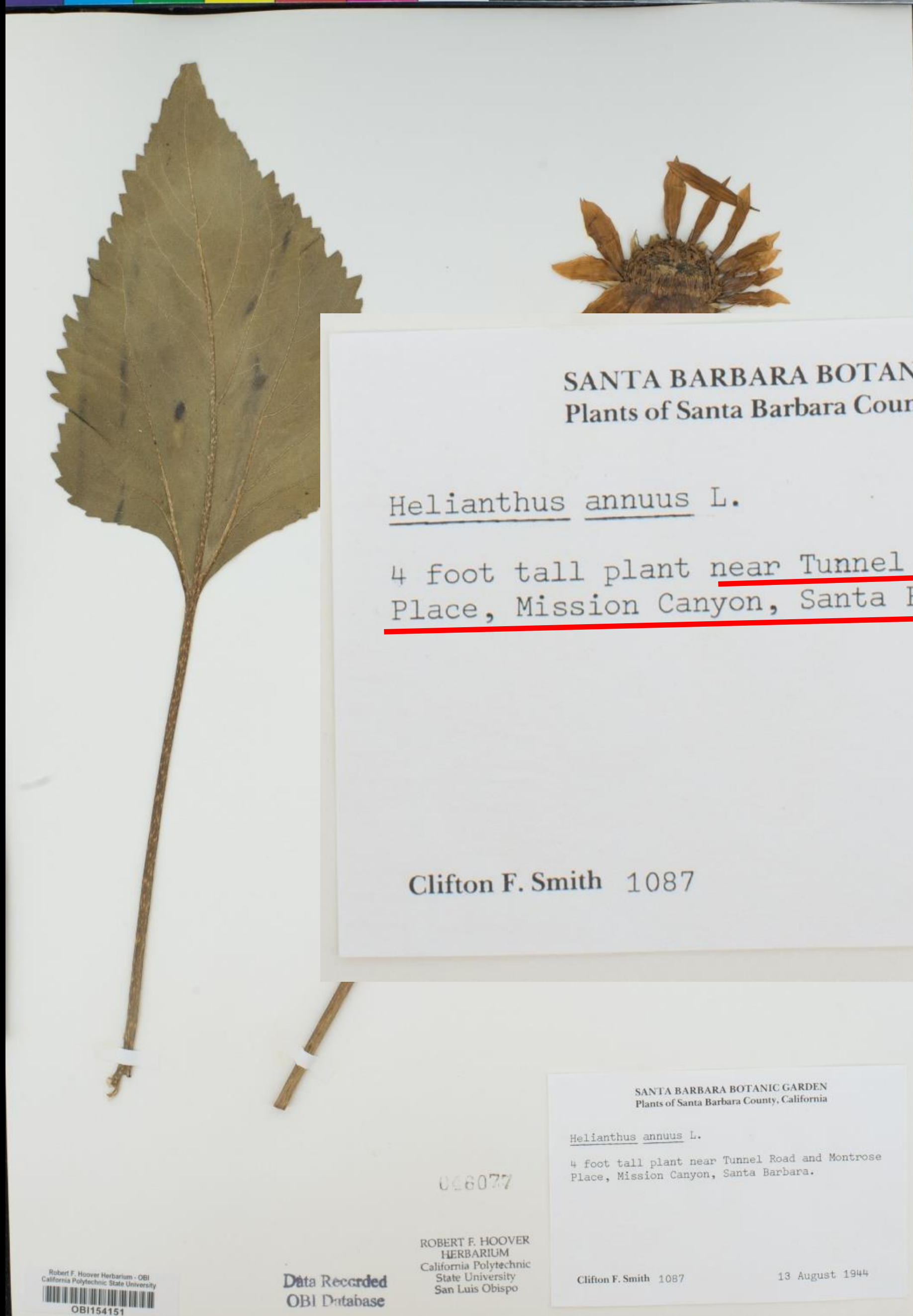
Introduction to Georeferencing, with Tips & Tricks

Georeferencing Training



SANTA BARBARA BOTANIC GARDEN
Plants of Santa Barbara County, California

Helianthus annuus L.

4 foot tall plant near Tunnel Road and Montrose Place, Mission Canyon, Santa Barbara.

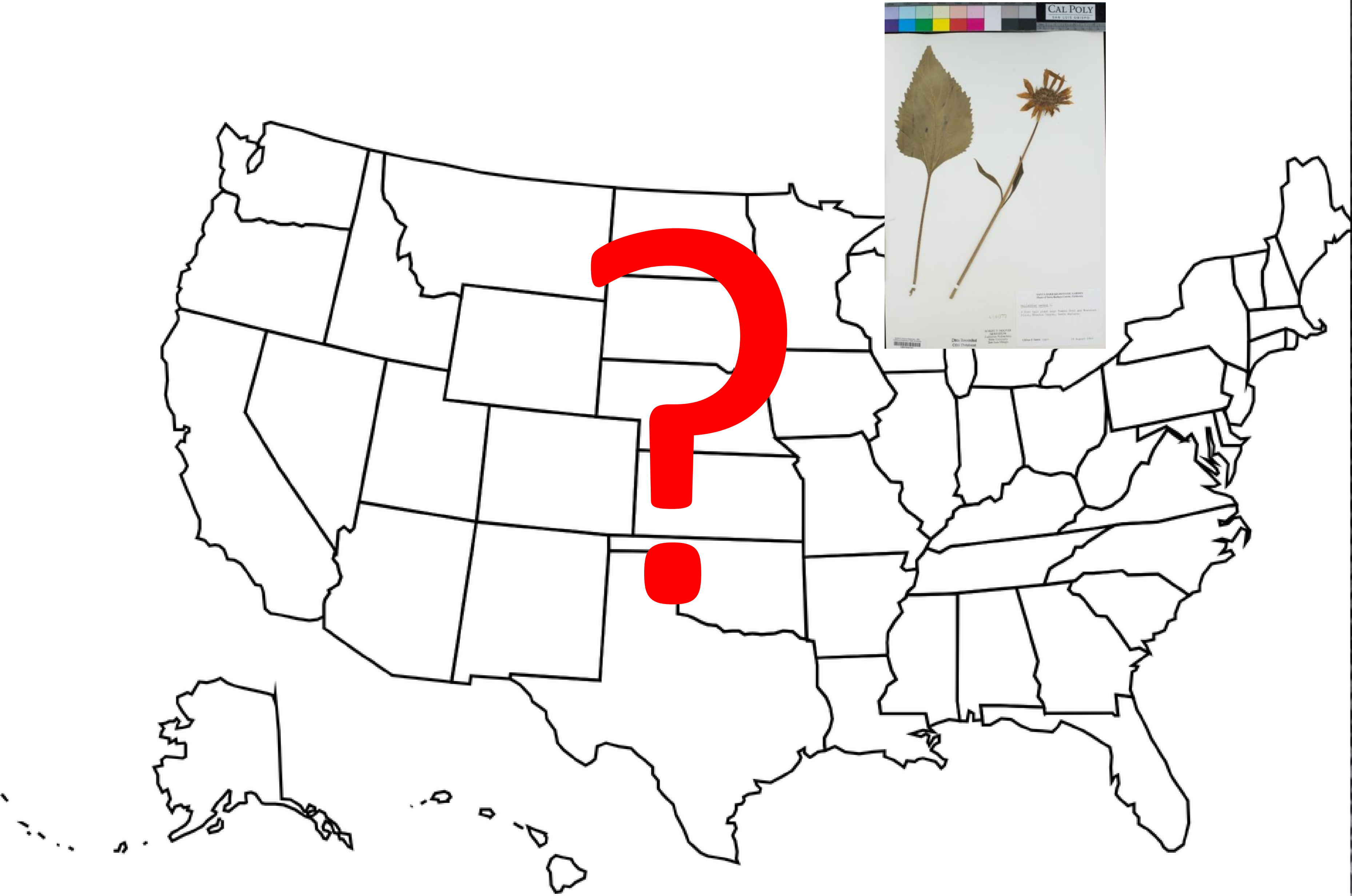
Clifton F. Smith 1087 13 August 1944

SANTA BARBARA BOTANIC GARDEN
Plants of Santa Barbara County, California

Helianthus annuus L.

4 foot tall plant near Tunnel Road and Montrose Place, Mission Canyon, Santa Barbara.

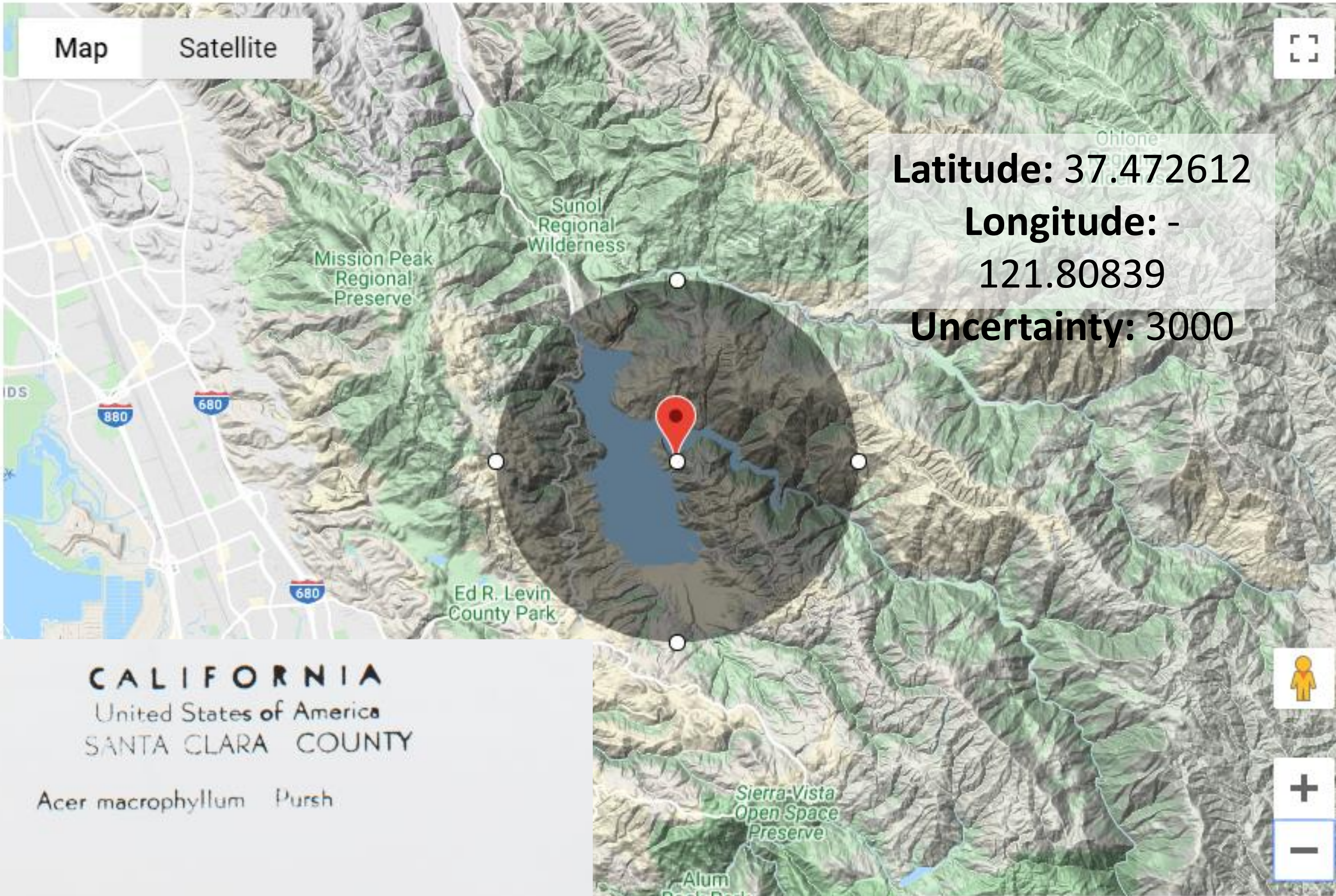
Clifton F. Smith 1087 13 August 1944

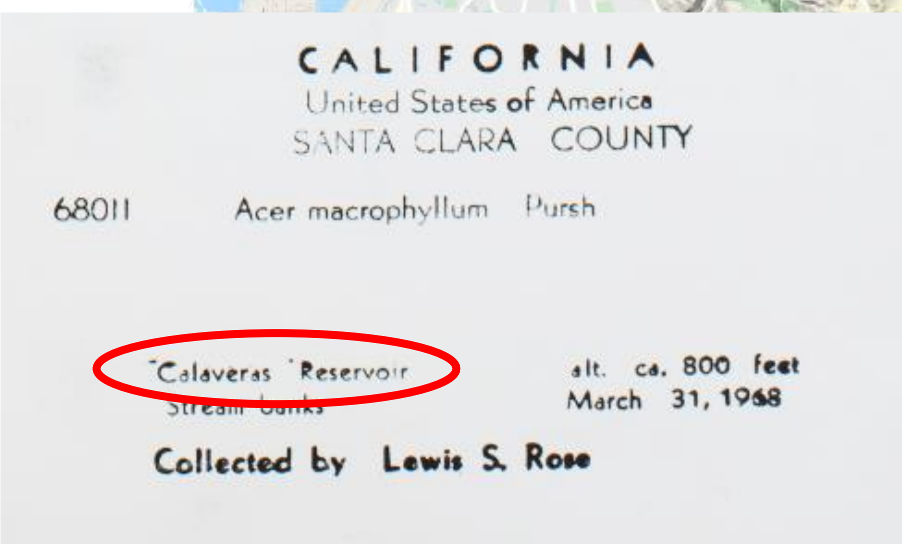

CAL POLY
?

