Georeferencing Museum Specimens: Beginner's Course

Georeferencing Basics & Practice Exercises

Michael Denslow - March 5th, 2026

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Goals, Opportunities & Challenges

- ❏ Explain georeferencing
- ❏ Make the process of georeferencing straightforward and fun
- ❏ Test out the efficacy of a *short* course
- ❏ Expose participants to GEOLocate tools
- ❏ Recruit georeferencers for ongoing California Academy of Science projects

- ❏ Feature simple use cases

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Outline

Georeferencing Basics

- ❏ What is geospatial information?
- ❏ What is georeferencing?
- ❏ Geographical Concepts
- ❏ Standards
- ❏ Research Examples
- ❏ Exercise 1: Georeferencing, Reverse georeferencing
- ❏ Exercise 2: Collaborative Georeferencing Tool (COGE)

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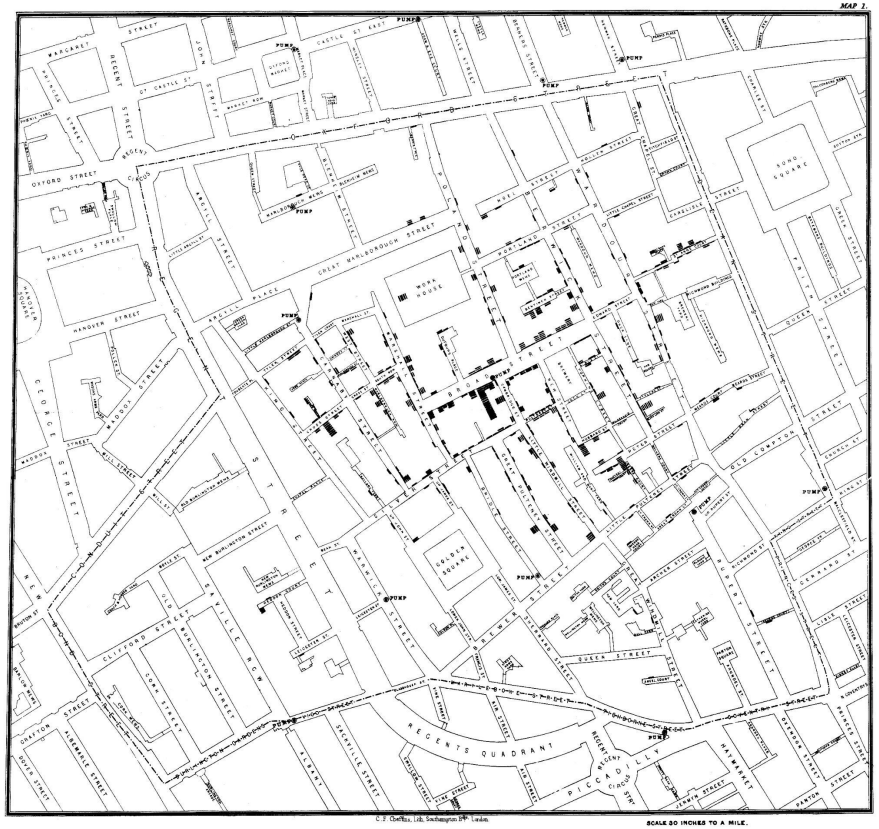
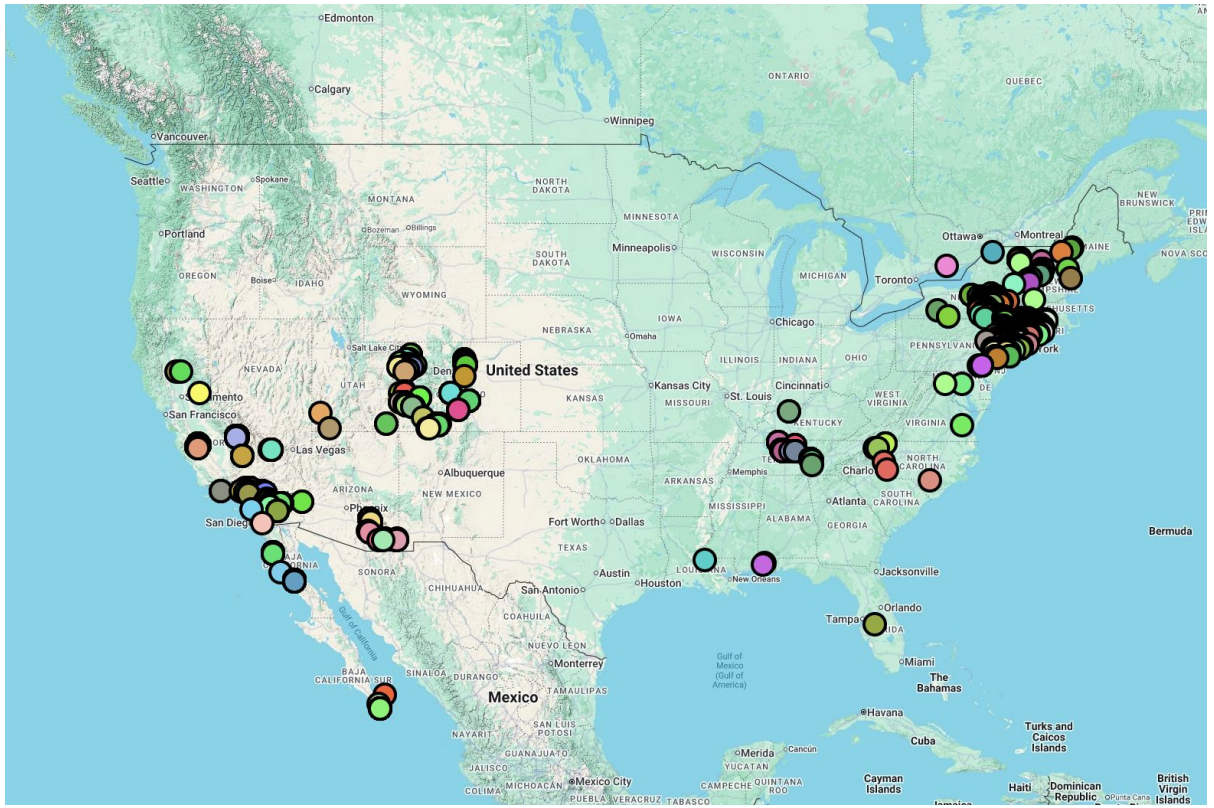
Geospatial information

