and Seasonality to be recorded using the relevant codes from [Tables 4, 5](#) and [6](#).

5.1 Presence codes

[Table 4](#) outlines the definitions for the various coding options for a taxon's Presence within a particular area. These Presence codes and their definitions apply to both spatial data (i.e., polygons and point data) and non-spatial data (e.g., Countries of occurrence in SIS).

Note that the presence codes were updated in February 2014, so please make sure that you check the new definitions, and understand what implications this might have for any existing spatial data, if these have not been migrated yet (see [section 10.1.1](#)). See the EOO section ([section 7.1](#)) to check how this parameter should be calculated using the revised Presence codes.

Table 4: Codes for recording the Presence of a taxon within a polygon or point occurrence.

CODE	PRESENCE	DEFINITION
1	Extant	The species is known or thought very likely to occur currently in the area, which encompasses localities with current or recent (last 20-30 years) records where suitable habitat at appropriate altitudes remains (see note 3). Extant ranges should be considered in the calculation of EOO. When mapping an “assisted colonisation” it is important to note that this range should be treated as Extant.
2	Probably Extant	<i>This code value has been discontinued for reasons of ambiguity. It may exist in the spatial data but will gradually be phased out.</i>
3	Possibly Extant	There is no record of the species in the area, but the species may possibly occur, based on the distribution of potentially suitable habitat at appropriate altitudes, although the area is beyond where the species is Extant (i.e., beyond the limits of known or likely records), and the degree of probability of the species occurring is lower (e.g., because the area is beyond a geographic barrier, or because the area represents a considerable extension beyond areas of known or probable occurrence). Identifying Possibly Extant areas is useful to flag up areas where the taxon should be searched for. Possibly Extant ranges should not be considered in the calculation of EOO.
4	Possibly Extinct	The species was formerly known or thought very likely to occur in the area (post 1500 AD), but it is most likely now extirpated from the area because habitat loss and/or other threats are thought likely to have extirpated the species, and there have been no confirmed recent records despite searches. Possibly Extinct ranges should not be considered in the calculation of EOO.
5	Extinct	The species was formerly known or thought very likely to occur in the area (post 1500 AD), but it has been confirmed that the species no longer occurs because exhaustive searches have failed to produce recent records, and the intensity and timing of threats could plausibly have extirpated the taxon. Extinct ranges should not be considered in the calculation of EOO.
6	Presence Uncertain	A record exists of the species' presence in the area, but this record requires verification or is rendered questionable owing to uncertainty over the identity or authenticity of the record, or the accuracy of the location. Presence uncertain records should not be considered in the calculation of EOO.

Notes:

1. These codes are mutually exclusive, e.g. a polygon coded as “Extant” cannot also be coded as “Extinct”.
2. In accordance with the Red List Categories and Criteria, Extant polygons can include inferred or projected sites of present occurrence (see the *Guidelines for Using the IUCN Red List Categories and Criteria* for further guidance).
3. When there is uncertainty as to whether or not a species still occurs in an area in which it was formerly known to occur (usually because there have been no recent surveys), it is necessary for Assessors to judge whether it is more appropriate to assign a coding of Extant or Possibly Extinct (based on

available knowledge of remaining habitat, intensity of threats, adequacy of searches, and other evidence).

4. EOO calculations should be based on polygons coded as Extant only.
5. The old Presence code 2 (Probably Extant) is now discontinued. See section 10.1.1 for more information

5.2 Origin Codes

[Table 5](#) outlines the definitions for the various coding options for a taxon's Origin within a particular area. These Origin codes and their definitions apply to both spatial data (i.e., polygons and point data) and non-spatial data (e.g., Countries of occurrence in SIS)

Table 5: Codes for recording the Origin of a taxon within a polygon or point occurrence.

