4.2 Biogeographical Provinces

The flora and fauna of the earth's biosphere may be categorised in four ways: taxonomic, ecological, phylogenetic or biogeographic. Each of these categories are interrelated and each have their own set of tools for interpretation.

Udvardy M. 1975. A classification of the biogeographical provinces of the world. IUCN Occas. Pap. 1–50. http://cmsdata.iucn.org/downloads/udvardy.pdf

In his paper, Miklos Udvardy was at pains to reconcile a set of long standing differences between the classifications of the world's biogeographical regions adopted by zoologists (Wallace & Sclater) and botanists (based on Engler, 1879) in the hopes of arriving at a unified system. It is debatable as to whether he achieved this, nowadays book shelves are scattered with titles containing the words "Palaearctic" or "Nearctic", attesting to the continued value of the Wallace/Sclater system (updated by Holt et al. in 2013) and geospatial data has been made freely available by the botanists utilising their system (updated by Takhtajan in 1969 and Brummitt in 2001)

In Udvardy's paper the compromise system consists of a set of **biogeographic regions**, each subdivided into **biotic provinces**, each of which being dominated by a major **biome** or **biome-complex**.

Wallace & Brummitt

There are currently two different classifications that we may wish to use in order to carry out biogeographical analyses:

1. the traditional **Zoogeographical system**, familiar to many due to the work of Wallace (*The Geographical Distribution of Animals*) who adopted and developed the work of Sclater (see below.)
2. the work carried out under the auspices of TDWG based upon botanical expeditions over time and published by Brummitt; the botanist's equivalent of Wallace's work, a **Phytogeographical system** (see below.)

1. The **Zoogeographic system** categorizes regions according to distinctive faunas, the gene pools within each may be considered to be different.

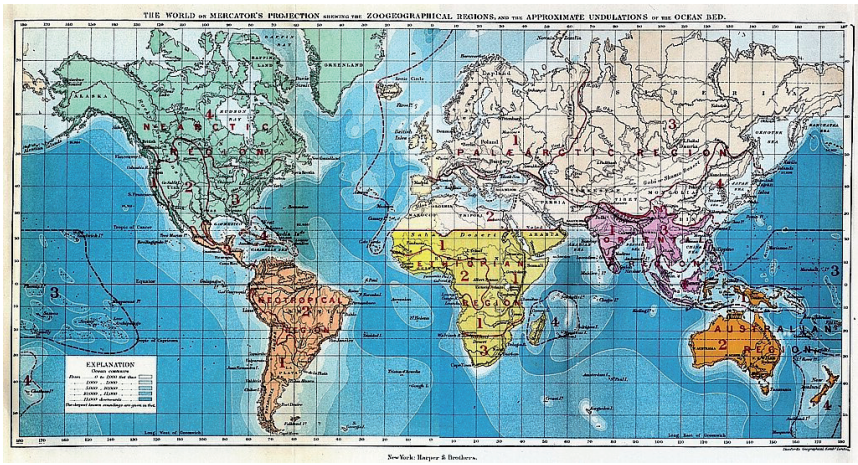

Figure 1. Map from Wallace A.R. 1876

2. The **Phytogeographical system** is based upon the needs of botanists who wanted more biologically based "countries", regions and continents for recording botanical distributions or arranging specimens.

A system of convenience, the advantage of this system, from the point of view of biogeographical mapping, is that detailed geospatial data in the form of country tiles is available freely online, geospatial maps from Royal Botanic Gardens, Kew (http://www.rbgkew.org.uk/gis/tdwg) supported by the various designations and general data from TDWG (International Working Group on Taxonomic Databases) at http://www.tdwg.org/geo2.htm as well as the paper by Brummitt (see References).