- Data identified with a specific geographical location





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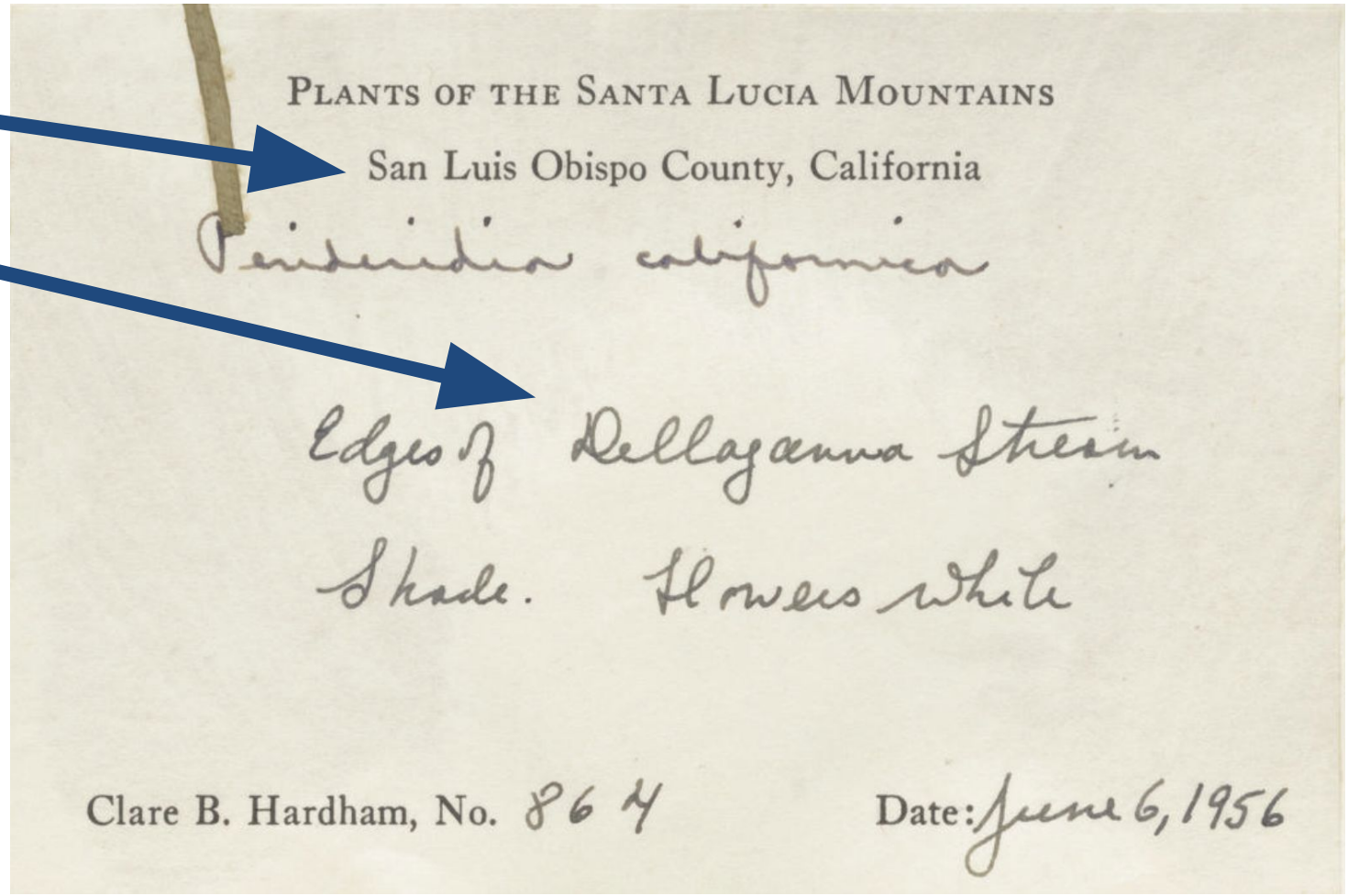
Geospatial information

Museum Context

- ❑ Higher geography
- ❑ Locality



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Geospatial information

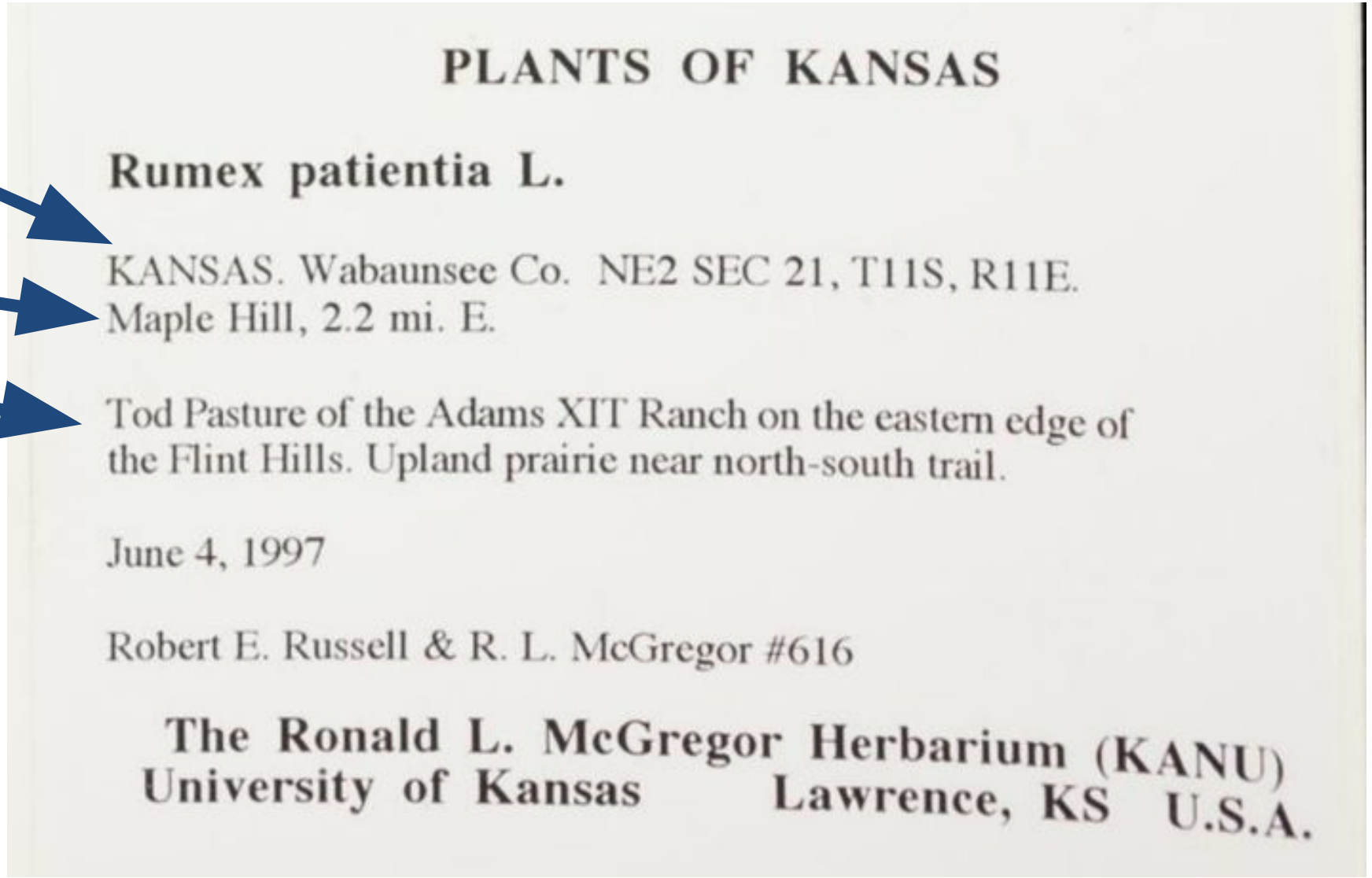
Museum Context

- Higher geography
- Locality

Image courtesy of Notes from Nature and the University of Michigan Museum of Zoology

Geospatial information

- ❑ Higher geography
- ❑ Locality
- ❑ ?