CODE	ORIGIN	DEFINITION
1	Native	The species is/was native to the area.
2	Reintroduced	The species is/was reintroduced within its known historical range through either direct or indirect human activity
3	Introduced	The species is/was introduced outside of its known historical distribution range through either direct or indirect human activity. <u>Does not include</u> species subject to assisted colonisation. Includes species intentionally moved outside of its native range to perform a specific ecological function.
4	Vagrant	The species is/was recorded once or sporadically, but it is known not to be native to the area.
5	Origin Uncertain	The species' provenance in an area is not known (it may be native, reintroduced or introduced)
6	Assisted Colonisation	Species subject to intentional movement and release outside its native range to reduce the extinction risk of the taxon.

Notes:

1. EOO estimates should be based on Origin codes 1, 2, and 6.
2. The codes are mutually exclusive, e.g. a polygon coded as Introduced cannot also be coded as Native.

5.3 Seasonality Codes

[Table 6](#) outlines the definitions for the various coding options for a taxon’s Seasonality within a particular area. These Seasonality codes and their definitions apply to both spatial data (i.e., polygons and point data) and non-spatial data (e.g., Countries of occurrence in SIS).

Table 6: Codes for recording the Seasonality of a taxon within a polygon or point occurrence.

CODE	SEASONALITY	DEFINITION
1	Resident	The species is/was known or thought very likely to be resident throughout the year
2	Breeding Season	The species is/was known or thought very likely to occur regularly during the breeding season and to breed and capable of breeding
3	Non-breeding Season	The species is/was known or thought very likely to occur regularly during the non-breeding season. In the Eurasian and North American contexts, this encompasses ‘winter’.
4	Passage	The species is/was known or thought very likely to occur regularly during a relatively short period(s) of the year on migration between breeding and non-breeding ranges.
5	Seasonal Occurrence Uncertain	The species is/was present, but it is not known if it is present during part or all of the year.

Notes:

1. ‘Regularly’ means known or thought to occur in at least 30% of years. Where it is deemed important to record the occurrence of breeding/passage etc. for a species which occurs less often than 30% of years (e.g. because the population is now tiny), the category can be ticked, but a comment added to the Notes field (e.g. only recorded in 2 years during 1985-2000).
2. If the species does not regularly breed, but there are occasional breeding records, this can be noted in the “Dist_Comm” field.
3. If there is insufficient information to be confident of assigning Non-breeding Season vs. Passage categories, a best guess should be made, and a comment entered in the Notes field that some ambiguity exists. Where there is extreme uncertainty, the ‘Seasonal Occurrence Uncertain’ value should be used.

5.3.1 Presence, Origin and Seasonality quick reference

[Table 7](#) presents a “quick reference” summary of the Presence, Origin and Seasonality codes from [Tables 4, 5](#) and [6](#).

Please note that these codes are mutually exclusive within the columns. For example, a polygon coded as Presence “1 (Extant)” cannot also be coded as “5 (Extinct)”; however, Presence can be coded as “1 (Extant) and Origin as “5 (Origin uncertain)” for the same polygon.

Table 7: Summary of Presence, Origin and Seasonality codes.

Code	Presence	Origin	Seasonality
1	Extant	Native	Resident
2	Probably Extant *	Reintroduced	Breeding season
3	Possibly Extant	Introduced	Non-breeding season
4	Possibly Extinct	Vagrant	Passage
5	Extinct (post 1500)	Origin uncertain	Seasonal Occurrence Uncertain
6	Presence uncertain	Assisted Colonisation	

6 Spatial information in SIS

6.1 Countries with multiple distribution codes in the spatial data

In SIS there is only one entry recorded for each country where the taxon occurs (e.g., Countries of Occurrence (COO)). However, since it can happen that within a country there are multiple polygons or points with different distribution codes, it is important that the appropriate corresponding code is captured for the non-spatial data. Below are the rules to guide this coding to ensure correspondence between the spatial and non-spatial data.