Georeferencing

Process of assigning geocoordinates (latitude and longitude) and error of estimation (“uncertainty”) to a textual locality description


CAL POLY
Specimen was here!



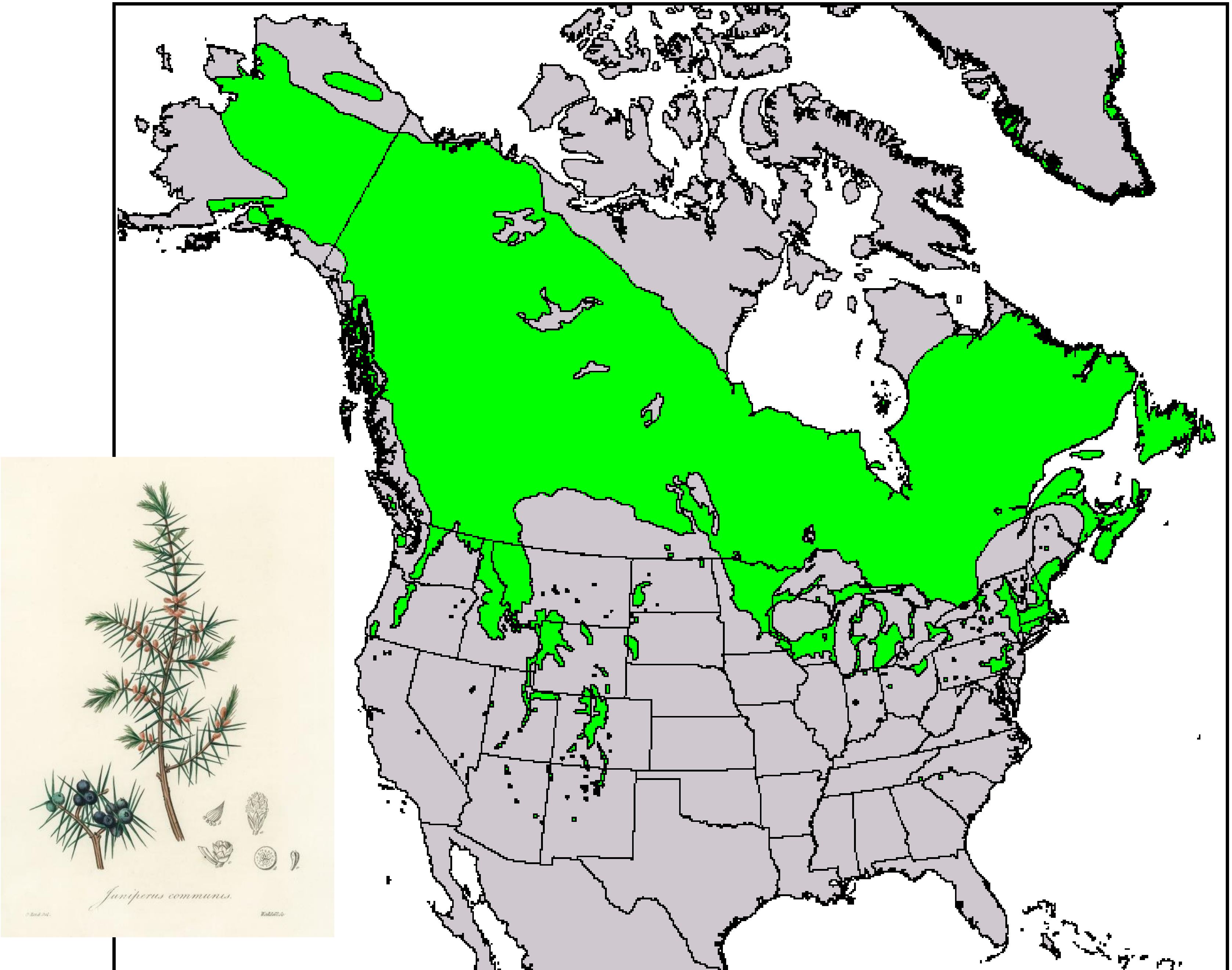

CALIFORNIA
United States of America
SANTA CLARA COUNTY

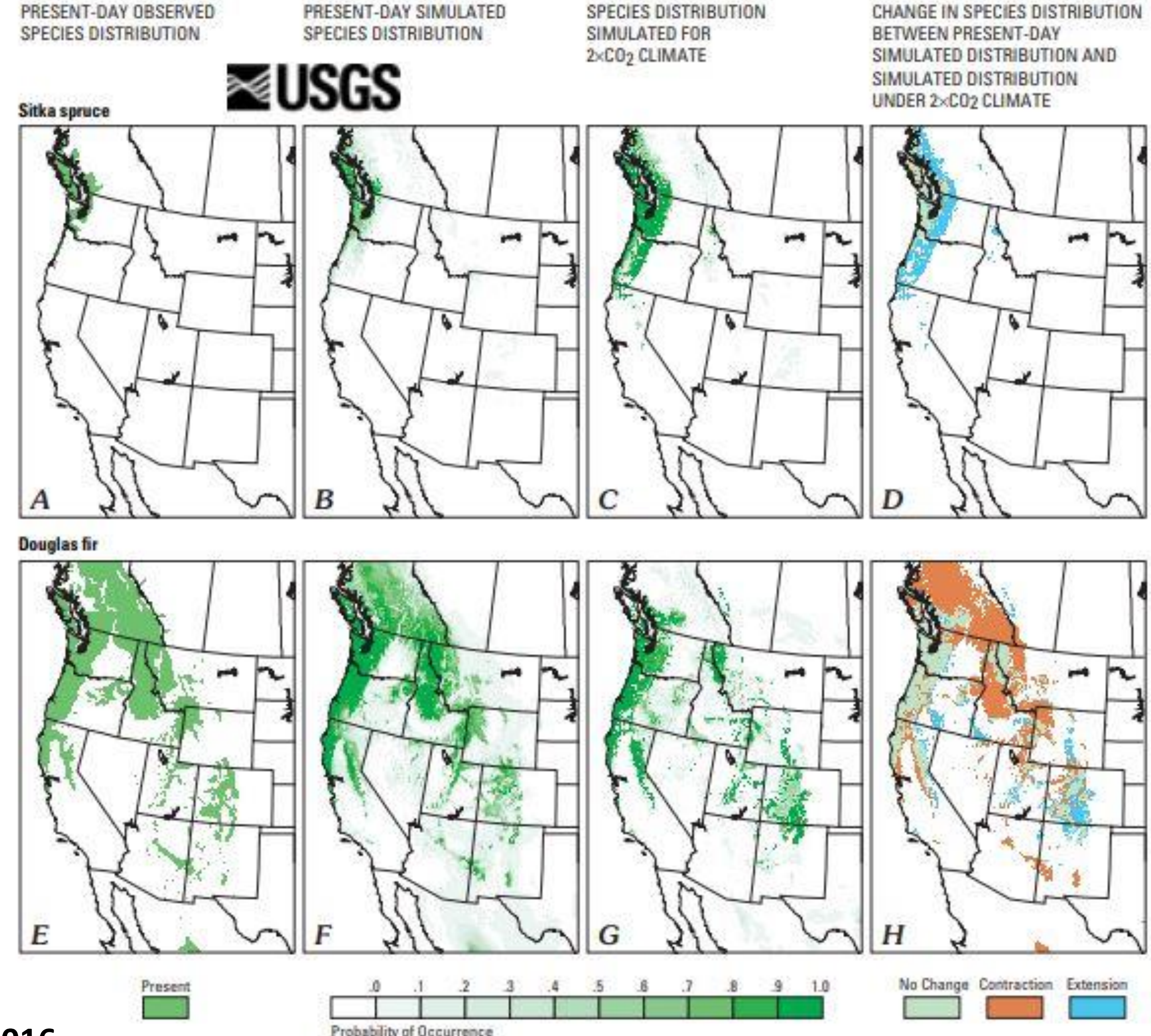
68011 Acer macrophyllum Pursh

Calaveras Reservoir alt. ca. 800 feet
Stream banks March 31, 1968

Collected by Lewis S. Rose

Why do we georeference?


Juniperus communis.



USGS 2016

https://pubs.usgs.gov/circ/c1153/c1153_4.htm

Some Georeferencing terminology

occurrence

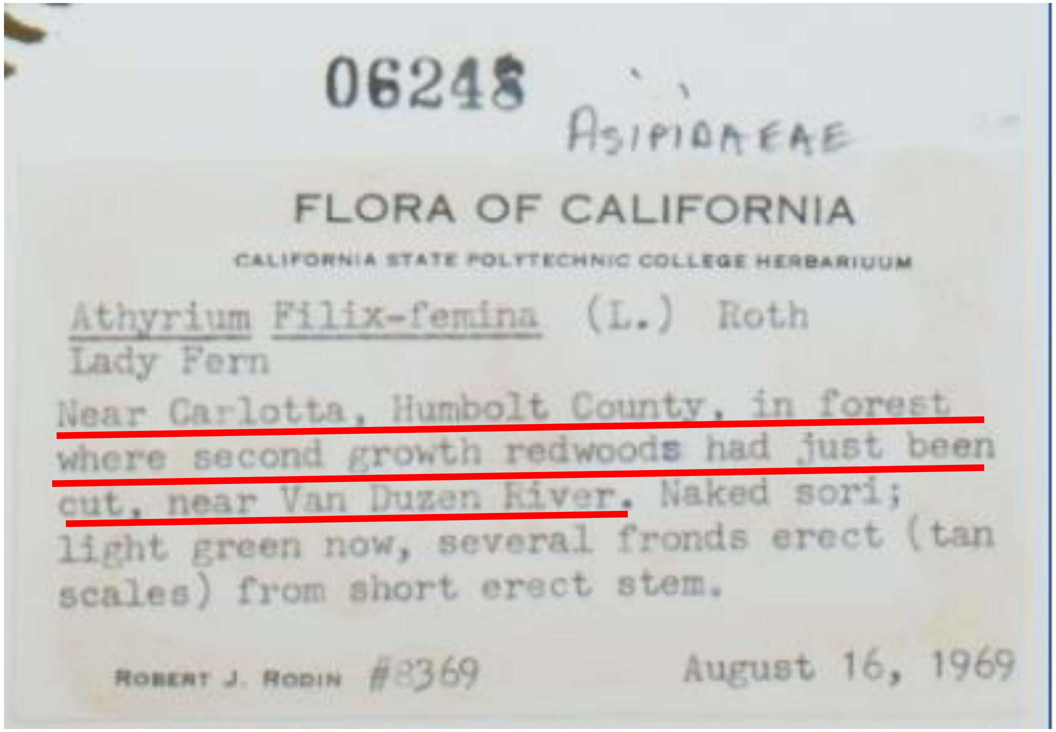
event of a specimen being collected, represented by a single specimen