PLANTS OF KANSAS

Rumex patientia L.

KANSAS. Wabaunsee Co. NE2 SEC 21, T11S, R11E.
Maple Hill, 2.2 mi. E.

Tod Pasture of the Adams XIT Ranch on the eastern edge of the Flint Hills. Upland prairie near north-south trail.

June 4, 1997

Robert E. Russell & R. L. McGregor #616

The Ronald L. McGregor Herbarium (KANU)
University of Kansas Lawrence, KS U.S.A.

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Geospatial information

- Terminology check in!
- **Locality:** represents named place

- How do we represent the locality on a map?
  - **Geographic coordinate system**
  - Represents specific positions
  - Latitude and Longitude

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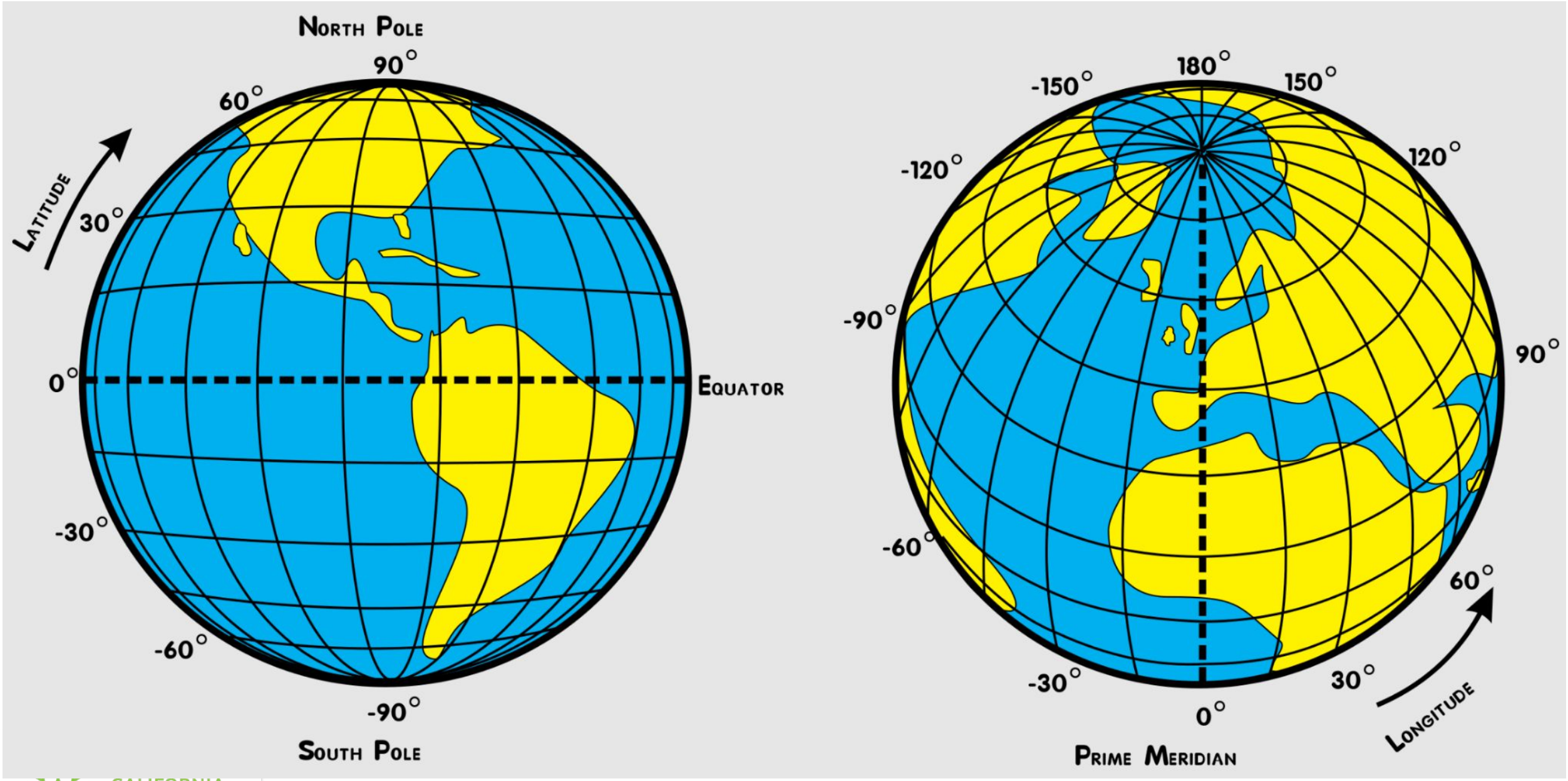

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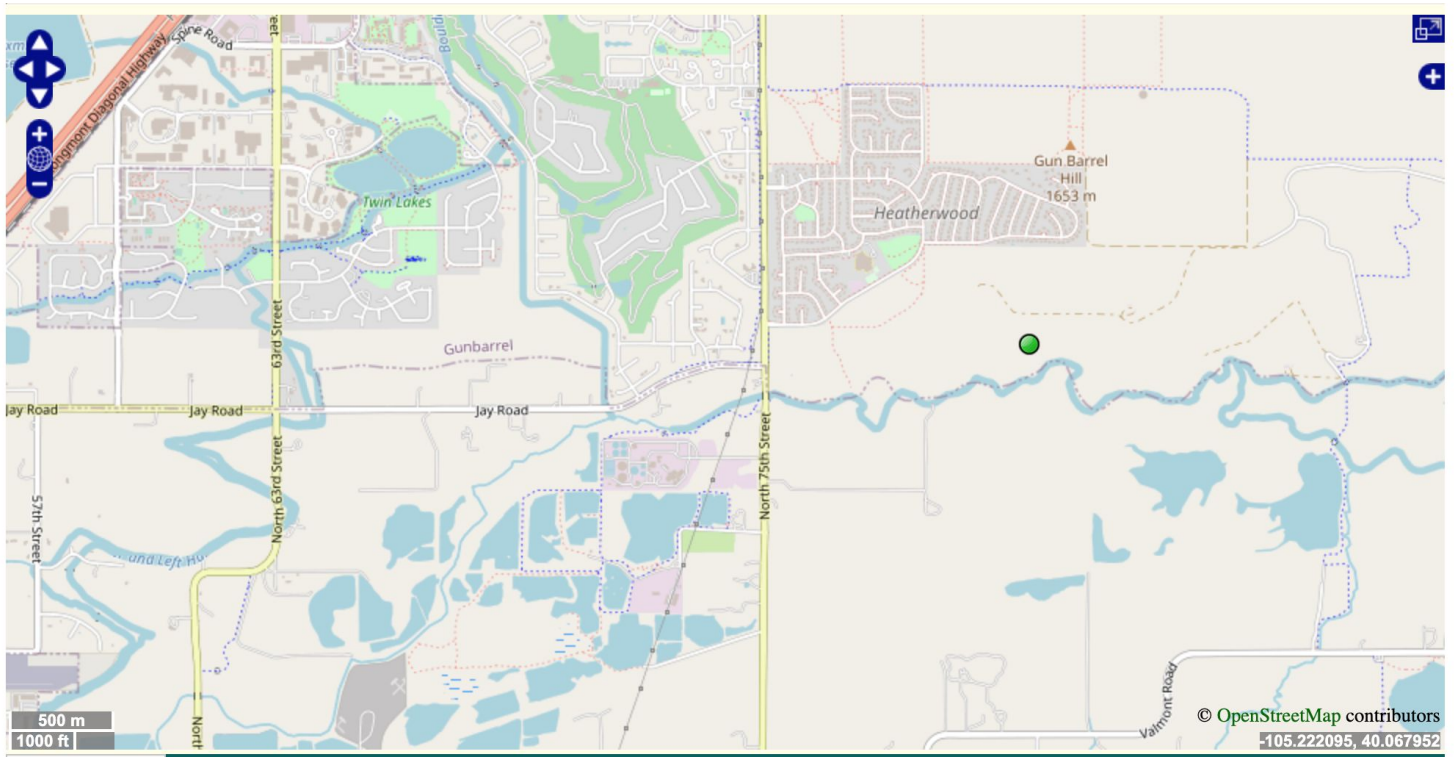
Latitude and longitude schematic, Wikipedia