- Presence codes (> means has precedence over):
1. Extant > 3. Possibly Extant > 4. Possibly Extinct > 5. Extinct > 6. Presence Uncertain
- Origin codes:
1. Native > (2. Reintroduced / 6. Assisted Colonisation) > 3. Introduced > 4. Vagrant > 5. Origin Uncertain

For example, if a taxon has two polygons (A and B) for Country X, where polygon A is coded as Presence 1 and Origin 5, and polygon B is coded as Presence 3 and Origin 3, then when recording the COO for Country X, Presence should be 1 and Origin should be 3.

Note that in recording Countries of Occurrence in SIS, it is possible for a country to have multiple subcountries which may have different Presence, Origin and Seasonality codes. The same rules as above apply. For example, if a taxon occurs in two subcountries (A and B) for Country X, where subcountry A is coded as Presence 1 and Origin 5, and

subcountry B is coded as Presence 3 and Origin 3, then when recording the COO for Country X, Presence should be 1 and Origin should be 3.

7 Extent of occurrence (EOO), area of occupancy (AOO)

7.1 Extent of occurrence (EOO)

Extent of occurrence (EOO) is defined as "the area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred or projected sites of present occurrence of a taxon, excluding cases of vagrancy".

EOO is a parameter that measures the spatial spread of the areas currently occupied by the taxon. It is included in the IUCN Red List Criteria as a measure of the degree to which risks from threats are spread spatially across the taxon's geographical distribution (see section 4.9 of the [Red List Guidelines](#)).

7.1.1 How should EOO be calculated for polygon maps and point maps?

EOO should be calculated by applying a Minimum Convex Polygon (MCP) (the smallest polygon in which no internal angle exceeds 180 degrees and which contains all the sites of occurrence) around the mapped range, which should be mapped as accurately as possible based on all of the available data.

More information on EOO can be found in Joppa, L. N., Butchart, S. H. M., Hoffmann, M., Bachman, S. P., Akçakaya, H. R., Moat, J. F., Böhm, M., Holland, R. A., Newton, A., Polidoro, B. and Hughes, A. 2016. Impact of alternative metrics on estimates of extent of occurrence for extinction risk assessment. *Conservation Biology* 30: 362–370. [doi:10.1111/cobi.12591](https://doi.org/10.1111/cobi.12591).

Exceptions will **not be allowed** for taxa with:

1. 'Doughnut distributions' e.g., aquatic species confined to the margins of a lake. (Such distributions should reduce not increase extinction risk for threats that are also restricted to similar distributions).
2. Small and highly disjunction subpopulations (e.g., for which the majority of the population occurs on a mainland with an additional subpopulation on a small and distant island, the inclusion of which within the MCP would considerably increase the EOO estimate). Note this contradicts what is stated in the Mace *et al.* (2008) paper.

3. Curved linear distributions that are shaped in an arc. (Most of the increase in EOO estimate for such taxa would be as a result of joining up the various "blobs" into a single polygon, rather than from including the area within the inside of the curve).

In the case of migratory species, EOO should be based on the minimum of the breeding or nonbreeding (wintering) areas, but not both, because such species are dependent on both areas, and the bulk of the population is found in only one of these areas at any time. If EOO is less than AOO, EOO should be changed to make it equal to AOO to ensure consistency with the definition of AOO as an area within the EOO.

For more information on EOO, see section 4.9 in the [Red List Guidelines](#).

The IUCN Red List EOO Calculator tool, which runs in ArcGIS, (downloadable from the [IUCN Red List Spatial Resources](#) page on the IUCN Red List website) calculates EOO using only polygons and points of Presence 1 (Extant) and Origin 1 or 2 (Native and Re-Introduced), and it does so separately for Seasonality codes 1 and 2 (if present) or 1 and 3 (if present), with EOO being taken as the lower of these two values.