(for our purposes, occurrence = specimen)

locality

textual description of where the specimen was collected

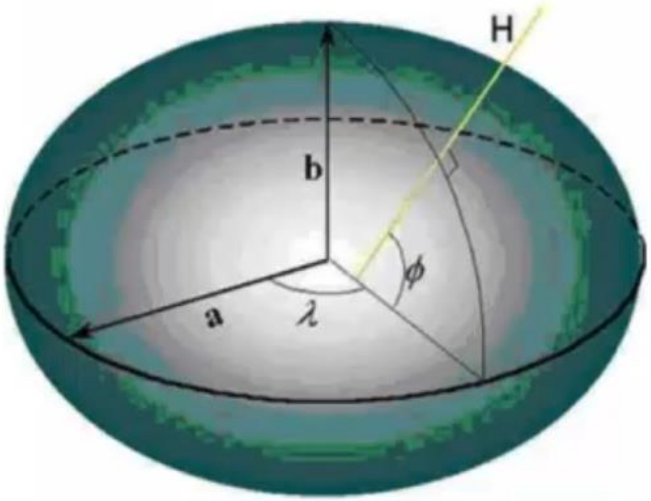
(locality = location)

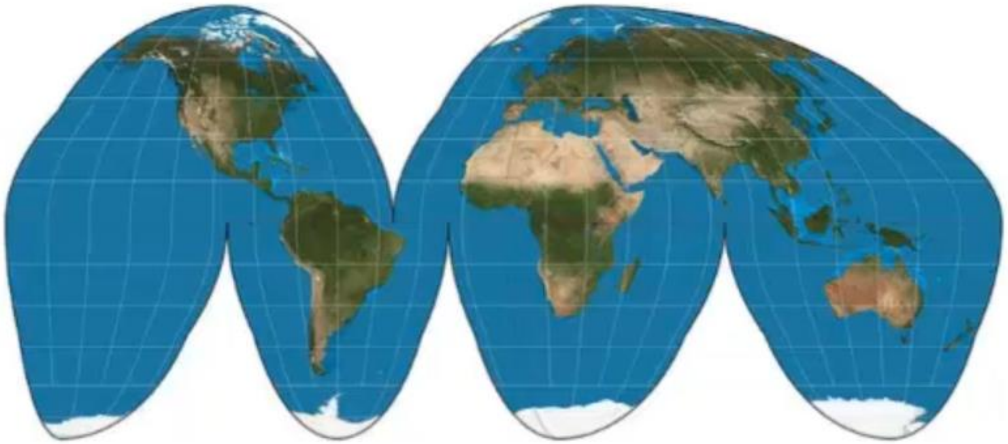


Geographical Concepts

3 main concepts

- ❑Projection
- ❑Datum
- ❑Coordinate system





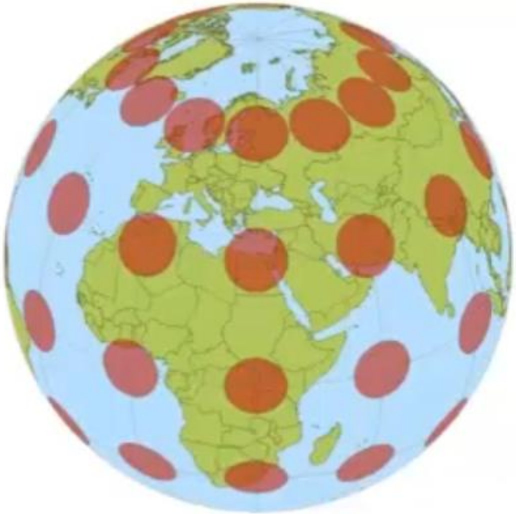
Geographical Concepts: Projections

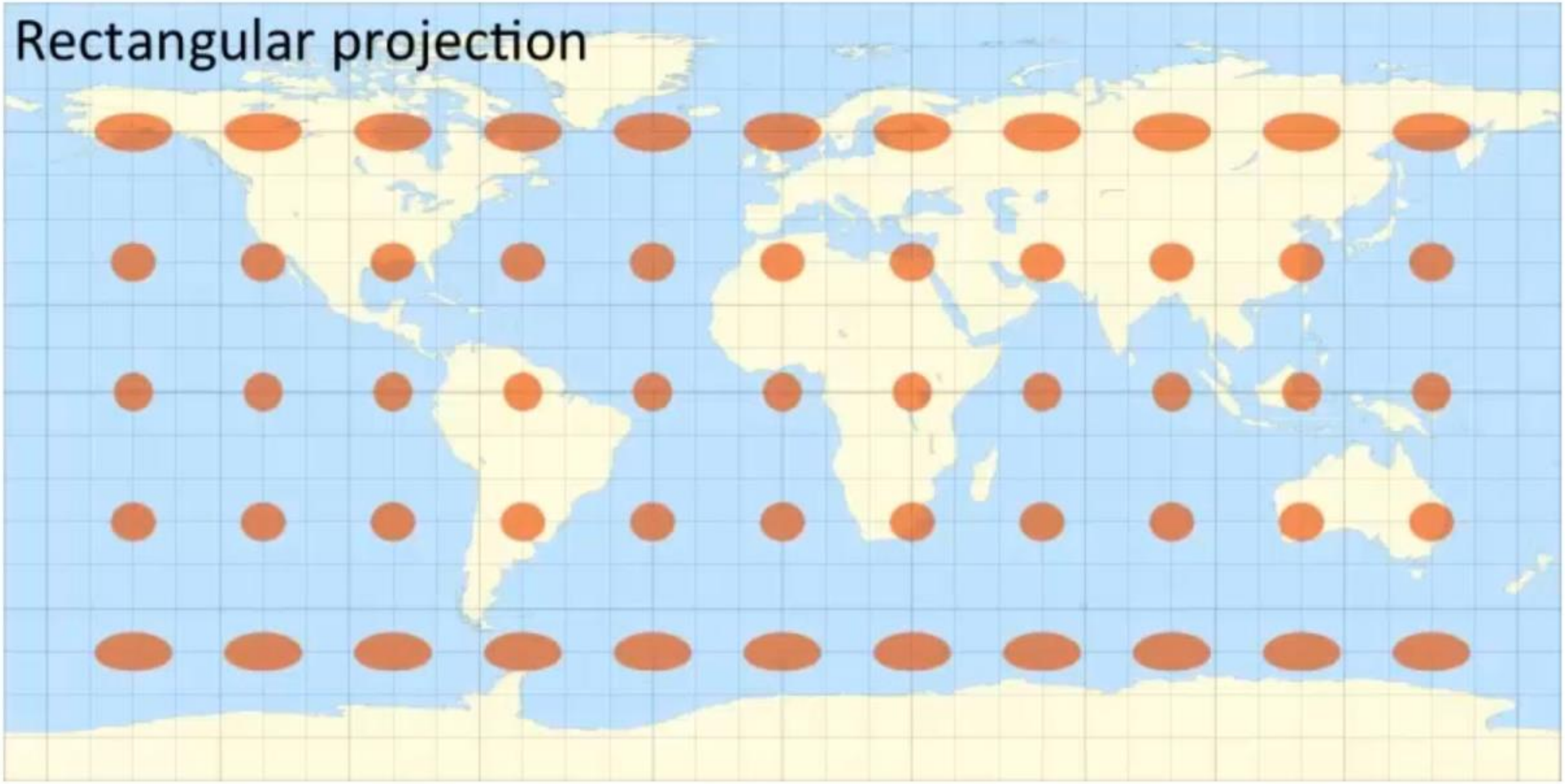
Geographical Concepts: Projection

Geographical Concepts: Projections

Bonne equal-area projection

What projections do

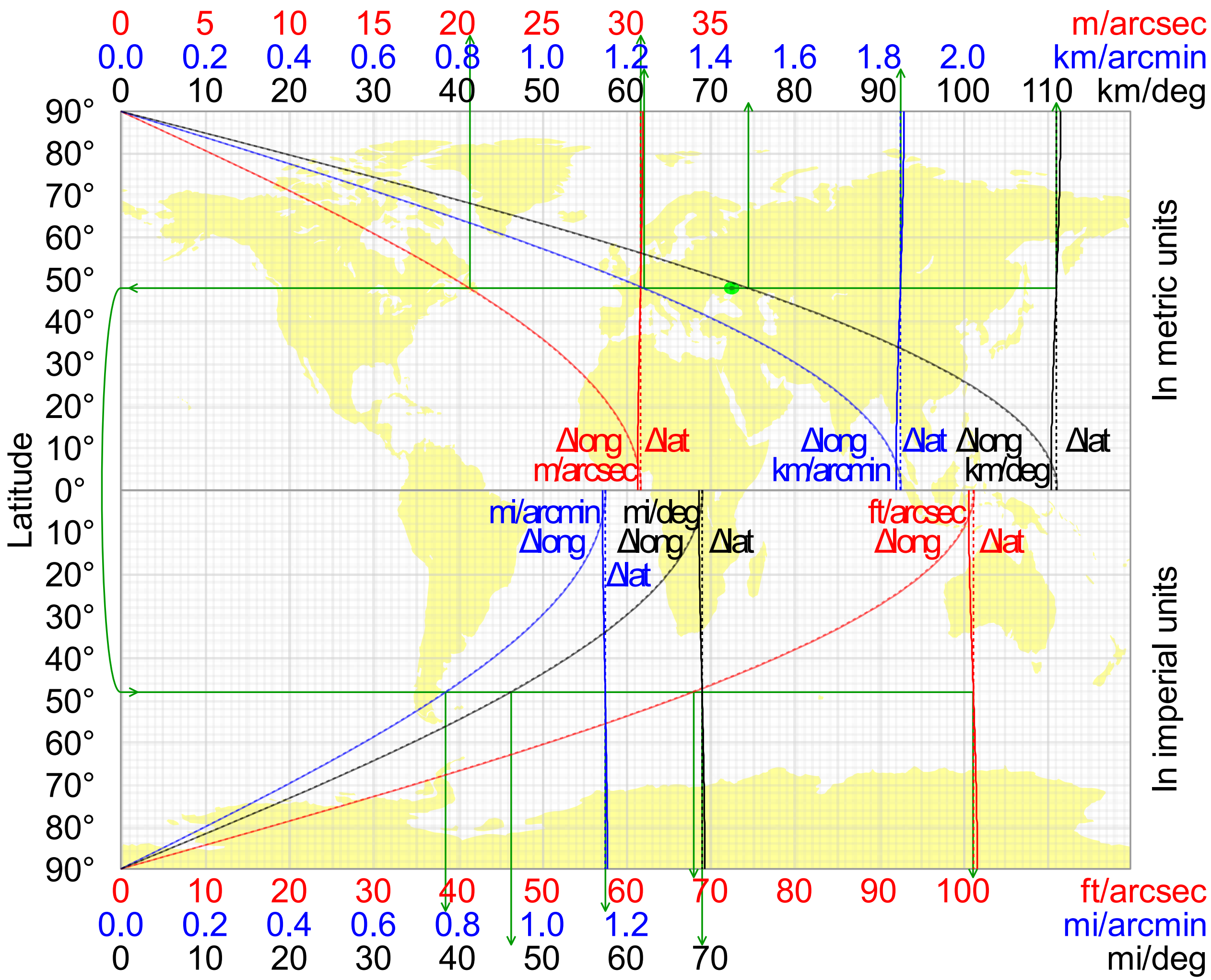




Tissot's Indicatrix of distortion

[Wikipedia]

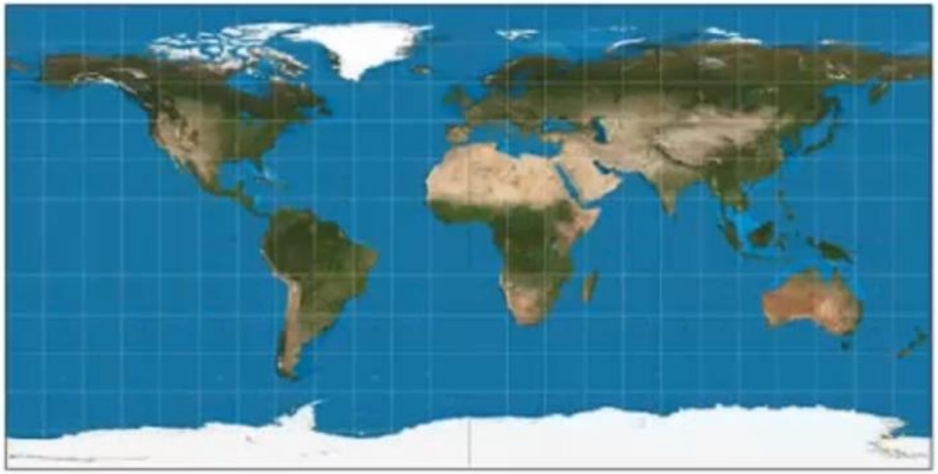
The length of a degree of longitude (east–west distance) depends only on the radius of a circle of latitude.