Georeferencing basics

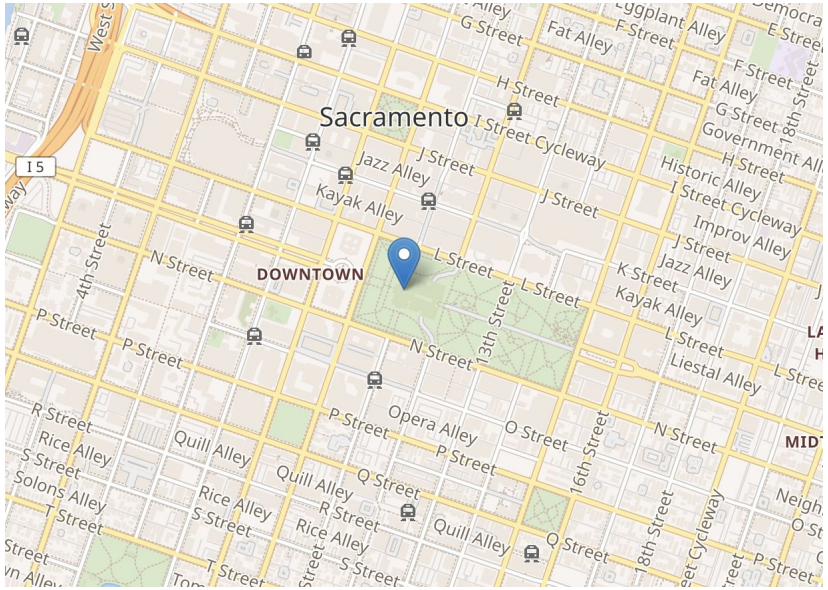
- What is it?
  - Converting a locality (*named place)* to geographic coordinates
- Example
  - Locality = White Rocks, 5 miles east of Boulder, Colorado
  - 40.067952, -105.2222095 and more...



Screengrab from Open Street Maps, M.W. Denslow

Georeferencing basics

- Terminology check in!
- **Georeferencing**
  - Specific meaning in natural history context (converting localities)
  - vs. use in aerial imagery rectification
- Geocoding
  - Convert street address to coordinates
  - California State Capitol, 1315 10th and L St, Sacramento, CA
  - 38.576667, -121.493611



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Georeferencing basics

- Named place (“Feature” in reference document)
  - a place of reference in a locality description
  - locality text string
  - ‘White Rocks, 5 miles east of Boulder, Colorado’
- Direction
  - east
- Offset
  - 5 miles
- Details will vary greatly
  - Older labels tend to be less specific

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Geographical concepts

Projection

- ❏ Flatten the earth's surface into a plane to make a map
- ❏ All projections distort in some way

Image showing Mercator projection, Wikipedia

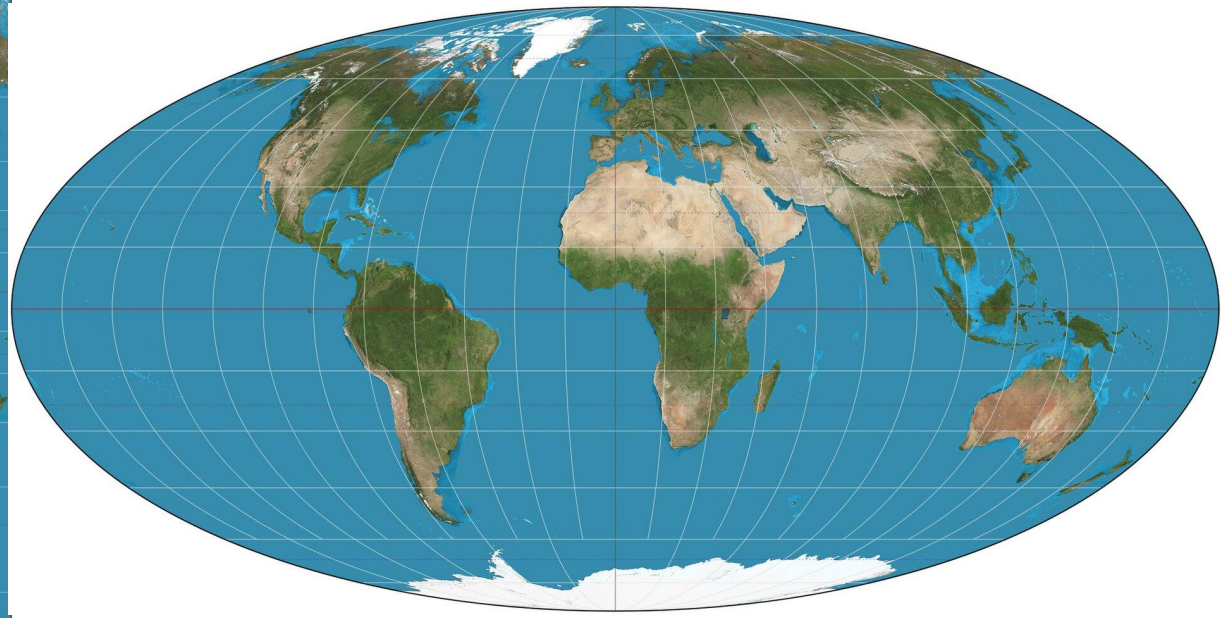

Image showing an equal-area projection, Wikipedia

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Geographical concepts

Projection

If you want to use this sample code in a different geographic location, you need to modify the well-known IDs (WKIDs) for StatePlane and UTM.

Draw polyline | Draw polygon

Web Mercator (WKID:102100)
Length:18158 meters

State Plane Oregon North(WKID:32126)
Length:12753 meters

UTM Zone 10 (WKID:32610)
Length:12749 meters

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Screengrab of Compare Measurements tool
esri.com, M.W. Denslow

Geographical concepts

Projection

- Web Mercator projection
- Standard for web applications
- When using GEOLocate you don't need to worry about recording projection information.