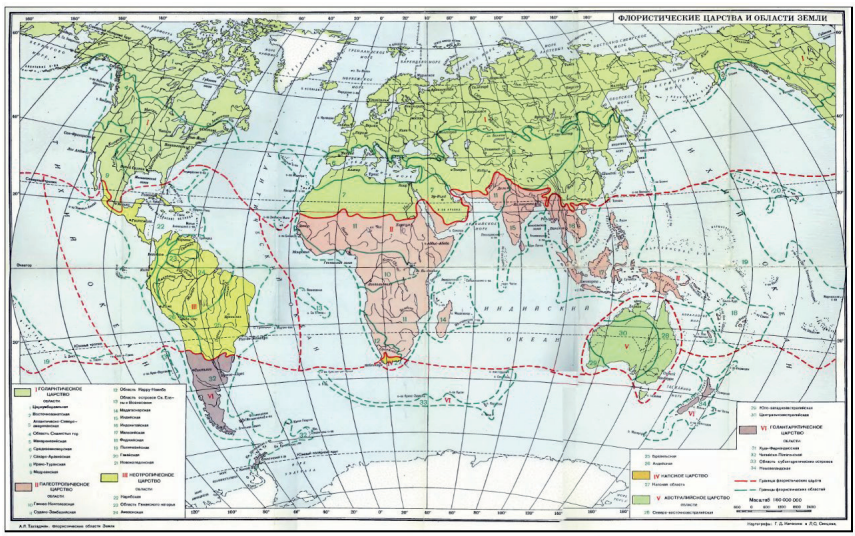

Figure 2. Map from Takhtajan A. 1986. Floristic Regions of the World. University of California Press, 522 pp.

4.2.1 Terrestrial Ecoregions

The **Terrestrial Ecoregions** have arisen out of efforts to devise a satisfactory classification of the world's biotic areas for purposes of conservation. Udvardy[3] made contributions to this work as part of UNESCO's "Man and the Biosphere" programme (IUCN, 1975).

A vector geospatial dataset able to depict these ecoregions accompanied Olson & Dinerstein, 2002 on which the map below is based.

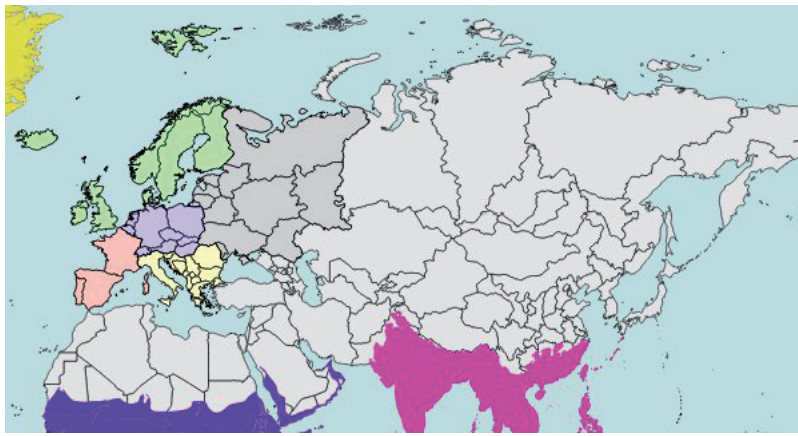

Figure 3. Traditional Palaearctic region (CRS - World_Gall_Stereographic) based on Olson et al, 2002. and TWDG country outlines after Brummitt, 2001 (European regions pastel coloured)

Since 2002 there has been a revised version of the Zoogeographical regions:

Figure 4. A modern interpretation of the Zoogeographical regions: (Holt et al. 2013) http://macroecology.ku.dk/resources/wallace

Back in 1975, the dawn of biogeography, biogeographers were scarce and so was data thus the achievements made up to that point were remarkable. Holt et al. use a much larger quantity of data, sophisticated modern statistical methodology and mapping techniques to come up with this new interpretation of the Zoogeographical regions which bears out much of the analysis carried out 140 years previously. Significantly this work increases the number of realms to 11, reassigning parts of the old Palaearctic to the Saharo-Arabian and Sino-Japanese

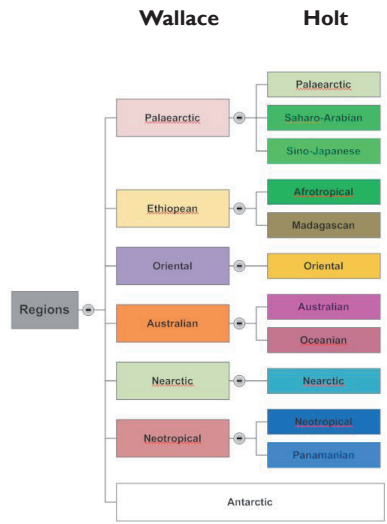

Figure 5. Comparison of Regions described by Wallace and updated by Holt

In the introduction to a 2010 paper by Kreft & Jetz, the authors begin by stating "Biogeographical regionalizations, such as zoogeographical regions, floristic kingdoms or ecoregions, represent categorizations central to many basic and applied questions in biogeography, ecology, evolution and conservation."

🕮 Kreft H, Jetz W. 2010. A framework for delineating biogeographic regions based on species distributions. J. Biogeogr. 37:2029–53

Their point is well made, if you are going to examine distributions with respect to biogeographic regions then those region definitions must be specified.

The paper additionally provides a comprehensive historical account of such definitions together with details of current methodologies.