φ	Δ^1_{lat}	Δ^1_{long}
0°	110.574 km	111.320 km
15°	110.649 km	107.551 km
30°	110.852 km	96.486 km
45°	111.133 km	78.847 km
60°	111.412 km	55.800 km
75°	111.618 km	28.902 km
90°	111.694 km	0.000 km

Length of one degree (black), minute (blue) & second (red) of latitude and longitude at a given latitude in WGS84. The green arrows show that Donetsk (green dot) at 48°N has a Δlong of 74.63 km/° and a Δlat of 111.2 km/° [Wikipedia] DJB = 101.38 km / °

Projection Examples



Geographic:
preserves
North-South distance

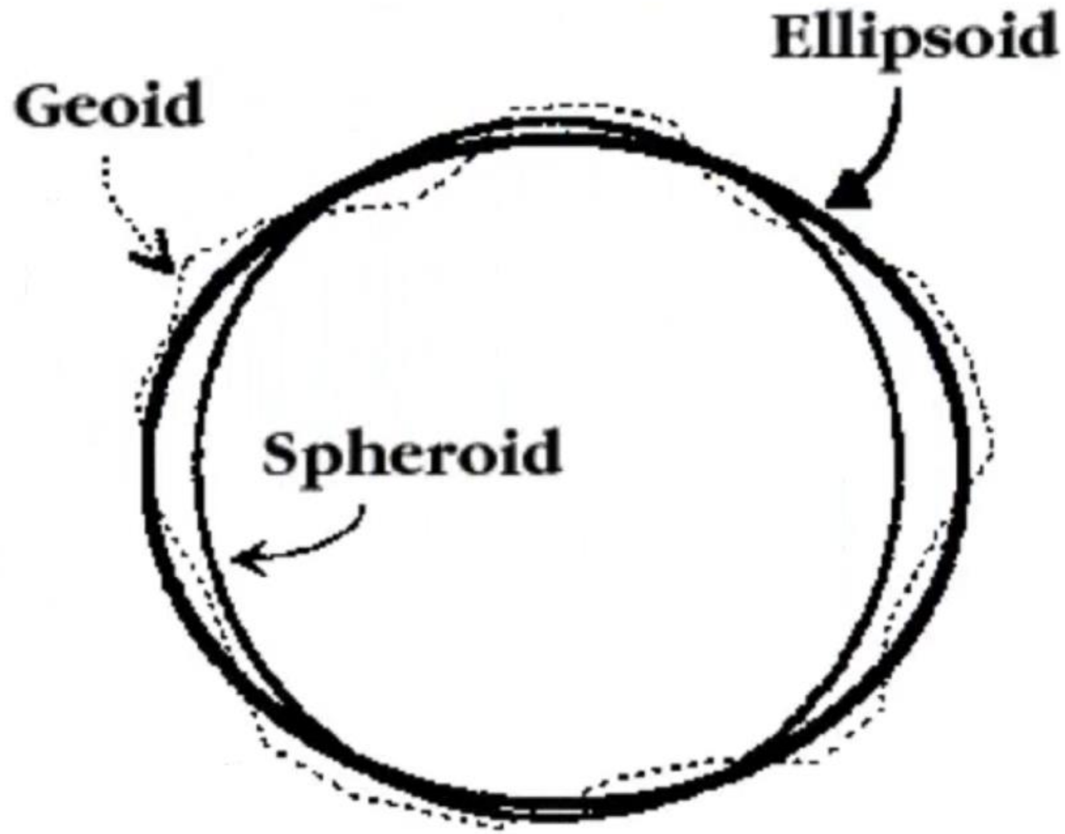
Mercator:
preserves shape (terrible for poles, distorts area)

Projections: Take Home Message

- Projections compromises…
  - Equal-area
  - True shape
  - True scale
  - True direction

- Select projection to fit your needs

Geographical Concepts: Datum



Geographical Concepts: Datums

Common Datums

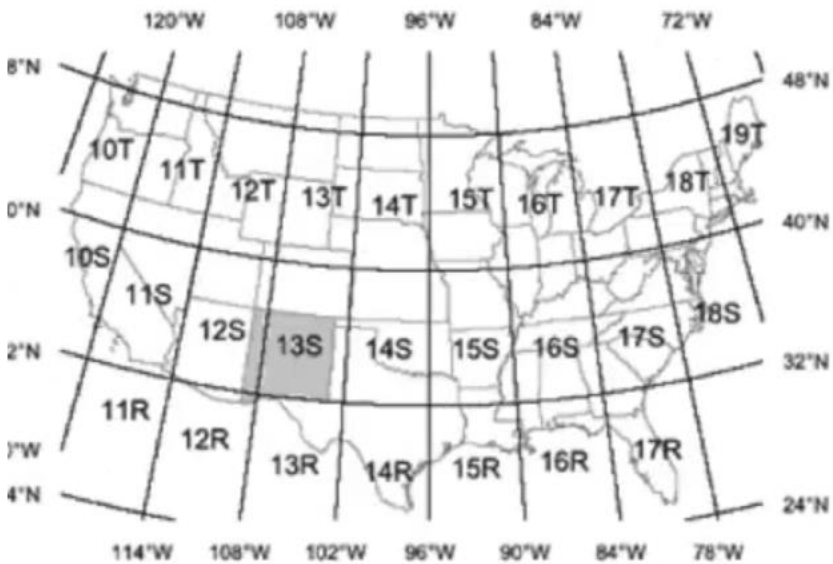
NAD27 (North American Datum 27): system derived from land-based surveys, using Clarke 1886 ellipsoid

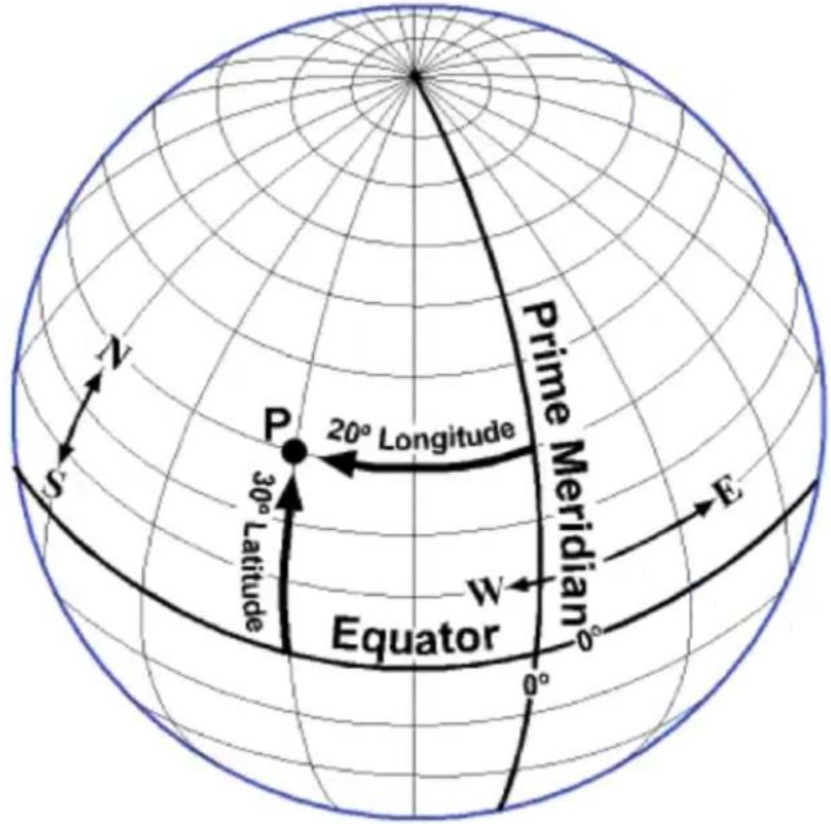
NAD83 (North American Datum 83): satellite-based system using the Earth's center as a reference point; eventually adopted as GRS80 (Geodetic Ref. System 1980)

WGS84 (World Geodetic System 1984): mathematically refined GRS80 used by the US military and default for GPS

For most uses, NAD83, GRS80, WGS84 are equivalent.

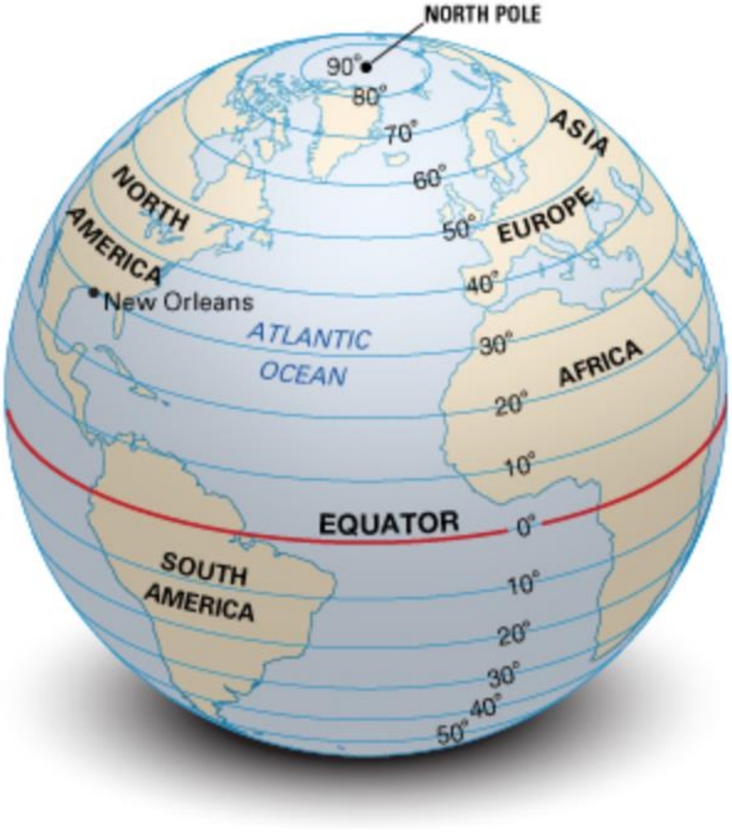
Geographical Concepts: Coordinate Systems





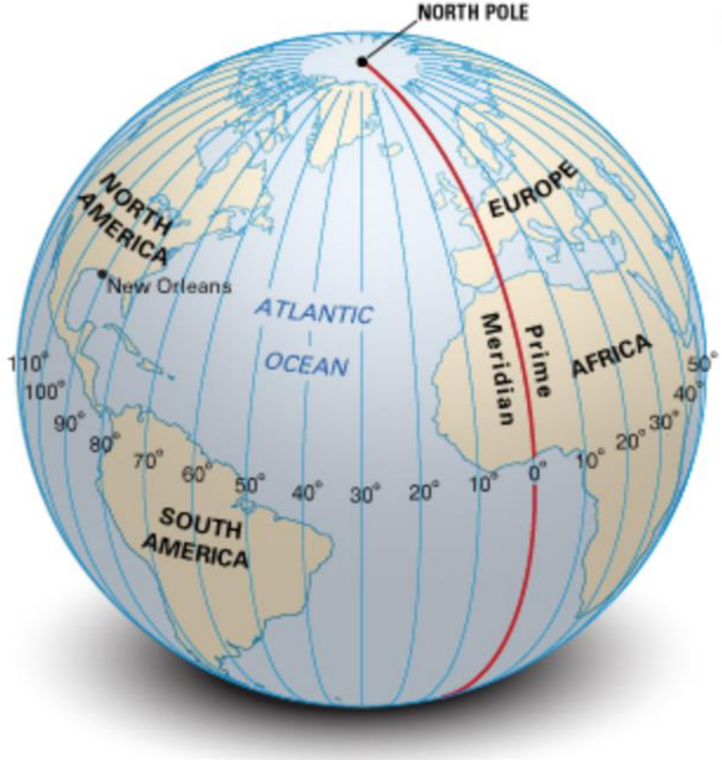
latitude

angular distance that a location is north or south of the equator, measured along a line of longitude