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Image showing Mercator projection, Wikipedia

Geographical concepts

Datum

- Used to measure a location across the Earth's surface in a coordinate system
- A reference point
- WGS84 now standard (NAD27, NAD83)

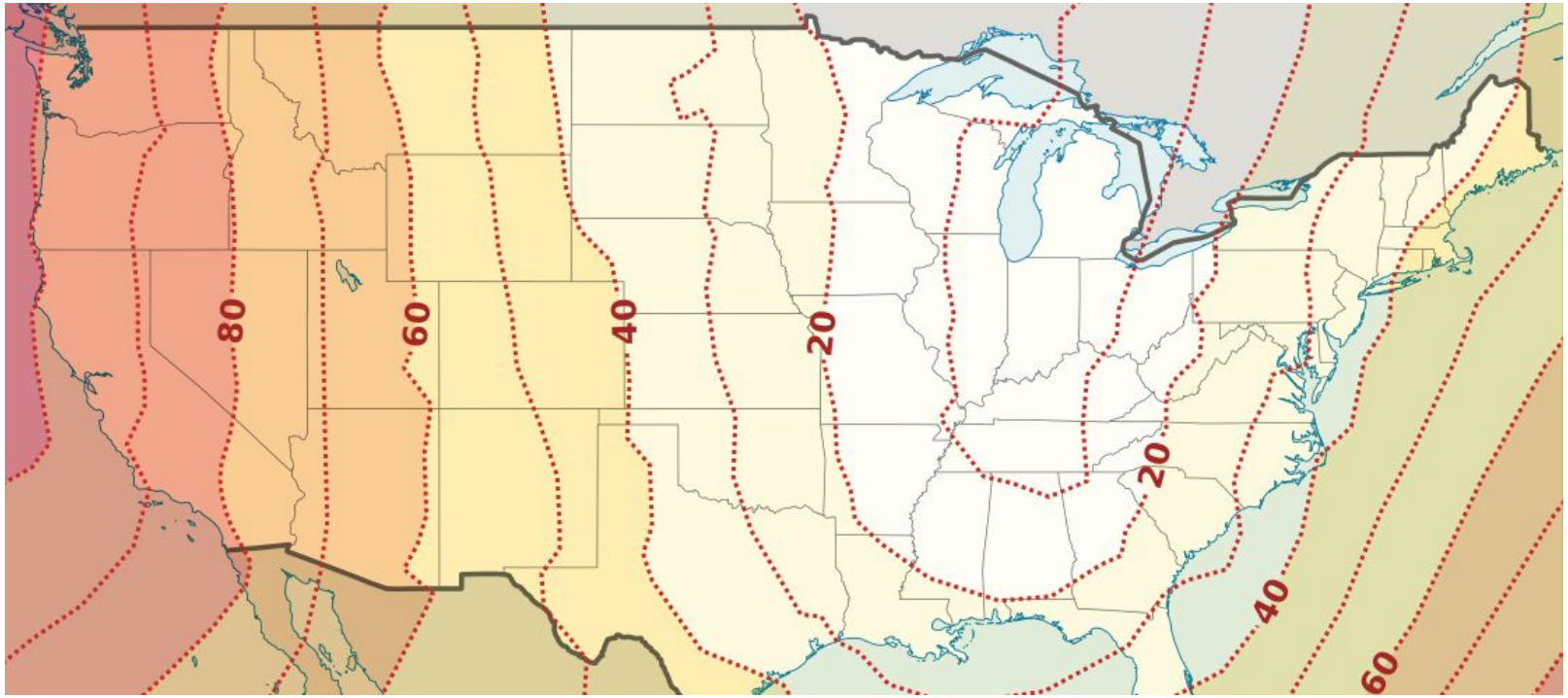

Image courtesy of Nelson Rios, Yale Peabody Museum of Natural History

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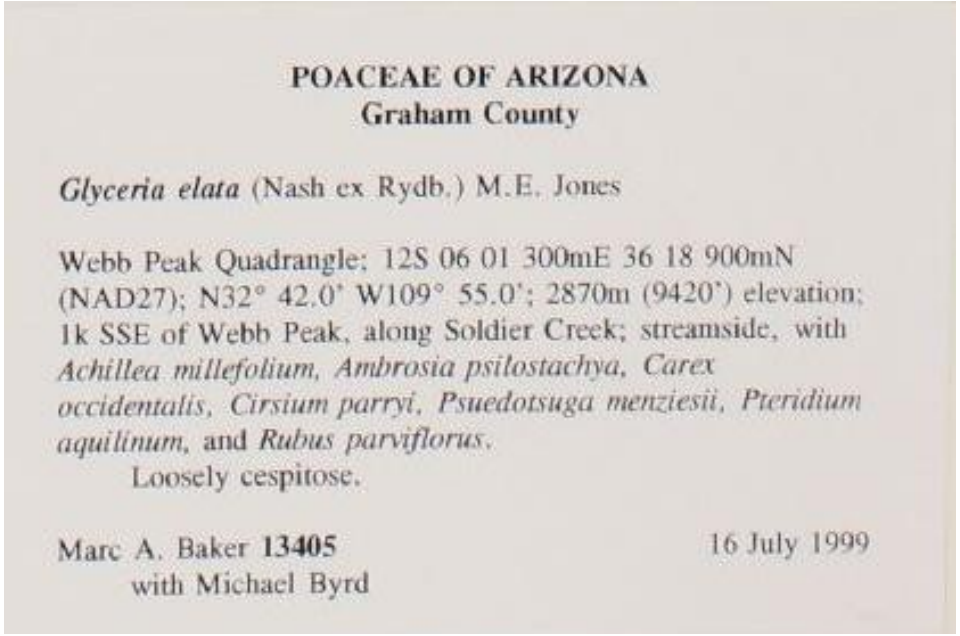
Geographical concepts

Datum

- ❏ WGS84 now standard
- ❏ All maps in GEOLocate use WGS84
- ❏ Our main concern is with labels that have different datum already recorded
- ❏ These cases are more about converting a georeference.



POACEAE OF ARIZONA
Graham County

Glyceria elata (Nash ex Rydb.) M.E. Jones

Webb Peak Quadrangle; 12S 06 01 300mE 36 18 900mN (NAD27); N32° 42.0' W109° 55.0'; 2870m (9420') elevation; 1k SSE of Webb Peak, along Soldier Creek; streamside, with *Achillea millefolium, Ambrosia psilostachya, Carex occidentalis, Cirsium parryi, Psuedotsuga menziesii, Pteridium aquilinum,* and *Rubus parviflorus.*
Loosely cespitose.

Marc A. Baker **13405** 16 July 1999
with Michael Byrd

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Geographical concepts

What is a coordinate system?