Area or geometry calculations is recommended be performed in Cylindrical Equal Area (world) projection (but other projections can also be used if they provide better results e.g. for specific locations)

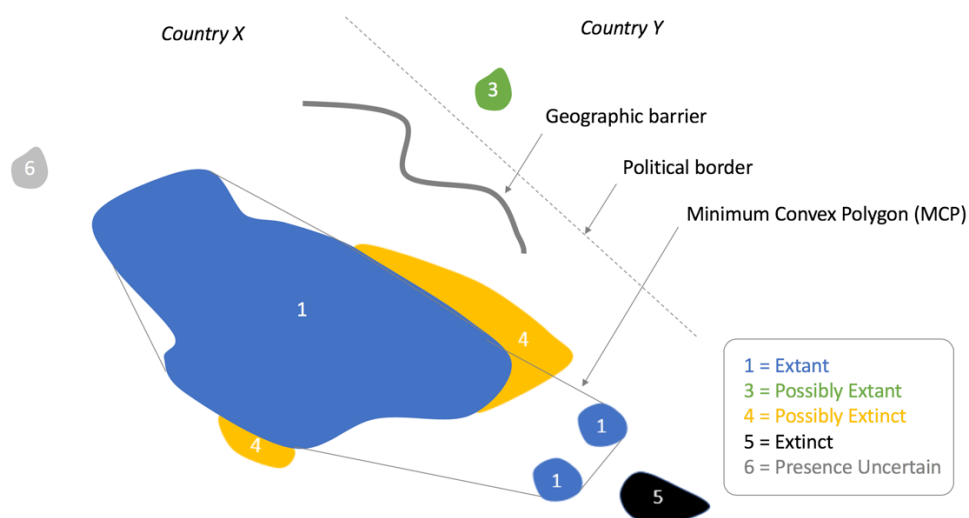


Figure 1: Schematic representation of polygon coding and calculation of EOO.

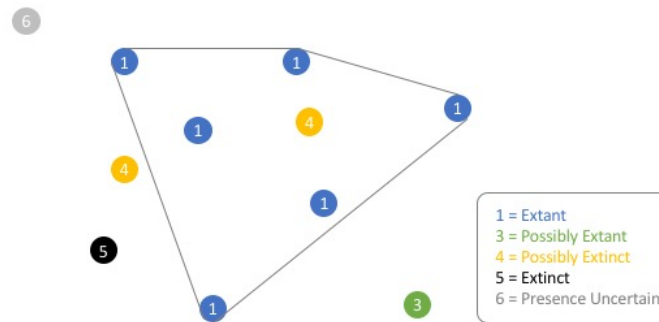


Figure 2: Schematic representation of point coding and calculation of EOO.

7.2 Area of occupancy (AOO)

Area of occupancy (AOO) is a scaled metric that represents the area of suitable habitat currently occupied by the taxon. Area of occupancy is included in the IUCN Red List Criteria for two main reasons:

1. AOO is a measure of the ‘insurance effect,’ whereby taxa that occur within many patches or large patches across a landscape or seascape are ‘insured’ against risks from spatially explicit threats. In such cases, there is only a small risk that the threat will affect all occupied patches within a specified time frame. In contrast, taxa that occur within few small patches are exposed to elevated extinction risks because there is a greater chance that one or few threats will affect all or most of the distribution within a given time frame.
2. There is generally a positive correlation between AOO and population size. AOO can therefore be a useful metric for identifying species at risk of extinction because of small population sizes when no data are available to estimate population size and structure.

