Biology

July 21, 2020

1 Introduction

Biology is the study of organisms. An organism is a physical object which is the manifestation of a design encoded in itself or other organisms. This includes everything from viruses to humans and leaves room for things which may not exist on the earth should we ever find those things.

2 Organization

In biology organisms are classified using a taxonomic system.

- domain
- kingdom
- phylum
- class
- order
- family
- genus
- species

Reference

However, it's not this simple as there are more branches needed to describe all of life that just this organizational structure, that's why we have a concepts of Clade.
The highest level, Domain consists of three categories:

- Archaea (Single Celled)
- Bacteria (Single Celled)
- Eukarya (Multi-celled)

3 Plants

Plants are multi-cellular organisms of the kingdom Plantae.
The Plants are divided into the Embryophyta(Land Plants) and the (Water Plants).
Plants are then divided into two groups.
The first of which is the set of vascular plants, also known as the Tracheophytes, form a large group of plants that are defined as land plants that have lignified tissues (the xylem) for conducting water and minerals throughout the plant.
The other group is the set of non-vascular plants which is also known as the Bryophytes.
The vascular plants are then divided into the Spermatophyta(Seed Plants) and the (Non-seed plants)
The Spermatophyta are then divided into Angiospermae(Flowering Plants) and Gymnospermae(Non-flowering Plants)
The Angiospermae are then divided into Dicots and Monocots.

4 Species: Ginkgo biloba

- Kingdom: Plantae
- Clade: Tracheophytes
- Genus: Ginkgo
- Species: G. biloba

5 Environmental Conditions

There are going to be many factors which effect plant growth and reproduction. The place we will start is heat and cold.
First we will start with cold. According to the wiki:

> "A hardiness zone is a geographic area defined to encompass a certain range of climatic conditions relevant to plant growth and survival."

It defines 13 zones by average annual extreme minimum temperature.
For example, a plant may be described as "hardy to zone 10" which means that it can withstand temperatures down to -1 $°C$
Next we have the American Horticultural Society (AHS) heat zones. This defines 12 zones which are a simple count of the number of days over 30 °C (86 °F)

USDA Hardiness Zones

Zone	From	To
0 a	<	-53.9 °C (-65 °F)
0 b	-53.9 °C (-65 °F)	-51.1 °C (-60 °F)
1 a	-51.1 °C (-60 °F)	-48.3 °C (-55 °F)
1 b	-48.3 °C (-55 °F)	-45.6 °C (-50 °F)
2 a	-45.6 °C (-50 °F)	-42.8 °C (-45 °F)
2 b	-42.8 °C (-45 °F)	-40 °C (-40 °F)
3 a	-40 °C (-40 °F)	-37.2 °C (-35 °F)
3 b	-37.2 °C (-35 °F)	-34.4 °C (-30 °F)
4 a	-34.4 °C (-30 °F)	-31.7 °C (-25 °F)
4 b	-31.7 °C (-25 °F)	-28.9 °C (-20 °F)
5 a	-28.9 °C (-20 °F)	-26.1 °C (-15 °F)
5 b	-26.1 °C (-15 °F)	-23.3 °C (-10 °F)
6 a	-23.3 °C (-10 °F)	-20.6 °C (-5 °F)
6 b	-20.6 °C (-5 °F)	-17.8 °C (0 °F)
7 a	-17.8 °C (0 °F)	-15 °C (5 °F)
7 b	-15 °C (5 °F)	-12.2 °C (10 °F)
8 a	-12.2 °C (10 °F)	-9.4 °C (15 °F)
8 b	-9.4 °C (15 °F)	-6.7 °C (20 °F)
9 a	-6.7 °C (20 °F)	-3.9 °C (25 °F)
9 b	-3.9 °C (25 °F)	-1.1 °C (30 °F)
10 a	-1.1 °C (30 °F)	+1.7 °C (35 °F)
10 b	+1.7 °C (35 °F)	+4.4 °C (40 °F)
11 a	+4.4 °C (40 °F)	+7.2 °C (45 °F)
11 b	+7.2 °C (45 °F)	+10 °C (50 °F)
12 a	+10 °C (50 °F)	+12.8 °C (55 °F)
12 b	+12.8 °C (55 °F)	<