Longitude

angular distance east or west of the prime meridian on the earth's surface along a line of latitude

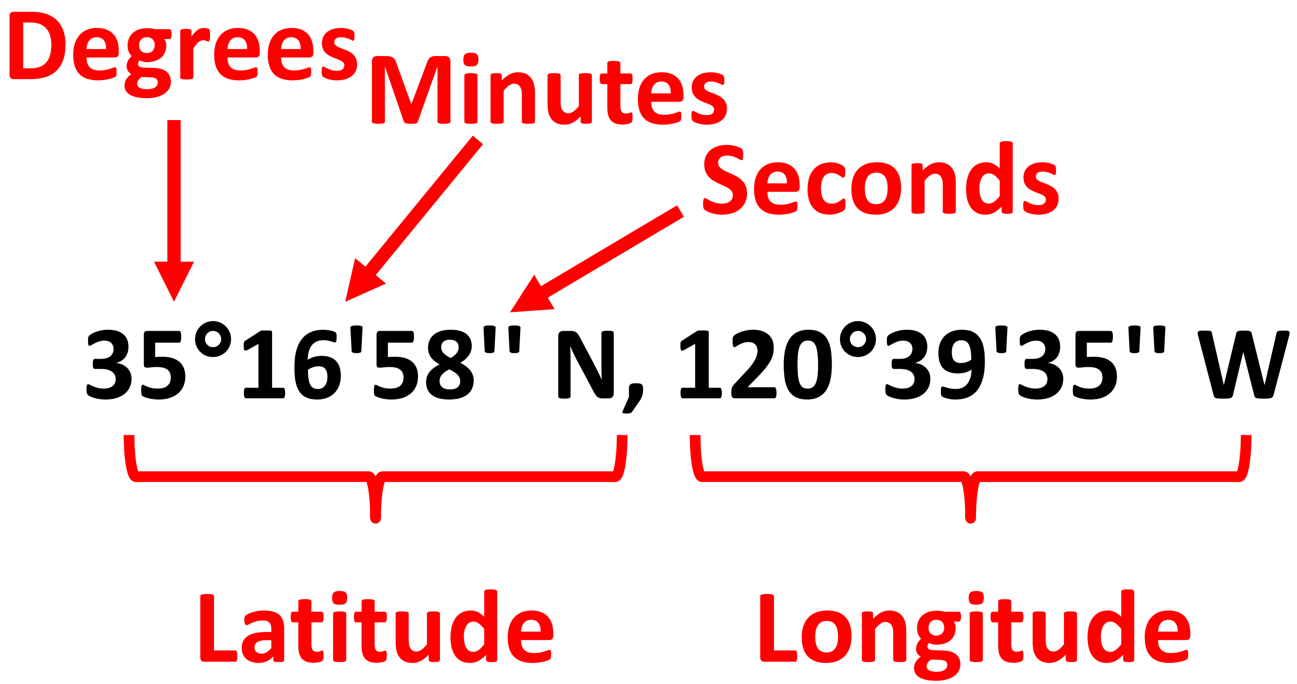


Decimal degrees

35.282752° , -120.659615°

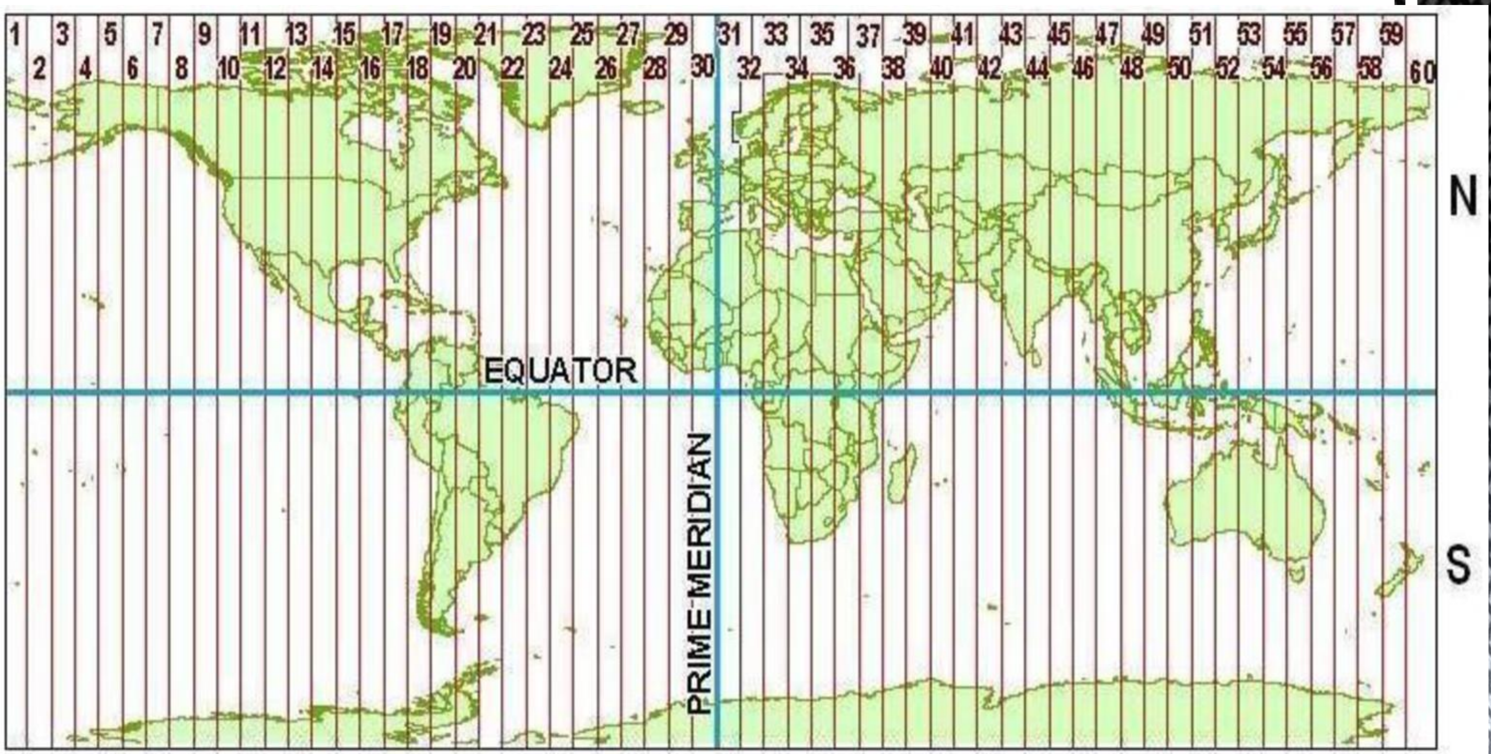
Latitude **Longitude**

Degrees, minutes, seconds



UTM coordinates

- Universal Transverse Mercator
- Standardized coordinate system based on a metric rectangular grid system
- Earth divided into sixty 6° longitudinal zones



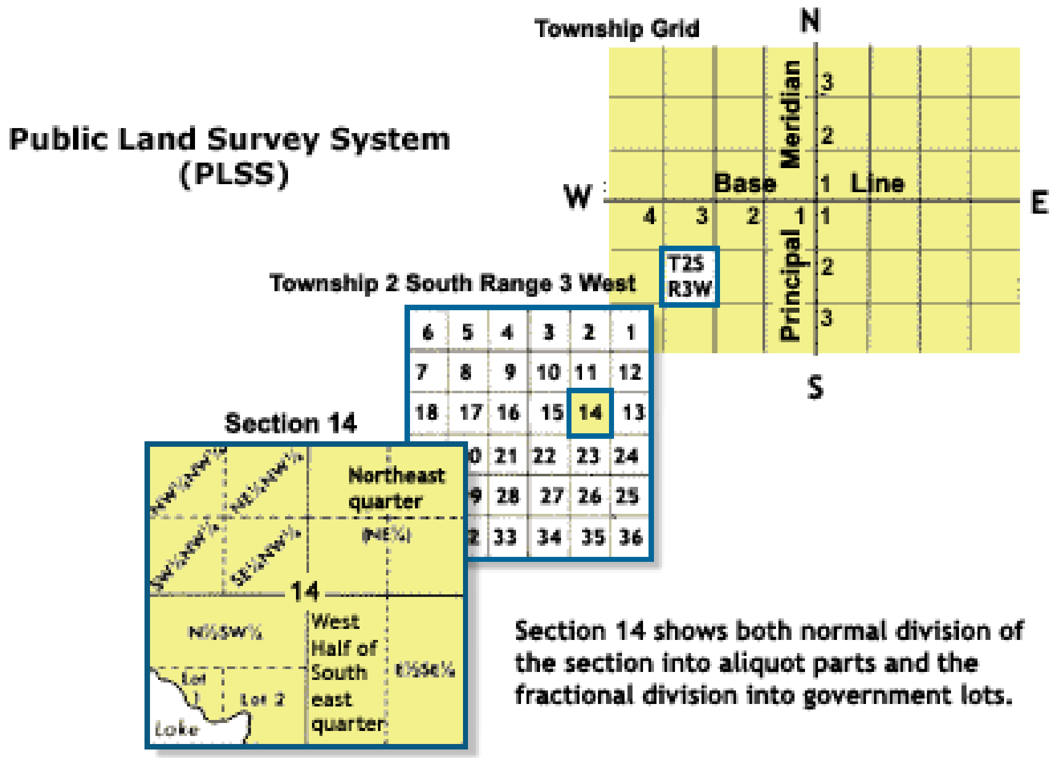
UTM coordinates

10N 662800E 3968600N

Zone **Easting** **Northing**

Township, Range, Section

- U.S. Public Land Survey System
- Divides land into <u>sections</u> (1 sq. mile), with 36 sections per <u>township</u>.
- <u>Range</u> is the distance east or west of a defined meridian (units of 6 miles).



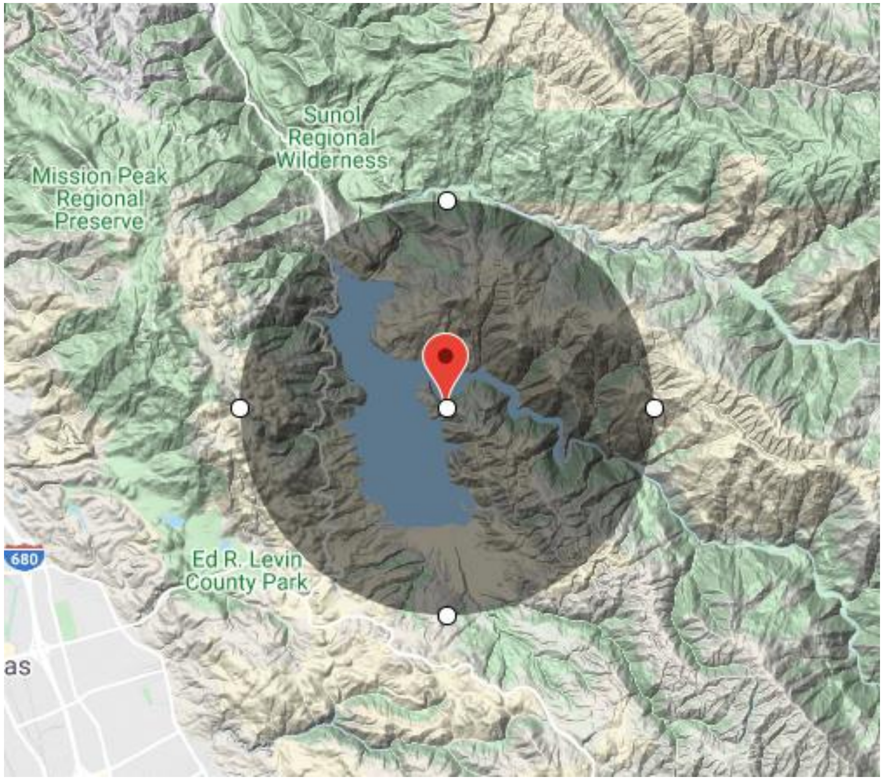
Township, Range, Section

T10N R36W sec 33 NW 1/4

Township **Range** **Section**

Uncertainty/error

estimation of the confidence we have in our assignment of latitude/longitude values to a given locality



error radius

Error polygon

Georeferencing Protocol used by TORCH: The Point-radius method in GeoLocate

(Latitude, Longitude) + Uncertainty Radius & Datum https://www.geo-locate.org/web/WebComGeoref.aspx **LINK TO GeoLocate CoGe PORTAL**

Search

Symbiota Sandbox Ho... | Symbiota ClayBox | iDigBio Portal | iDigBio Portal | Identify people to co... | BRIT-Data - Synology ... | TCU Full Catalog & Us... | TCU

Home | Web Application | Collaborative Georeferencing | Developer Resources | Education & Outreach | Support and

GEOLocate Collaborative Georeferencing Web Client

Workbench | Results

Available communities (check name to set):

Data sources in selected community:

Username:

Password:

Login

Continue

The point-radius method

remember to play your **CARDS** right!