To ensure valid use of the criteria and maintain consistency of Red List assessments across taxa it is essential to scale estimates of AOO using 2 x 2 km grid cells. Estimates of AOO are highly sensitive to the spatial scale at which AOO is measured. Thus, it is possible to arrive at very different estimates of AOO from the same distribution data if they were calculated at different scales. The thresholds of AOO that delineate different

categories of threat in criteria B2 and D2 are designed to assess threats that affect areas in the order of 10-2,000 km², and therefore assume that AOO is estimated at a particular spatial scale. The Red List Guidelines require that AOO is scaled using 2 x 2 km grid cells (i.e., with area of 4 km²) to ensure that estimates of AOO are commensurate with the implicit scale of the thresholds. Use of the smallest available scale (finest grain) to estimate AOO (sometimes erroneously called "actual area" or "actual AOO") is not permitted, even though mapping a species' distribution at the finest scale may be desirable for purposes other than calculating AOO. Habitat maps with higher resolutions can be used for other aspects of a Red List assessment, such as calculating reduction in habitat quality as a basis of population reduction for criterion A2(c) or estimating continuing decline in habitat area for B2(b), as well as for conservation planning.

For more information on AOO, see section 4.10 in the [Red List Guidelines](#).

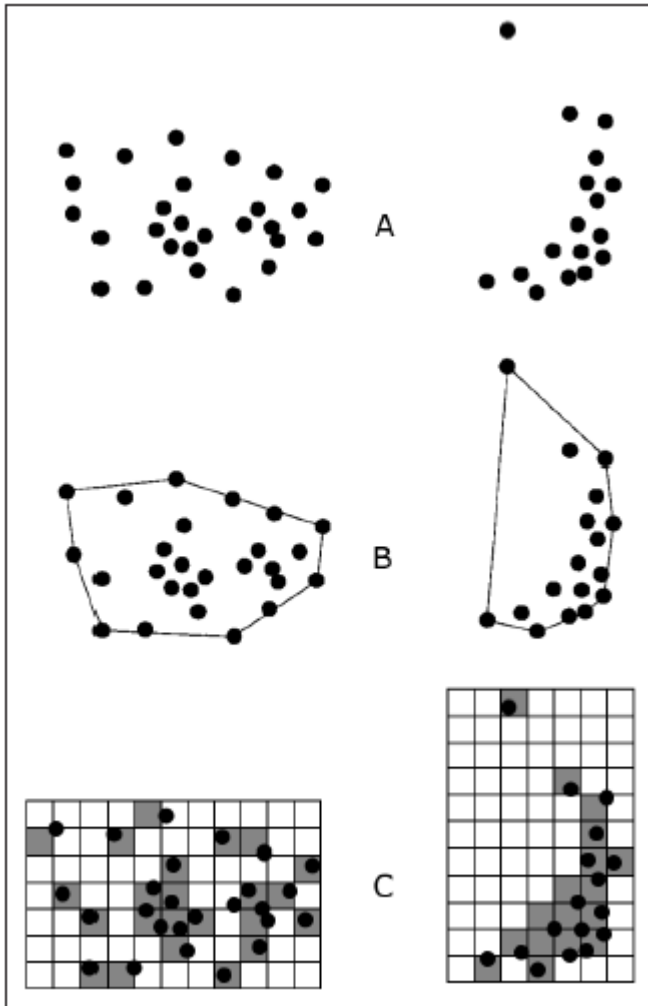


Figure 3: Two examples of the distinction between extent of occurrence and area of occupancy; (A) is the spatial distribution of known, inferred or projected sites of occurrence, (B) shows one possible boundary to the extent of occurrence, which is the measured area within this boundary, (C) shows one measure of area of occupancy which can be measured by the sum of the occupied grid squares.

8 Generating a distribution map

8.1 Software and formats

There are several ways in which maps can be generated, and the preference is always to generate **digital maps** (i.e., maps in the form of Shapefiles, or KML or ESRI File Geodatabase etc...). There is a suite of software which can be used to do this, namely:

1. ArcGIS desktop – licensed software. IUCN can provide a license for this under strict terms of use (contact the [IUCN Red List](#) for further information), provided

the software is being used for the assessment of a taxon, or for such similar purpose.

2. QGIS – free open-source software
3. Google Earth Pro – free software.
4. Google My Maps in Google Drive – free software.