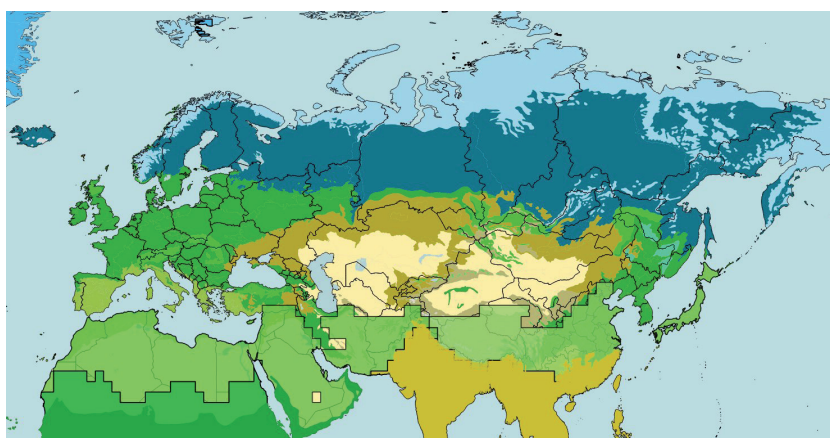

Figure 6. Palaearctic region according to modern analyses (Holt et. al 2013). Terrestrial ecoregions applied across the palaearctic region are from Olson, 2001 (http://maps.tnc.org/gis_data.html). [this is pretty but wants redoing]

4.2.2 Nomenclature

biomes, regions, ranges, biotopes, realms, trophic levels, ecosystems etc. etc. [from Adrian - is this the best place?]
Use Pitman Ch3, possibly Lomolino and always check Huggett
Just to ensure that all terms are covered with brief definitions.
[stub]
From the different analyses which are indicated in the above works it is apparent that there are also a number of different nomenclatures associated with each.
In practical terms this means quoting your sources for any maps that you use in your publication and adopting the terminology from the paper which provides the geospatial data used in your analysis:

Regions and realms

A study of a community in the Sino-Japanese **region** would require a reference to Holt et al., 2013 and if the study referred to previous works on the palaearctic **region** then this would need to reference Olson, 2002.
Wallace's term "**realm**" is utilised in Olson & Dinerstein, 1988.

Biomes

There have been a number of studies of factors influencing the geospatial presence of particular plant and animal communities. Each of them considered different abiotic factors affecting the distribution of communities and each arriving at different sets of geospatial zones and thus each utilising different terminologies and nomenclature.
Other nomenclatures are in use, each using different terms to expand upon the concept of biomes; thus Whittaker, 1975 (27 **biome-types**, some with subcategories); Goodall, 1974 (30 **ecosystem types**, expanded to include aquatic and underground systems); Walter 2002 (9 **zonobiomes**); Schultz 1988 (9 **ecozones**); Bailey 1989 (22 **ecoregions**); Olson & Dinerstein 2001 (7 realms, 12 marine realms, 14 **biomes**, 13 freshwater biomes, 5 marine biomes); Mücher et. al 2010 (8 **biomes** which subcategorise to 31 - Europe only)
For our practical purposes, we are confined to those studies which we are able to obtain in the form of geospatial datasets and thus would wish to use their terminology.

Term	Author	Tier	Usage
Province	Used to encompass all geospatial terms, no specific definition within this context		
Continent	Brummitt	1a	Level 1 units (Brummitt)
Realm	Wallace	1	
Region	Sclater	1	
	Brummitt	1b	Level 2 units (Brummit)
	Holt, 2013	1	update of Wallace's zoogeographical units
Subregion	Wallace	2	

	Botanical country	Brummit	2	Level 3 units (Brummit)
	Country	ISO, Brummitt	3	Level 4 units (basic recording units)
Ecoregion		modified **region** based upon modern analysis		
		Olson, 2001	1, 2	ecoregion definitions (utilises some "classic" provinces)
		EEA	2	Formal zones adopted by EU "biogeographic regions" (Europe only)
	Biome	Olson, WWF, (via TNC)	2	zones definable by biodiversity characteristics, recording units sufficient for broad scale conservation efforts. The TNC (The Nature Conservancy) data is based upon Olson 2001 and WWF.
	Habitat zones	Metzger, Mucher	3	Detailed habitat mapping, analyses utilising a wide range of environmental variables. Recording units are fine enough for critical work. (Europe only)

Climatic zones

Huggett, p101

Biomes are large regions, defined by a number of abiotic factors such as climate, relief, geology, soils and vegetation which have a significant influence on the kinds of fauna and flora to be found there.