- **C** – **Classify** the locality description
- **A** – **Assign** geocoordinates by finding the locality
- **R** – Determine the error **radius** for the estimated coordinates (or an error polygon, when appropriate)
- **D** – **Document** the georeferencing rationale
- **S** – **Save** your work!

The point-radius method

remember to play your **CARDS** right!

- **C** – **Classify** the locality description
- **A** – **Assign** coordinates by finding the locality
- **R** – Determine the error **radius** for the estimated coordinates (or an error polygon, when appropriate)
- **D** – **Document** the georeferencing rationale
- **S** – **Save** your work!

Locality types**

- Bounded place (*e.g.*, "Las Vegas")
- Undefined area (*e.g.*, "Hills south of Los Osos")
- Street address
- Junction, intersection, crossing
- River, stream, road, path
- Mouth or headwaters of river, confluence of waterways, trailhead
- Near a named place (*e.g.*, "Near the Hoover Dam")
- Between two places (*e.g.*, "between Arlington & Fort Worth")
- Direction from a named place (*e.g.*, "North of Tulsa")
- Specified distance in an unnamed direction (*e.g.*, "5 km outside Norman")
- Specified distance in a named direction, no path given (*e.g.*, 30 km E of Sacramento)
- Specified distance in a named direction, path given (*e.g.*, 7 mi. W of Santa Barbara on 101)

**** Remember: The uncertainty or error radius will also depend on the locality type**

Do not georeference

- Specimens with vague or inaccurate localities

- Cultivated (non-wild) specimens

The point-radius method

remember to play your **CARDS** right!

- **C** – **Classify** the locality description
- **A** – **Assign** coordinates by finding the locality
- **R** – Determine the error **radius** for the estimated coordinates (or an error polygon, when appropriate)
- **D** – **Document** the georeferencing rationale
- **S** – **Save** your work!

The point-radius method

remember to play your **CARDS** right!

- **C** – **Classify** the locality description
- **A** – **Assign** coordinates by finding the locality
- **R** – Determine the error **radius** for the estimated coordinates (or an error polygon, when appropriate)
- **D** – **Document** the georeferencing rationale
- **S** – **Save** your work!

The point-radius method

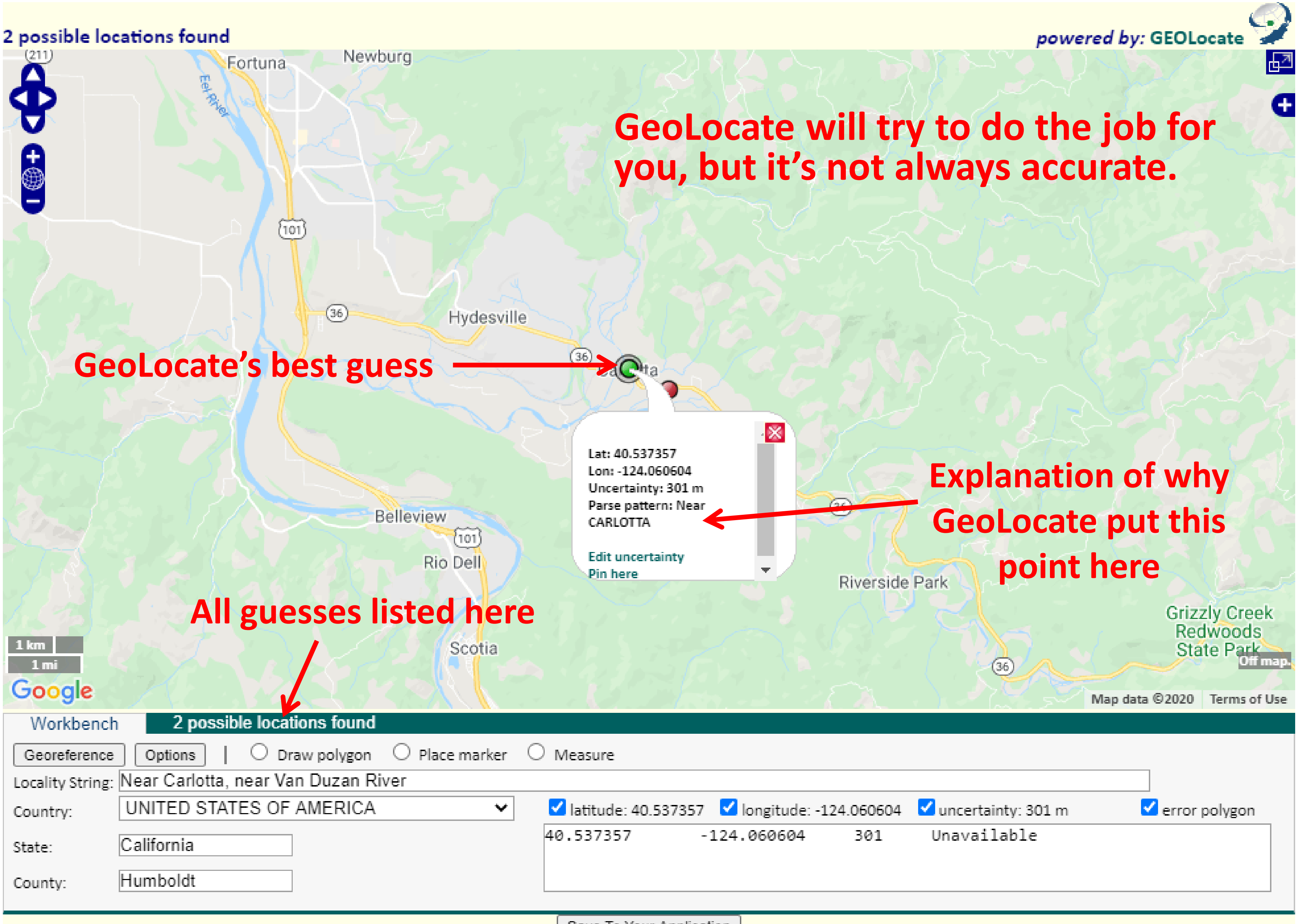
remember to play your **CARDS** right!

- **C** – **Classify** the locality description
- **A** – **Assign** coordinates by finding the locality
- **R** – Determine the error **radius** for the estimated coordinates (or an error polygon, when appropriate)
- **D** – **Document** the georeferencing rationale
- **S** – **Save** your work!

The point-radius method

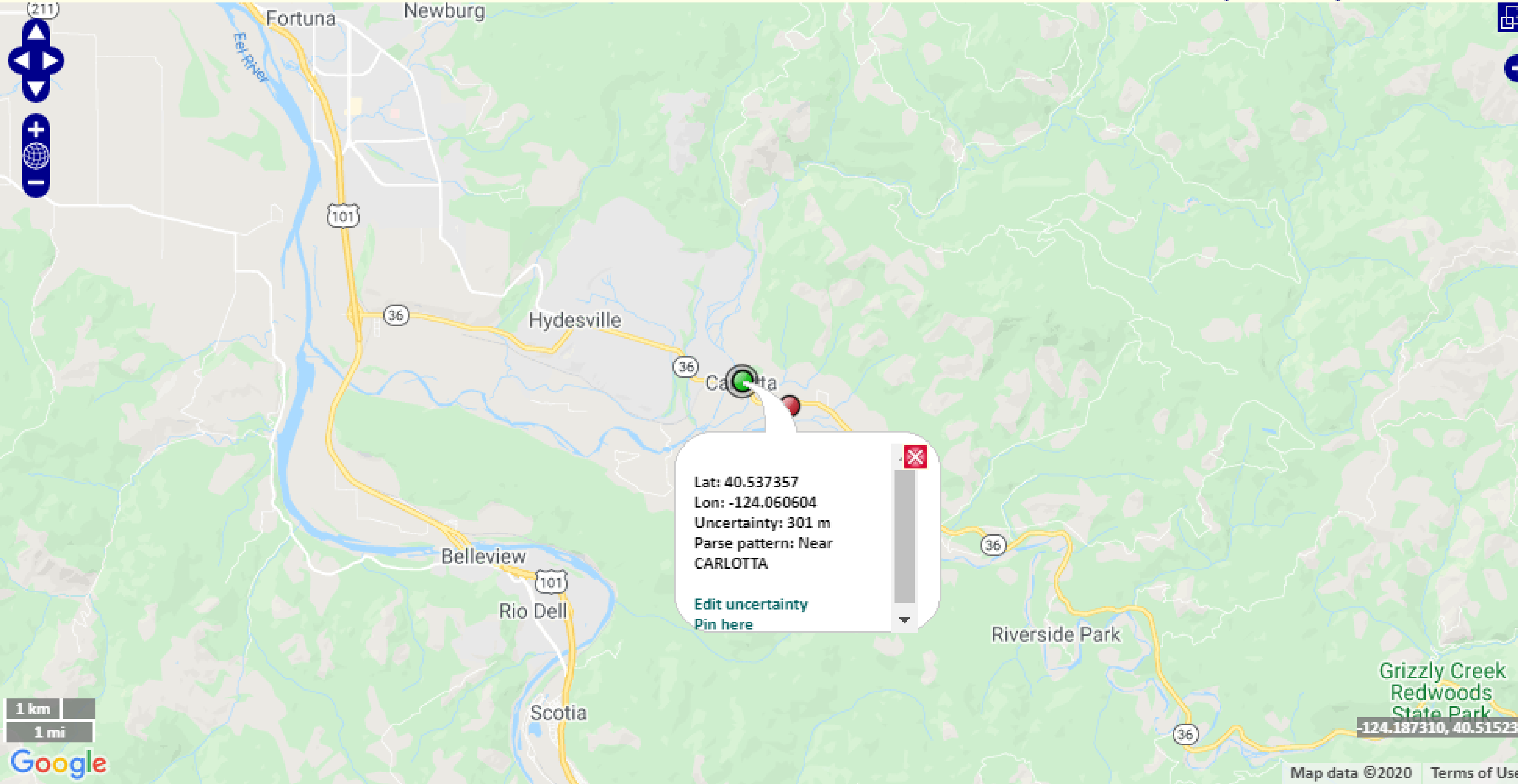
remember to play your **CARDS** right!

- **C** – **Classify** the locality description
- **A** – **Assign** coordinates by finding the locality
- **R** – Determine the error **radius** for the estimated coordinates (or an error polygon, when appropriate)
- **D** – **Document** the georeferencing rationale
- **S** – **Save** your work!