The IUCN Red List Unit and Red List Partners have developed a series of tools to make the mapping process easy for Assessors. These resources can be found on the [IUCN Spatial Data Resources page](#) on the IUCN Red List website.

8.2 Tools

The [IUCN Spatial Data Resources page](#) on the IUCN Red List website provides access to a range of tools to help you to create distribution maps for taxa being assessed for The IUCN Red List. Some important tools worth mentioning here are:

- [RedList Toolbox](#): This is designed for use with ArcGIS Desktop, and includes documentation to help Assessors generate a digital map in the appropriate format and structure.
- [GeoCAT](#): RBG Kew developed this free, online tool to allow users to create maps using point data. It supports the IUCN Points standards, and also includes tools that automatically calculate EOO and AOO (based on the point data). The polygons from GeoCAT are not suitable as maps.
- [IUCN Red List Mapping Tool \(Freshwater species\)](#): This free, online mapping tool was developed for creating distribution maps for inland water species. It is integrated with SIS (i.e., it links to taxa within existing working sets in SIS) and it includes HydroBASINs, allowing users to map to those areas. Please contact the Freshwater [Biodiversity](#) Unit for more information.

8.3 Standard GIS layers / basedata

A recommended list of GIS layers (or ‘spatial basedata’) is available for Assessors to use when they are creating distribution maps. These layers include, for example, the Country layer, which should be used as the base-layer for mapping taxa to countries. It is important that Assessors use these recommended spatial data layers (basedata maps) to ensure that the generated maps comply with other tools within the Red List, and also to standardize the maps displayed on the IUCN Red List.

More information on these base-layers can be found on the [IUCN Spatial Data Resources page](#) on the IUCN Red List website.

These base-layers may change, or decisions may be taken by the IUCN SSC Red List Technical Working Group to recommend different base-layers; therefore, it is strongly recommended that Assessors check the IUCN Red List website for current guidance and information.

8.4 Mapping consistency

The following recommendations are provided to ensure consistency between taxa being mapped:

1. **How to convert points to polygon ranges:** due to the nature of a taxon it is at the expert's discretion to decide on the method of creating a polygon from points, if they would like to do it. Some suggestions (they can be used singly or in combination) are:
 - a) Buffering the points to a taxon's appropriate range. For example, consideration of the taxon's life history, such as roaming range, feeding range, breeding or migration.
 - b) Using habitat as a guide to map to known areas around the points.
 - c) Using spatial data from other ranges of other taxa, for example a prey or host species.
 - d) Bathymetry and altitude selection. Note that raster files cannot be submitted but conversion from raster to polygon is possible in ArcMap and QGIS software.
2. **Overlapping polygons within a taxon's range:** whilst it is entirely feasible for a species to have overlapping polygons with different attributes (e.g. Presence, Origin, different citations, etc...), it is important to ensure that this is actually really the case, and not a mistake during the mapping process. In order to prevent discrepancies, check whether the polygons overlap each other in joining areas. A taxon's subspecies, varieties and subpopulations within the taxon's range may overlap. Overlapping polygons can introduce geometry challenges, including during analysis.
3. **Mapping subspecies, varieties and subpopulations:** when mapping subspecies, varieties and subpopulations these ranges should be included within the species polygon.
4. **Restricted ranges:** when mapping to a small area, such as a cave, small HydroBASIN or island it is important to keep in mind the scope of the taxon and its habitat and ecology, while not generalizing the range as this may inflate the Minimum Convex Polygon (MCP) and change the extent of occurrence. For

inland water assessments, as with other groups, the map should represent the best possible representation of the distribution. For those inland water taxa with distributions more restricted than the finest scale HydroBASINs layer, the range should be mapped as a polygon reflecting e.g., the location of a cave or small wetland to which a taxon is restricted, rather than generalising to finest scale HydroBASIN layer.