AHS Heat Zones

Zone	From	To
1	<	1
2	1	7
3	8	14
4	15	30
5	31	45
6	46	60
7	61	90
8	91	120
9	121	150
10	151	180
11	181	210
12	210	<

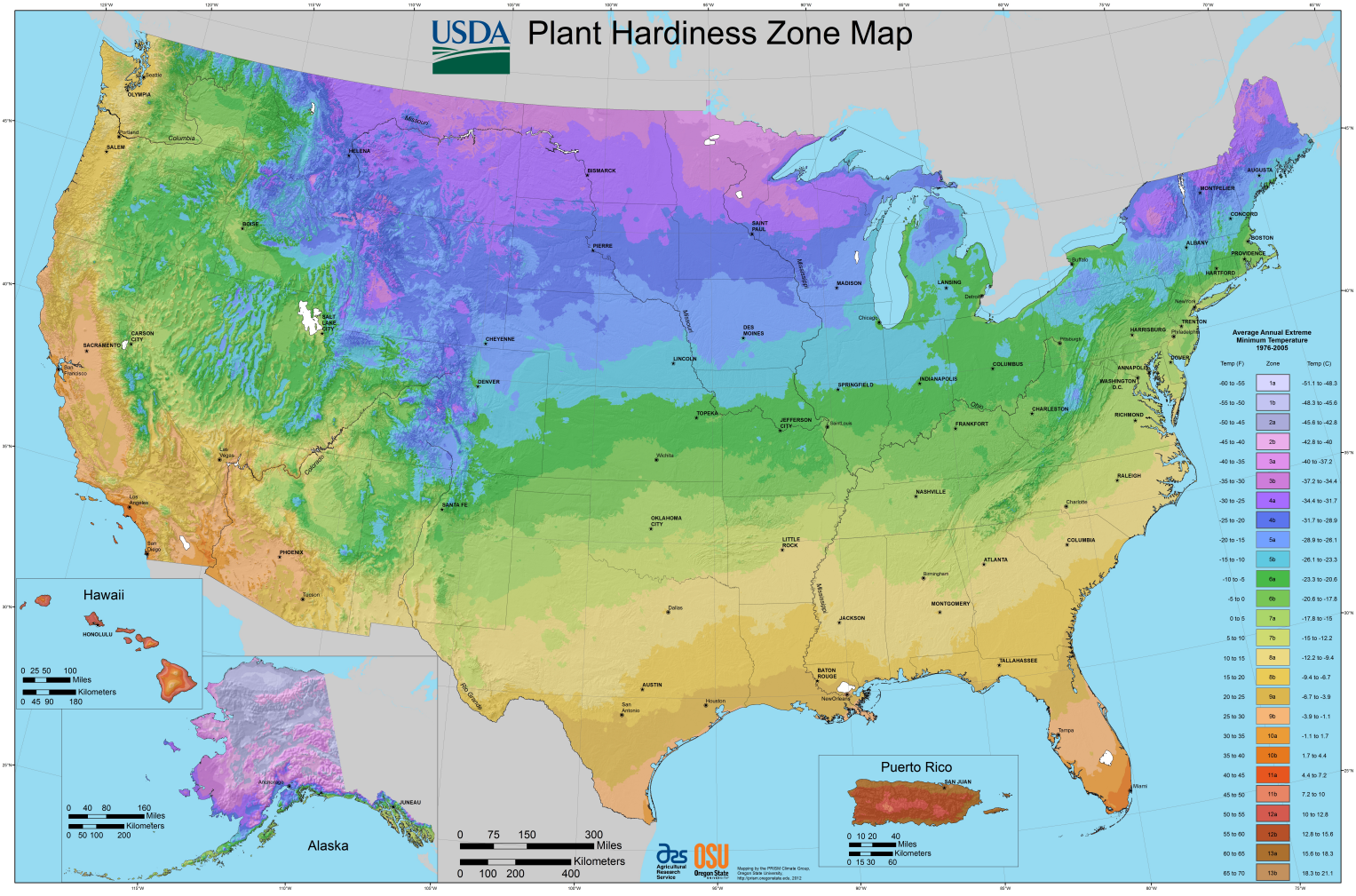

Figure 1: 2012 USDA Plant Hardiness Zone Map of the US

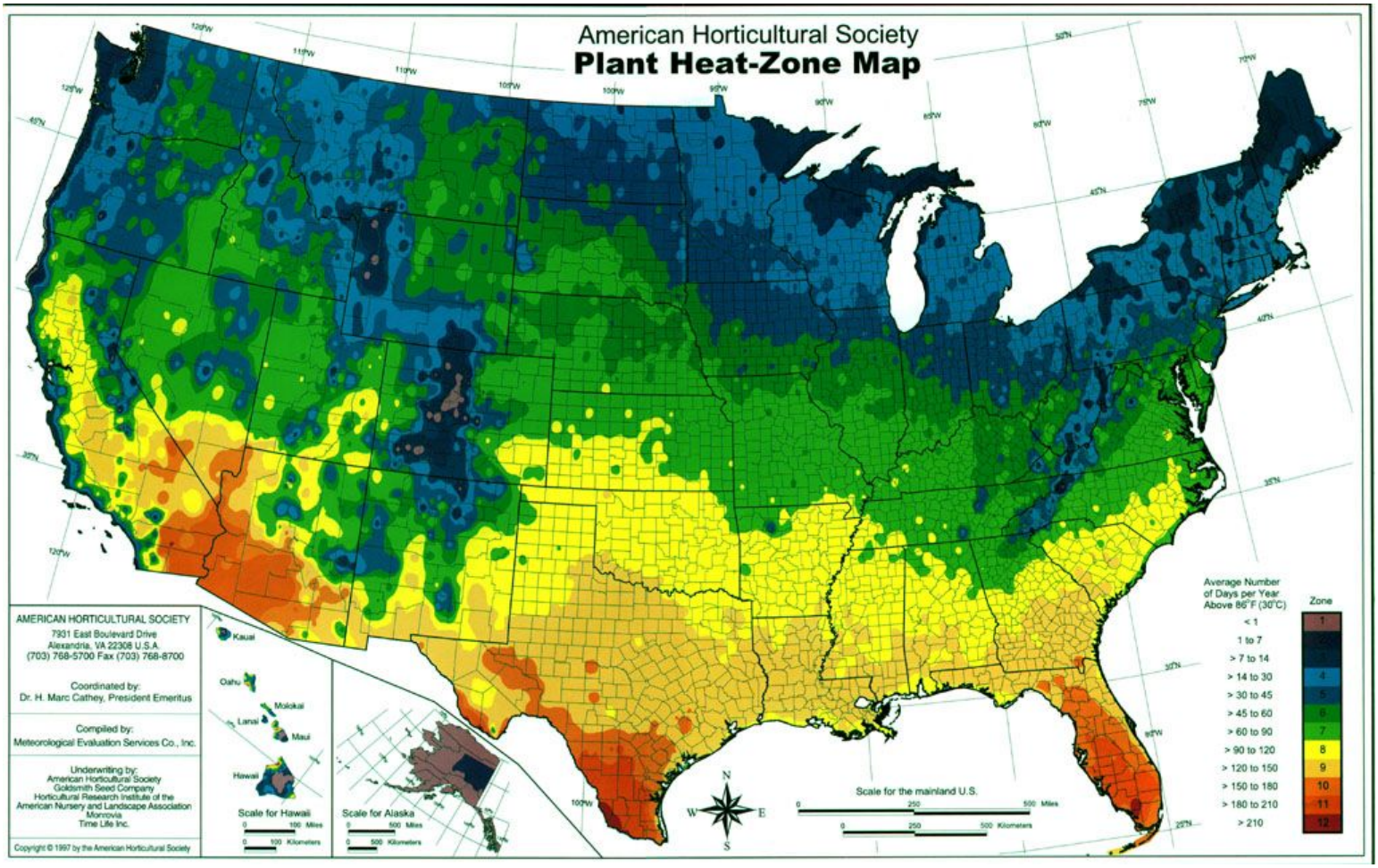

Figure 2: AHS Heat Zone Map of the US

From these images we can see that there is a more general pattern going on here. We have a heat function which is as follows: $F : \mathbb{R}^4 \to \mathbb{R}$ Where the inputs to F are r, θ, ϕ, τ which are: radial distance r, polar angle θ (theta), azimuthal angle ϕ (phi), time τ (tau). Additionally, the output is the heat at that point in space-time. Then when you pick a time, you can project the colored 3D shape onto a 2D image. That wouldn't give you either of the figures below however. Those are calculations, based on the tables, are a way of binning the information to make it easier to understand.

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