2 possible locations found
powered by: GEOLocate
GeoLocate will try to do the job for you, but it's not always accurate.
GeoLocate's best guess
Explanation of why GeoLocate put this point here
All guesses listed here
Fortuna
Newburg
Eel River
Hydesville
Belleview
Rio Dell
Scotia
Riverside Park
Grizzly Creek Redwoods State Park
Lat: 40.537357
Lon: -124.060604
Uncertainty: 301 m
Parse pattern: Near CARLOTTA
Edit uncertainty
Pin here
1 km
1 mi
Google
Map data ©2020
Terms of Use
Off map.
Workbench
2 possible locations found
Georeference
Options
Draw polygon
Place marker
Measure
Locality String: Near Carlotta, near Van Duzan River
Country: UNITED STATES OF AMERICA
State: California
County: Humboldt
latitude: 40.537357
longitude: -124.060604
uncertainty: 301 m
error polygon
40.537357 -124.060604 301 Unavailable
Save To Your Application

2 possible locations found

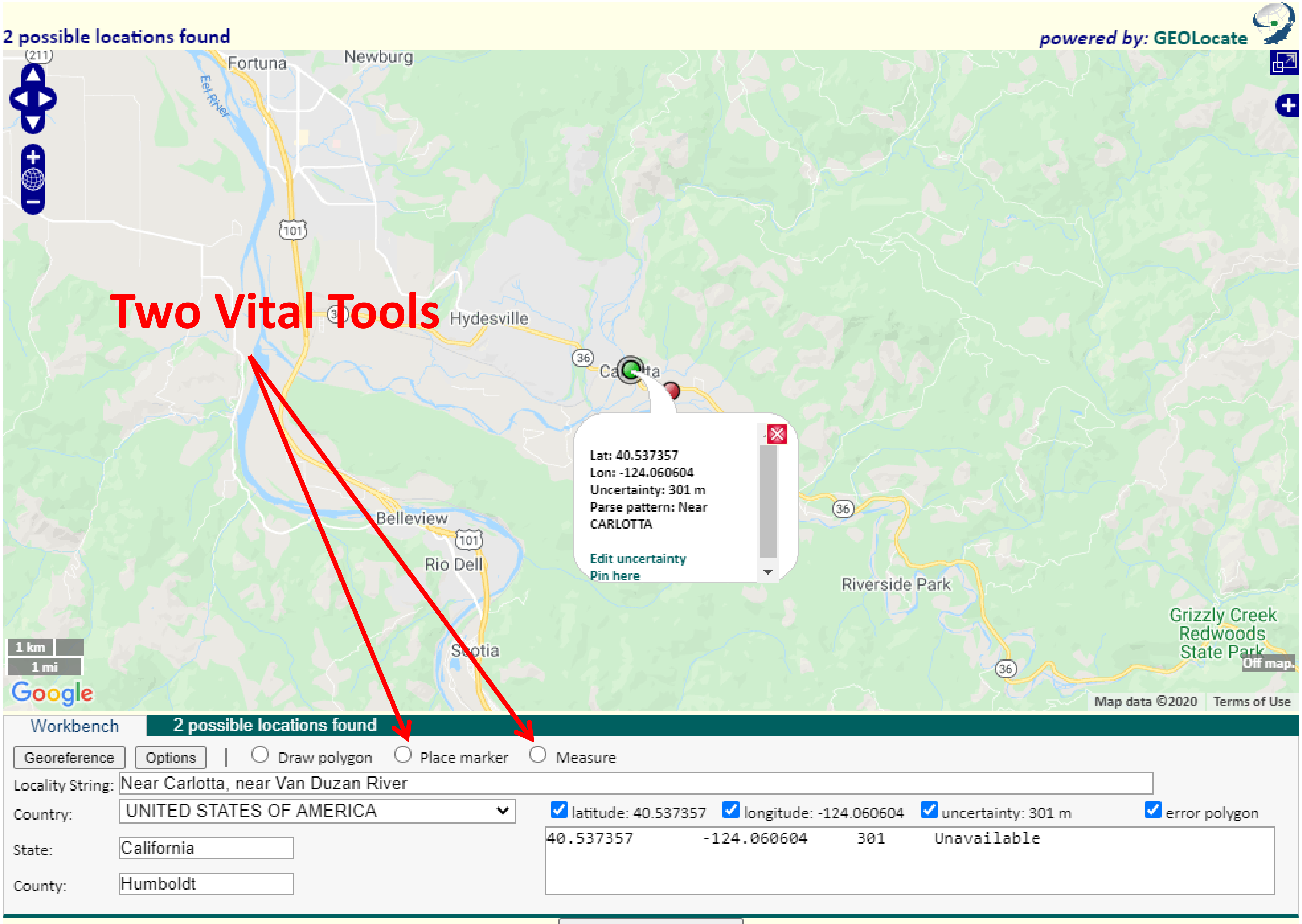
powered by: GEOLocate



Workbench | 2 possible locations found

- lat: 40.537357, lon: -124.060604, pattern: Near CARLOTTA, error polygon: Unavailable, uncertainty: 301 m, precision: Medium(53)
- lat: 40.5333, lon: -124.05, pattern: Near CARLOTTA, error polygon: Unavailable, uncertainty: 301 m, precision: Medium(53)

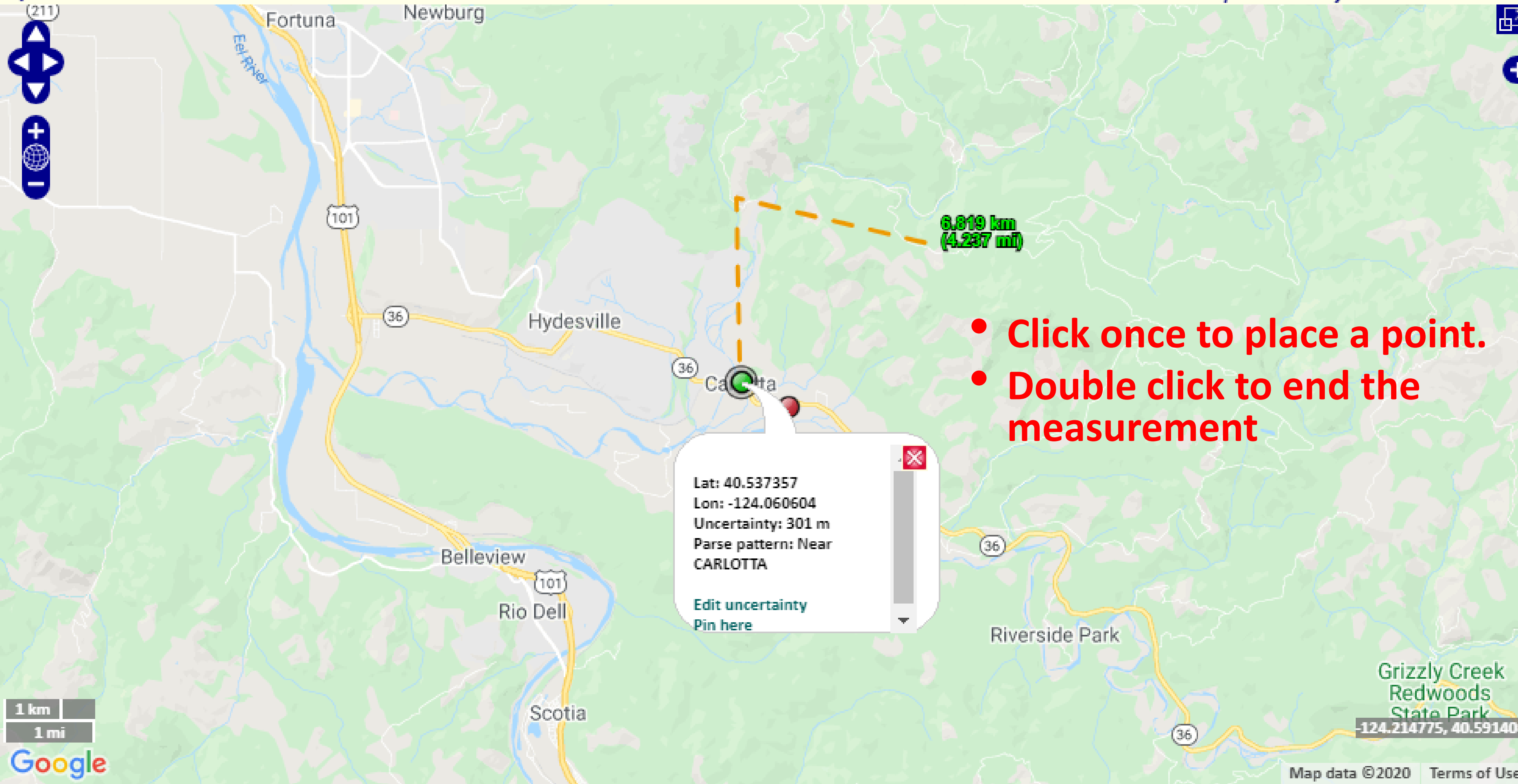
Explanation of why GeoLocate put this point here



2 possible locations found
powered by: GEOLocate
Two Vital Tools
Fortuna
Newburg
Eel River
Hydesville
Carlotta
Lat: 40.537357
Lon: -124.060604
Uncertainty: 301 m
Parse pattern: Near CARLOTTA
Edit uncertainty
Pin here
Belleview
Rio Dell
Scotia
Riverside Park
Grizzly Creek Redwoods State Park
Off map.
1 km
1 mi
Google
Map data ©2020
Terms of Use
Workbench
2 possible locations found
Georeference
Options
Draw polygon
Place marker
Measure
Locality String: Near Carlotta, near Van Duzan River
Country: UNITED STATES OF AMERICA
State: California
County: Humboldt
latitude: 40.537357
longitude: -124.060604
uncertainty: 301 m
error polygon
40.537357 -124.060604 301 Unavailable
Save To Your Application

2 possible locations found

powered by: GEOLocate



- **Click once to place a point.**
- **Double click to end the measurement**

Workbench | 2 possible locations found

Georeference | Options | ○ Draw polygon ○ Place marker ○ Measure

Locality String: Near Carlotta, near Van Duzan River

Country: UNITED STATES OF AMERICA

☑ latitude: 40.537357 ☑ longitude: -124.060604 ☑ uncertainty: 301 m ☑ error polygon

State: California

County: Humboldt

40.537357 -124.060604 301 Unavailable

Examples by Category

**** Remember: The uncertainty or error radius will also depend on the locality type**

BOUNDED AREA

Examples:

- "Las Vegas"
- "Atascadero"

Coordinates

Estimate the geographic center of the boundaries of the area. If the center does not fall within the boundaries of the area, find the smallest enclosing circle that contains the entire feature, but has its center on the boundary of the feature.

Error radius

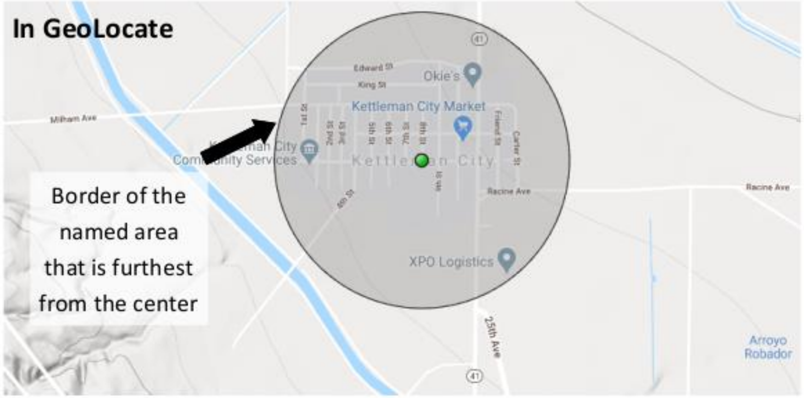
Measure distance from center of named feature to border of the named area that is furthest from the center.

CAUTION!

Some bounded areas are too large to georeference. Do not apply coordinates to county-level descriptions or larger.

Example:

"Kettleman City"



UNBOUNDED AREA

Examples:

- "Hoosier Pass"
- "Hills south of Los Osos"

Coordinates

Use visual evidence on a (topographical) map to determine the approximate center of the named place/feature.