5. **Island taxa:** When a taxon is present on an island it is important to state the island in the attributes due to organisations using different global country base layers in which some may not have the island you have selected.
6. **Marine taxa:** Due to the dynamic nature of the marine biome it is important to take bathymetry into account. Bathymetry ranges, like those in the habitat classification scheme, can be found on the Spatial Data Resources page. If for example, a taxon is found between 5-20 m depth then the polygon can be clipped to the 25 m bathymetry and the 5 m bathymetry can be erased.
7. **Projections:** Each taxon's spatial data is required to be projected (i.e., to a set coordinate system). This enables the taxon's spatial data to be applied to other spatial datasets for integration and storage. The recommended projection for the IUCN Red List is WGS84. To check the projection of a file go to the files properties in ArcMap and check the Source tab. If the "Geographic Coordinate System" says <Undefined>, you can use the Define Projection (Data Management) tool. If the "Geographic Coordinate System" is something other than the WGS_1984 projection you can convert it using the Project tool.
8. **Smoothing:** Smoothing a polygon removes sharp angles in the polygon and is used for aesthetic and visual reasons. If this tool is used, please ensure that it does not affect the coverage of the taxon's spatial range.

For tools, general guidance and information on best practices for mapping ranges please refer to the [IUCN Red List Spatial Data Resources](#) page.

8.5 Sensitive species guidelines

A taxon's map will not be shown or made publicly available when the *data_sens* field contains a 'Y' (this means that the specific taxon polygon is marked as being sensitive). Information on why this polygon or point is sensitive should be recorded in the *sens_comms* attribute (see table 2). A generalized polygon may be used instead; there are two methods to consider depending on the situation:

- **Buffer:** a buffer of a minimum of 10 km when more than one point is available (the buffer distance can be larger, e.g. the range could be mapped to country-level).
- **Irregular polygon:** if only one point is provided then a round buffer would show the species to be in the centre. An irregular shaped polygon would therefore show approximately where the taxon is distributed but generalized enough to avoid giving away its exact location.

For further details see the [IUCN Red List policy on Sensitive Data Access Restrictions](#).

9 What will happen to your map data?

Once distribution map data have been checked and processed, and are part of assessments that are being published on the IUCN Red List, the data are used in the following way:

- Points and polygons are displayed on the IUCN Red List website, via the Map Browser, which is an interactive tool.
 - There is a map icon on every taxon page on the IUCN Red List website, which opens the Map Browser.
 - The spatial data is projected to WGS84/ Mercator for display on the map.
- Points and polygons are used to determine EOO – using an MCP around the points/polygons.
- The points and polygons are used to generate images of the maps, using the Map Batcher, which presents them in a format for use in workshops, presentations, the PDFs of the assessments, etc.
- The data are also submitted to Integrated Biodiversity Assessment Tool (IBAT): IBAT provides a basic risk screening on biodiversity. It draws together information on globally recognised biodiversity information drawn from a number of IUCN’s Knowledge Products. The IUCN Red List of Threatened Species data are provided in a hexagonal grid format, as well as a full download of the spatial data depending on type of user access.
- Spatial data are made available for download individually, in bulk, or via an API for non-commercial use.
- Used in data analysis e.g. species richness maps, climate change vulnerability projections. In such circumstances, the spatial data used should be referenced and also credited appropriately.
- The Country of occurrence is not displayed in map, but is published in the taxon’s fact sheet on the Red List
- Maps that are marked as Sensitive in the map file data (i.e. data_sens field is TRUE) are not displayed on the IUCN Red List website, or made available, unless special permission has been granted.

- The data are also made available through an API (which is an interface through which the Red List data can be queried and used programmatically). Access to the API is granted through a token, to provide some level of control.

9.1 Countries of occurrence (COO) data

Countries of occurrence (COO) information is displayed on the IUCN Red List website. This information is used to support the website's functionality (especially country searches) and to allow basic analyses (e.g., endemism).