4.2.3 Europe interpretations

There are currently three different geospatial (non-political) definitions of Europe in use, based upon interpretations contained within various publications: Layer filters for use in QGIS are suggested (see Methods)

1. Europe

(*sensu* TDWG) The simplest outline to depict, the required specifications are contained within one field of the TDWG layers

🛠 Filter: "Level1_cod" = 1

2. Europe & Aegean

(*sensu* Fauna Europaea) including Turkey and the Aegean Islands

🛠 Filter: "Level1_cod" = 1 OR "ISO_Code" = 'CY' OR "Level4_cod" = 'TUR-OO' OR "Level4_cod" = 'EAI-OO'

3. Pan-Europe

(*sensu* EEA and LANMAP geospatial datasets) also includes the Caucasus

🛠 Filter: ""Level1_cod" = 1 OR "ISO_Code" = 'CY' OR "Level4_cod" = 'TUR-OO' OR "Level4_cod" = 'EAI-OO' OR "Level2_cod" = 33

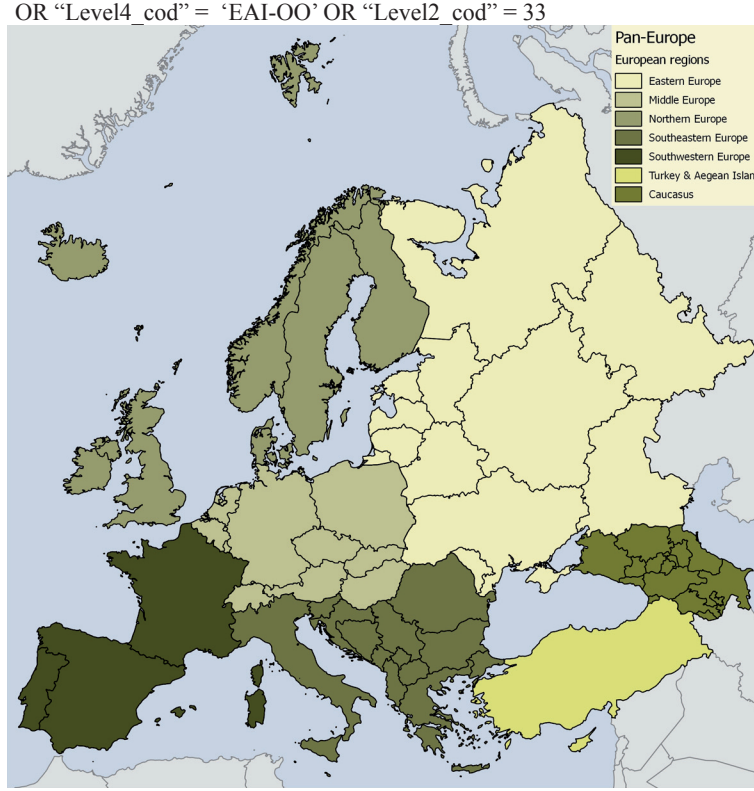

Figure 7. Pan-Europe. [EPSG: 3035] All country outlines from TDWG,

Choice of regions will depend upon data sources for your project, data-absent regions may be omitted.

4.2.4 European biogeographic regions

The development of detailed biogeographic provinces based upon detailed analyses represent pragmatic approaches taken by conservationists who are under increasing pressure to stem biodiversity loss and to place their efforts into a geospatial context. The following geospatial datasets are of two categories, the first is concerned with standards devised so as to fulfil various legislative requirements, the second category provides geospatial data of an extremely high biogeographical resolution, capable of supporting detailed analysis of communities.

Standards

There are European standard for these regions. Member EU countries have contributed to the development of a GIS dataset to be found on the European Environment Agency website. These are the *official delineations used in the Habitats Directive (92/43/EEC) and for the EMERALD Network set up under the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention.*)

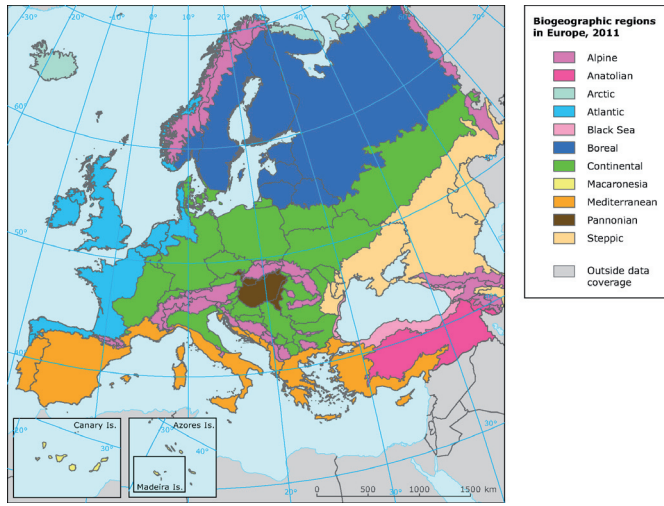

Figure 8. Methodology described in 4.8.2 [EPSG:3035]