- A system that uses numbers to uniquely determine the position of something in space
- 40.067952, -105.2222095

- Many kinds of coordinate systems
  - Universal Transverse Mercator (UTM)
  - Public Land Survey System*
    - Mostly western U.S.
    - Township Range and Section
    - Section = 1 sq. mile, 2.6 sq. km, 640 acres, 260 hectares

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Geographical concepts

Coordinate System: Latitude, Longitude format

- **Decimal degrees = 40.067952, -105.2222095**
- Degrees minutes seconds = 40° 4' 4.6266" N 105° 13' 19.9524" W
- Degrees decimal minutes = 40° 4.0771 N " 105° 13.3325 W

- Data storage
  - Decimal degrees = 2 fields
  - Degrees minutes seconds = 8 fields
  - Degrees decimal minutes = 6 fields

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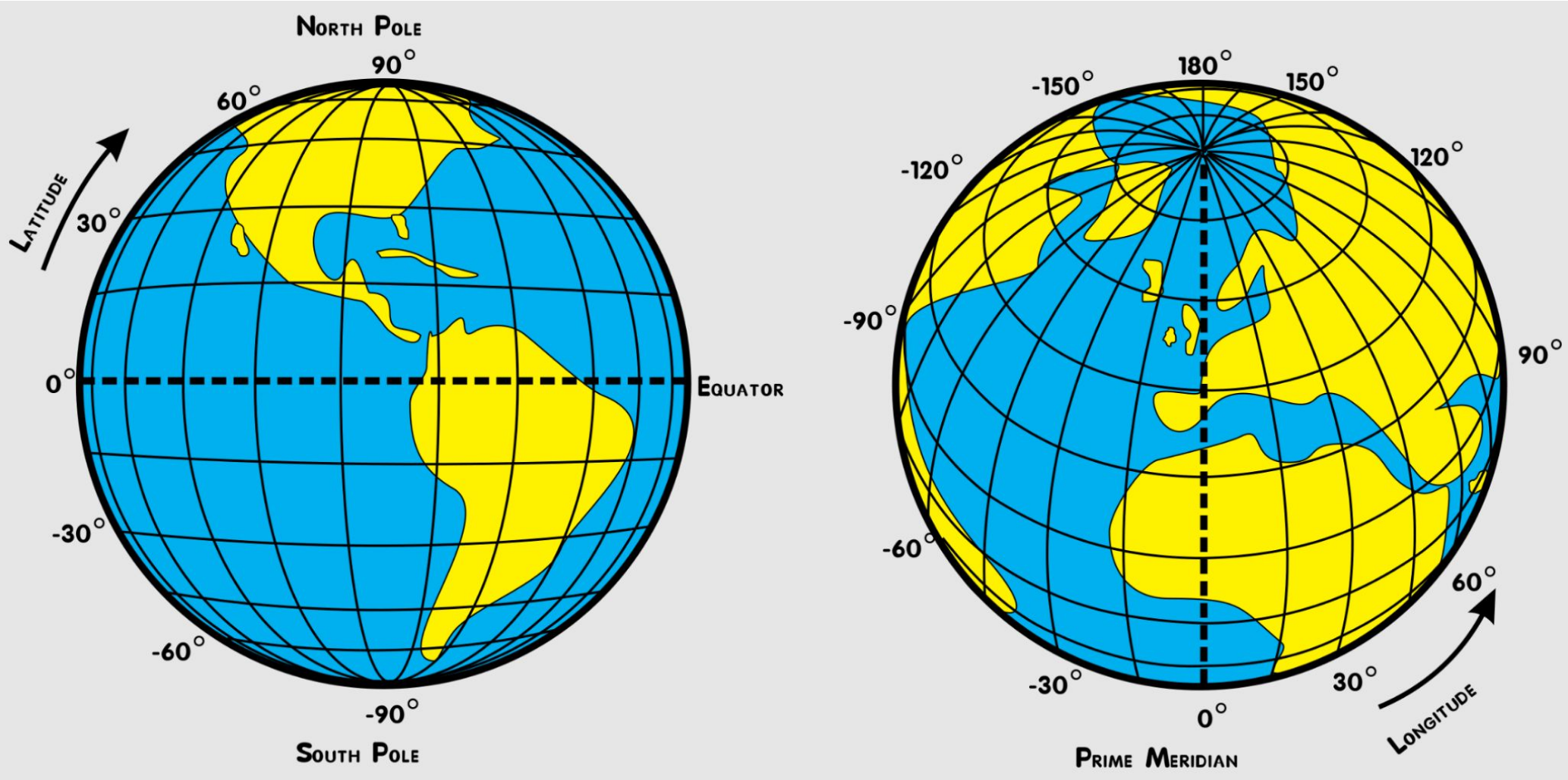
❑ Beware of positive and negative values!



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Latitude and longitude schematic, Wikipedia

Geographical concepts

Uncertainty: Imperfect or unknown information

- ❑ The extent of a locality
- ❑ Imprecision in distance measurements
- ❑ Imprecision in direction measurements

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Left: Louisiana state boundary 1800. Right: louisiana state boundary 2025. Wikipedia

Geographical concepts

Uncertainty: Imperfect or unknown information

- The extent of a locality
- **Imprecision in distance measurements**
- Imprecision in direction measurements

- Uncertainty with distance measure
  - 10.5 mi N of Denver = ±0.5 mi
  - 10.6 mi N of Denver = ±0.1 mi
  - 10.75 mi N of Denver = ±0.25 mi

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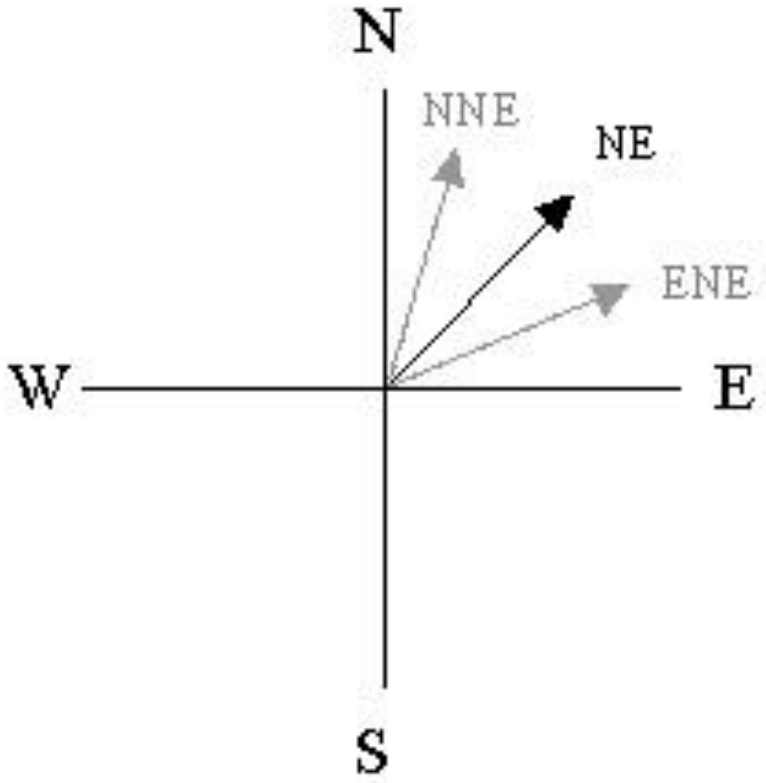
Geographical concepts

Uncertainty: Imperfect or unknown information

- The extent of a locality
- Imprecision in distance measurements
- **Imprecision in direction measurements**

- Uncertainty with directional precision
  - 10 mi N of Denver
  - Directional uncertainty is 45 degrees