9.2 Legend combinations from distribution codes

Different combinations of the Presence, Origin and Seasonality codes are used to create legends for the final distribution map.

The list of distribution codes used for the legends can be found on the [Spatial Data Resources page](#) on the IUCN Red List website.

10.0 Updates regarding Spatial Data

10.1 Presence Codes (last updated 2014)

Presence codes updated with new definitions. Data prior to this change will remain and updated as re-assessments take place.

10.1.1 Implications of updated Presence for existing spatial data

Some distribution maps published on the IUCN Red List were created using a previous version of the Presence codes. The implications of the current Presence codes (as defined in [Table 4](#)) on existing spatial data that have not been migrated yet are outlined below.

1. All polygons or points currently coded using the old Presence 2 (Probably Extant) should be recoded as Presence 1 (Extant).
2. For inland water taxa:
 - (i) HydroBASINS coded as Presence 2 should be recoded as Presence 1 if they fall within an MCP drawn around all existing Presence 1s, or as Presence 3 (Possibly Extant) if they fall outside of this MCP.
 - (ii) If **all** HydroBASINS in the map are coded as Presence 2 (e.g., where point locality data are unavailable and distributions have been inferred), you will need to decide which Presence code (1 or 3) is

appropriate for occurrence of the taxon in each of these areas. Please note that if Presence 3 is used for all HydroBASINs on the map, this may have consequences for the taxon's Red List assessment (e.g., EOO cannot be calculated if no records exist for the taxon, which will affect any taxa currently assessed under criterion B1); in such cases a reassessment will be required.

If unsure about the above, please contact the Red List Unit for further clarification.

3. Some polygons or points currently coded as 3 may need review to see whether they should be recoded as 1 (because they may actually represent inferred or projected sites of occurrence). This would not affect EOO estimation if such records are within the current MCP, but obviously would if such records fall beyond the current MCP.
4. Some polygons or points currently coded as Presence 6 (Presence Uncertain) may need to be reassigned to 1 or 4 (see Note 3 attached to [Table 4](#))

See [Figures 1](#) and [2](#) in [section 7.0](#) for more information on recoding Presence codes and on using the Presence codes for EOO calculations.

10.2 Origin code Assisted Colonisation (last updated 2016)

New Origin code (6) added for species subject to intentional movement and release outside its native range to reduce the extinction risk of the taxon.

10.3 Legend Update (last updated 2016)

The legend was improved to contain all the values for Presence, Origin and Seasonal. The new list can be found on the [IUCN Red List Spatial Resources](#) page. Previously, all the different legends (or distribution codes combinations) were not being displayed on the website, but now, they all are.

11 Abbreviations, acronyms and definitions

AOO: Area of occupancy. A parameter used in the IUCN Red List Categories and Criteria to measure the area within the 'extent of occurrence' which is occupied by a taxon, excluding cases of vagrancy (see section 4.10 of the [Red List Guidelines](#)).

Assisted colonisation: The intentional movement and release of an organism outside its indigenous range to avoid extinction of populations of the focal taxon. Within the mapping process, the assisted colonisation range should be coded in the attributes as Extant (Presence = Extant, Origin = Assisted Colonisation).

EOO: Extent of occurrence. A parameter used in the IUCN Red List Categories and Criteria to measure the spatial spread of the areas currently occupied by the taxon (see section 4.9 of the [Red List Guidelines](#)).

MCP: Minimum Convex polygon. This is the smallest polygon in which no internal angle exceeds 180 degrees and which contains all sites of known, inferred and projected occurrence.

Polygon: A map feature that bounds an area at a given scale, such as a country on a world map or a district on a city map.

Projection: A projection uses the datum as a point of reference, it's location on Earth. In GIS, there are two types of "coordinate systems": **Geographic** Coordinate System: a georeference or location of the map on the globe and **Projected** Coordinate System: how the map is displayed. The standard Geographical Coordinate System the IUCN Red List uses is [WGS 1984](#).