A word of caution about the use of this particular geospatial dataset, however, comes from Mücher et al., 2009 who observe that this is "*the product of committee discussions rather than a scientific output.*"

4.2.5 Landscape classification (abiotic)

The LANMAP classification is a purely abiotic system. It is a landscape classification of Pan-Europe with four hierarchical levels; using digital data on climate, altitude, parentmaterial and land use as determinant factors. The approach differs from the above systems in that it eschews the use of biotic factors. It's value therefore differs from biogeographical region definitions, it is more of an analytical resource, comparing distributions of fauna or flora against this map may reveal the abiotic factors governing their ranges.

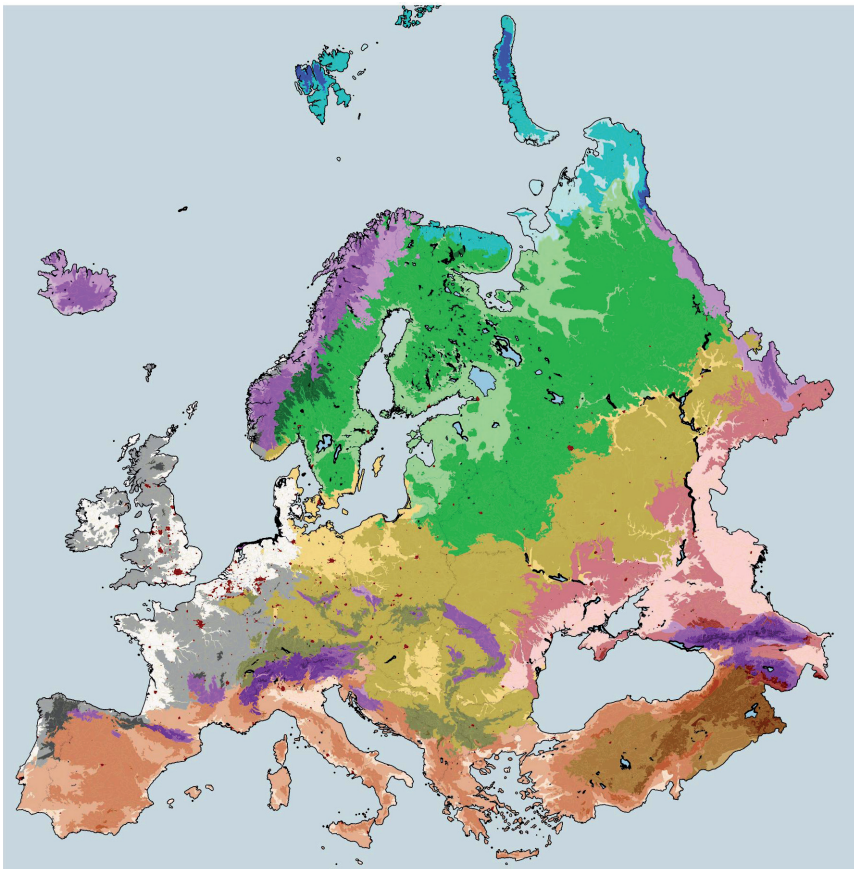

Figure 9. **LANMAP Level 2.** Depiction of the 31 categories in Level 2 (after Mücher et al., 2010) [EPSG: 3035]

Level 1 is based on **climate only** and has eight classes. The largest class is the Boreal region.

Level 2 is based on **climate and altitude** and has 31 classes. The largest class here is the Boreal hills.

Level 3 is based on **climate, altitude and parent material** and has 76 classes.

Level 4 is based on **climate, altitude, parent material and land cover** and has 350

landscape types. At this level the database has 14,000 landscape units

4.2.6 References

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Holt B.G., Lessard J.-P., Borregaard M.K., Fritz S.A., Araújo M.B., Dimitrov D., Fabre P.-H., Graham C.H., Graves G.R., Jønsson K.A., Nogués-Bravo D., Wang Z., Whittaker R.J., Fjeldså J. & Rahbek C. 2013. An Update of Wallace's Zoogeographic Regions of the World. 74-78 pp.

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Kreft H, Jetz W. 2010. A framework for delineating biogeographic regions based on species distributions. J. Biogeogr. 37:2029–53

Resources

Shapefile format, vector polygon at http://www.eea.europa.eu/data-and-maps/data/biogeographical-regions-europe-3

Further reading

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