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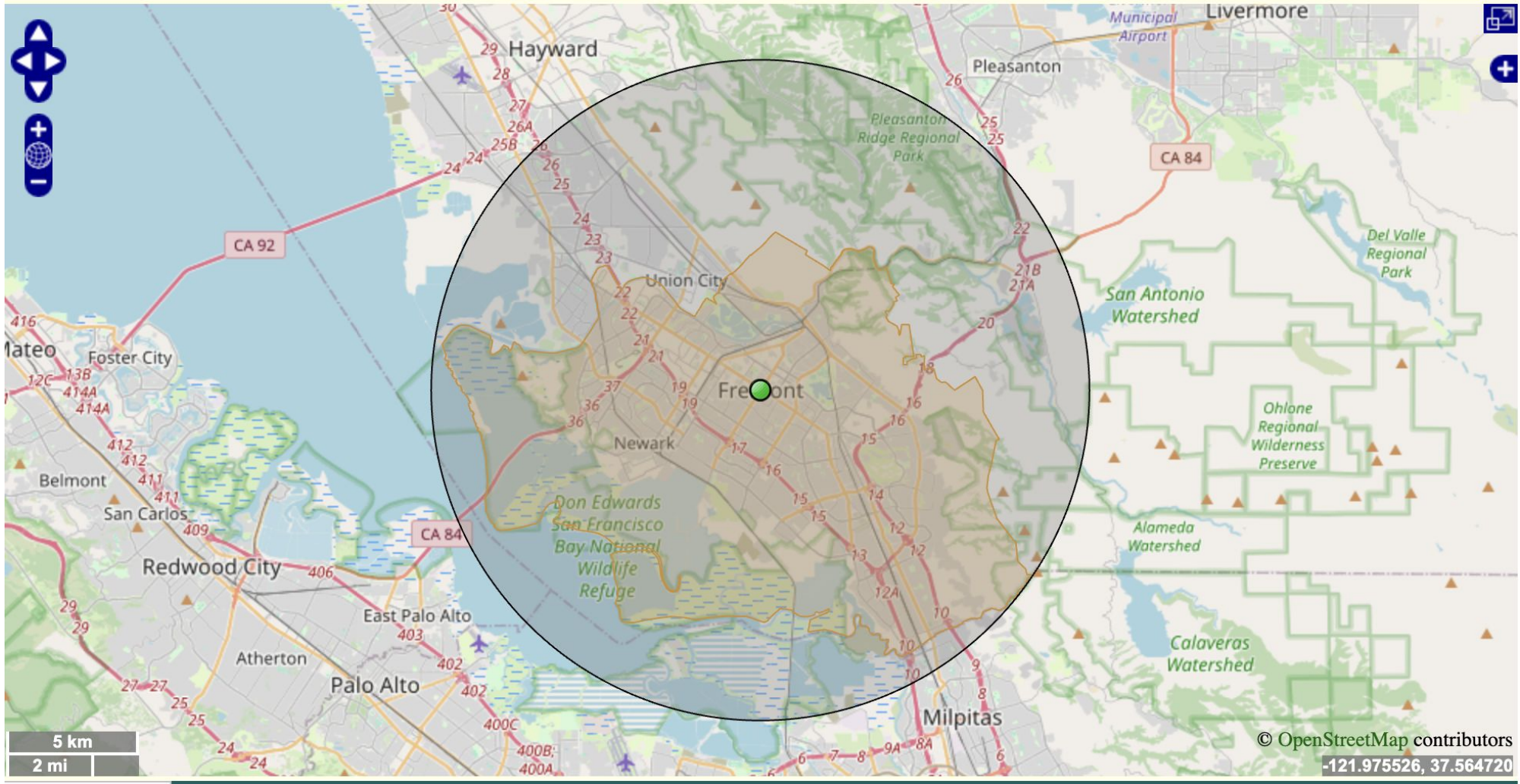
Geographical concepts

Uncertainty methods

- Point-radius vs. Shape Method



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Geographical concepts

Uncertainty methods

- Fremont, Alameda County, California

- Point-radius = 12921 meters
- Shape = very large number of values

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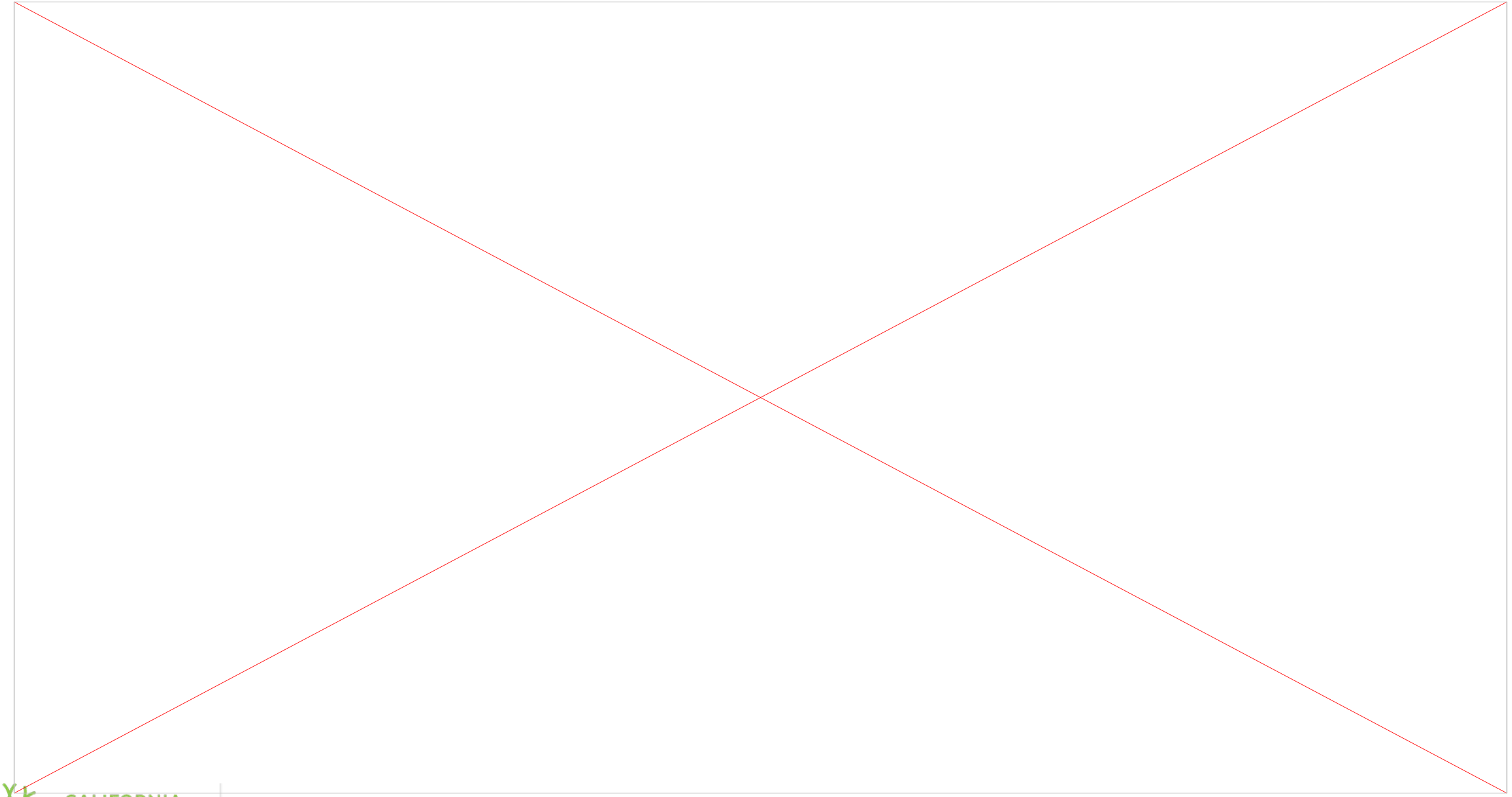

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Standards

Values to record (Darwin Core Terms)

- ❏ What is the Darwin Core Standard?
- ❏ It includes a glossary of terms intended to facilitate the sharing of information about biological diversity by providing identifiers, labels, and definitions.
- ❏ https://www.tdwg.org/standards/dwc/
- ❏ https://dwc.tdwg.org/terms/

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Standards

Values to record (Darwin Core Terms)

- ❏ Darwin Core Terms
- ❏ “California”
- ❏ stateProvince
  - ❏ The name of the next smaller administrative region than country (state, province, canton, department, region, etc.) in which the dcterms:Location occurs.

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Standards

Values to record (Darwin Core Terms)

- ❏ Latitude and Longitude: decimalLatitude, decimalLongitude
- ❏ Datum: geodeticDatum
- ❏ Uncertainty: coordinateUncertaintyInMeters
- ❏ Remarks: georeferenceRemarks
- ❏ Who: georeferencedBy
- ❏ When: georeferencedDate
- ❏ What: georeferenceSources
- ❏ How: georeferenceProtocol

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Standards

Values to record (Darwin Core Terms)

- ❏ Remarks: georeferenceRemarks
  - ❏ tells others how you decided where to place your point and how your uncertainty was estimated

- ❏ How: georeferenceProtocol
  - ❏ Georeferencing Quick Reference Guide (Zermoglio et al. 2020, https://doi.org/10.35035/e09p-h128)

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Standards

Values to record (Darwin Core Terms)

- ❏ decimalLatitude, decimalLongitude = **40.067952, -105.2222095**
- ❏ geodeticDatum = **WGS84**
- ❏ coordinateUncertaintyInMeters = **484**
- ❏ georeferenceRemarks = **assumed location was where trails intersected near overlook**
- ❏ georeferencedBy = **M. Denslow**
- ❏ georeferencedDate = **2021-07-15**
- ❏ georeferenceSources = **GeoLocate**
- ❏ georeferenceProtocol = **Zermoglio et al. 2020, https://doi.org/10.35035/e09p-h128**

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5 MINUTE BREAK

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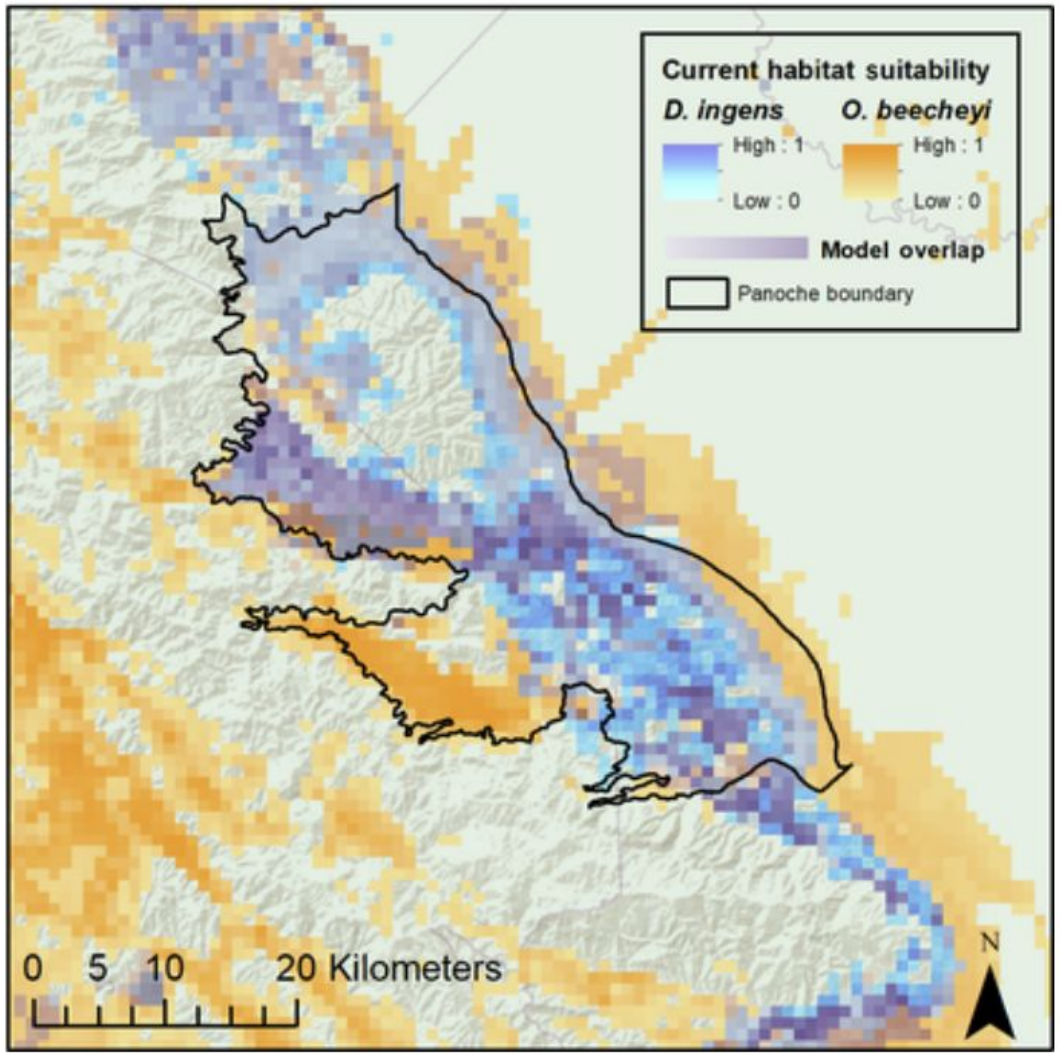
Research Examples

- Niche Models (Species distribution models)



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Georeferencing Activity

- Exercise 1 Synchronous Break Out: 10 minutes
- GEOLocate Web Application
- https://www.geo-locate.org/web/WebGeoref.aspx

https://docs.google.com/spreadsheets/d/13B9-qT0kuRqePJ0xN0RtFwXSc5_7LRQqMFKeP7Aoo2E/edit?gid=0#gid=0

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Georeferencing Activity

- Exercise 2 Synchronous Break Out: 30 minutes
- COGE
- https://www.geo-locate.org/web/WebComGeoref.aspx
- Project = Georeferencing Beginners Course
- Note that you may wish to use outside resources
  - Open Street Maps
  - Google Maps

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GEOLocate

- 3 components
- GEOLocate Web Application
  - One at a time
- GEOLocate Collaborative Georeferencing Web Client
  - Project based
  - Collaborative
  - Data managed centrally
- Collaborative Georeferencing Data Portal
  - Management of collaborative projects

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Georeferencing References & Resources

- Georeferencing Quick Reference Guide
  - https://docs.gbif.org/georeferencing-quick-reference-guide/1.0/en/
-
  - https://www.vertnet.org/resources/georef/
- Getty Thesaurus of Geographic Names Online
  - https://www.getty.edu/research/tools/vocabularies/tgn/index.html

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- **END**

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