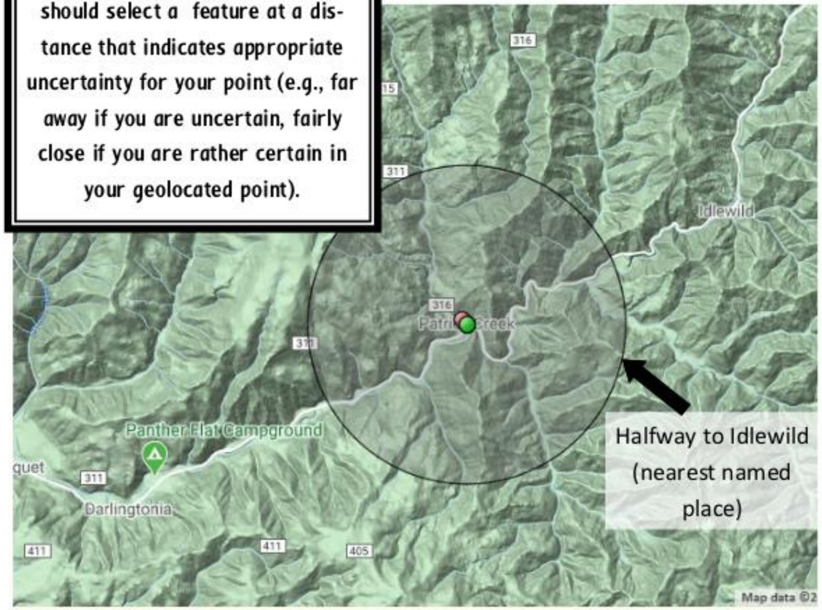
Error radius

Use half the measured distance from the selected coordinates to the center of the nearest named place (that is outside the rough area encompassed by the unbounded, named place)

CAUTION!
Selecting the nearest feature for the error radius can be tricky! You should select a feature at a distance that indicates appropriate uncertainty for your point (e.g., far away if you are uncertain, fairly close if you are rather certain in your geolocated point).

Example:

"Patrick Creek area"



STREET ADDRESS

Examples:

- "1 Orchard Lane, Berkeley, CA"
- "319 Stadium Dr., Tallahassee, FL"

Coordinates

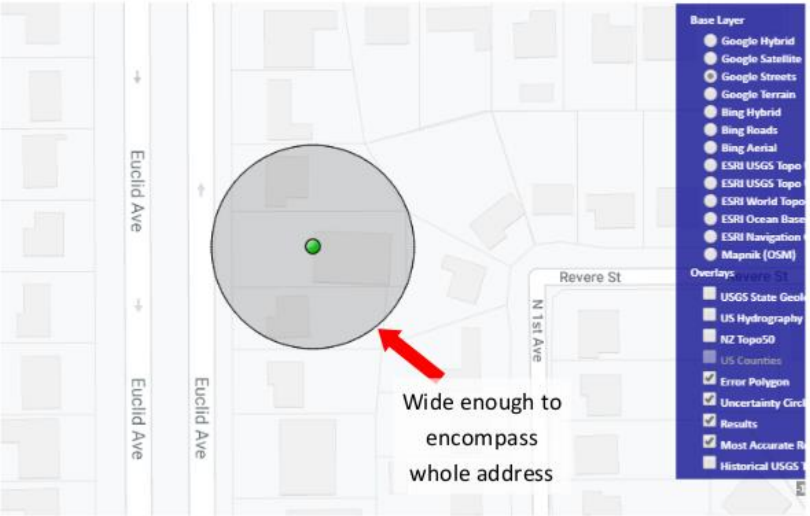
Locate the address using, e.g. Google maps

Error radius

Use half the measured distance from the coordinates to the address on either side of the given address, or as far as necessary to encompass the whole address/parcel. If the address is too difficult to determine, use half the distance to the further end of the block.

Example:

"at 2270 N. Euclid in Upland, at residence"



JUNCTION, INTERSECTION, CROSSING

Examples:

- "junction of Coora Rd. and E Siparia Rd."
- "bridge over Willamette River "

Coordinates

Use the coordinates of the center of the intersection.

Error radius

Use satellite or aerial images to find the extent of the intersection by measuring the distance from the center to the furthest part of it. If this is not possible, use the number of lanes of the larger of the two roads and multiply by 4 meters. If the locality is "near" the intersection, use half the distance to the nearest intersection or feature, whichever is less.

Example:

"near intersection of Meissner Rd and S Higuera St"

RIVER, STREAM, ROAD, PATH

Examples:

- "Sacramento River "
- "Los Osos Valley Road"

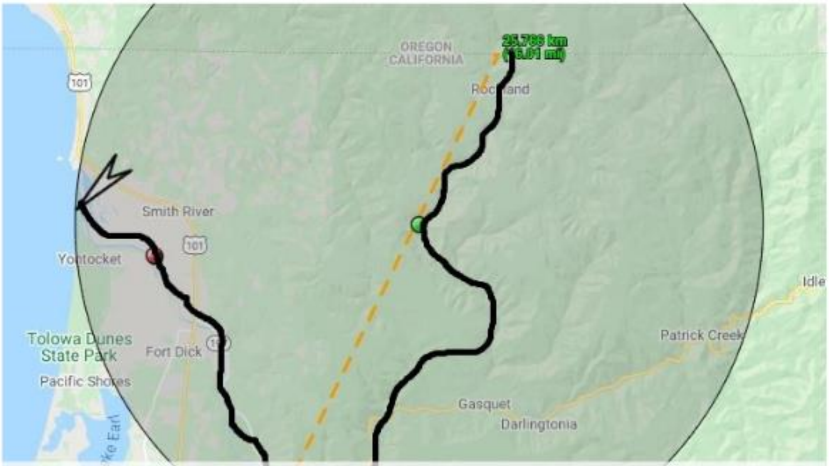
Coordinates

Make a straight line between the two points on the geographic feature that are most removed from each other, yet still within the administrative boundaries (e.g., county) specified in the locality description. Choose the point on the feature nearest to the midpoint of the line.

Error radius

Use one of the ends of the straight line that you made between the two points on the geographic feature that are most removed from each other, yet still within the specified administrative boundaries

Example: "California, Del Norte County, Smith River"



The black line shows the path of the Smith River. The dashed yellow line shows the "straight line between the two points on the geographic feature that are most removed from each other." Since the midpoint of the line is not on the river, we find the point on the river closest to the midpoint of the line. Then the error radius extends to the furthest end point of that river (grey arrow).

MOUTH/HEADWATERS OF RIVER, CONFLUENCE OF WATERWAYS, TRAILHEAD

Examples:

- "headwaters of the Missouri River "
- "Triangle Lake Trailhead"

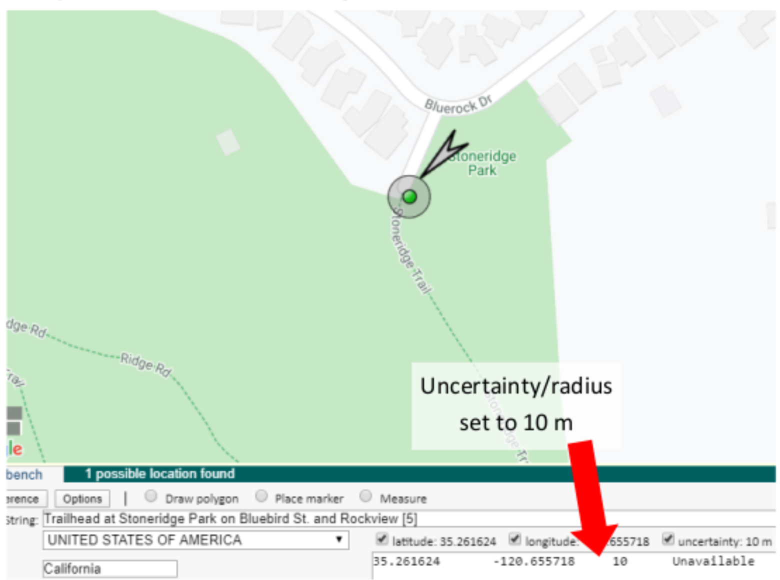
Coordinates

For a river mouth or confluence of waterways, select the midpoint of the line connecting the opposite shores where the waterways meet. For a river source, select the point of highest elevation on the river or create a boundary around the multiple streams contributing to the river and find the geographic center of that bounded area. For a trailhead, select the point where the trail begins.

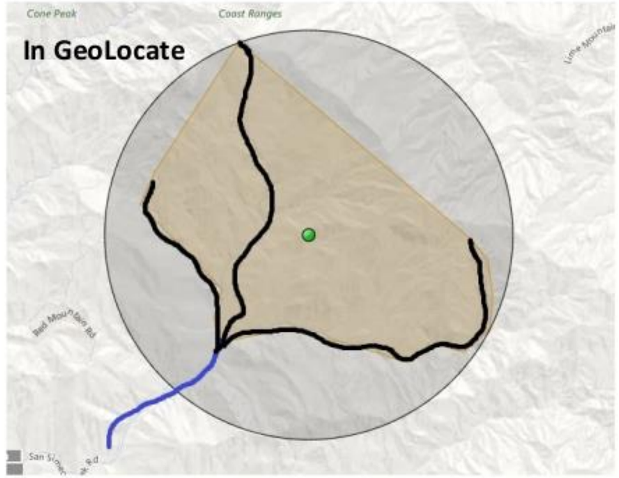
Error radius

For a river mouth or confluence of waterways, use the distance from the chosen point to the shore. For a single river source or trailhead, use 10 m.

Example 1:"Trailhead at Stoneridge Park on Bluebird St. and Rockview"



Example 2: "at headwaters of San Simeon Creek"



The blue line is San Simeon Creek, but the black lines are named forks of the San Simeon Creek. Since we don't know which one is referred to here, we draw a polygon to encompass all of the forks and adjust the radius accordingly. The marker is placed at the midpoint of the polygon.

Example 3: "mouth of Osos Creek"

Here's a case in which the reality is more complicated than the protocol makes it out to be. It's easy to pinpoint the mouth of the creek on a street map....

Google Satellite

...but not so much on a terrain map. Because the creek drains to a marshy area, here we chose to place the dot close to the "street maps" mouth of the creek, then use the uncertainty radius to indicate how uncertain we are about the collector's true meaning.

NEAR A NAMED PLACE

Examples:

- "vicinity of Mt. Hood"
- "near Sacramento"

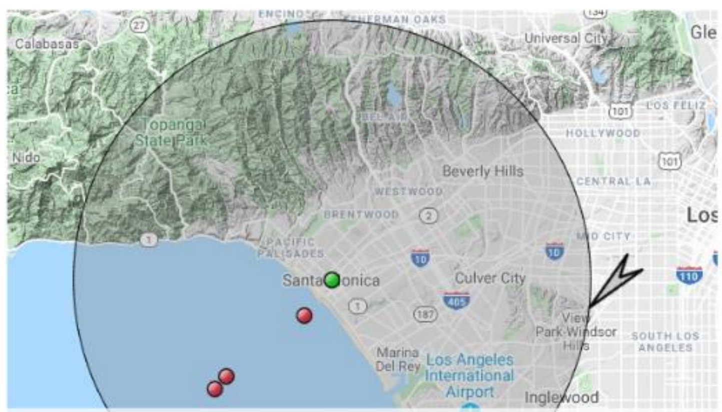
Coordinates

Determine the coordinates as either a BOUNDED AREA or UNDEFINED AREA, as appropriate.

Error radius

Determine the distance as either a Bounded area or Undefined area, as appropriate. Be generous in the size of this error radius (i.e., err on the side of making it larger than usual) since "near" and "vicinity" indicate a high level of uncertainty.

Example: "near Santa Monica"



Because this is a very vague locality description, we have to be very careful about how we indicate our uncertainty, which might require some extra research. From the record label, we found that the specimen was collected in 1891 and that the specimen was collected on "grassy hills". Looking at the terrain map, we see some hills outside the bounded area of Santa Monica. Combined with this and the fact that the surrounding named places might not have existed in 1891, we will be generous with our error radius here.

BETWEEN TWO PLACES

Examples:

- "between Atascadero and San Luis Obispo"
- "between Sacramento River and Main"

Coordinates

Use the midpoint between the centers of the two named places.

Error radius

Use half the distance between the centers of both named places.

Example: "between Mendota and Coalinga"

DIRECTION ONLY, NO DISTANCE

Examples:

- "N of Berkeley"
- "SW of Gainesville"

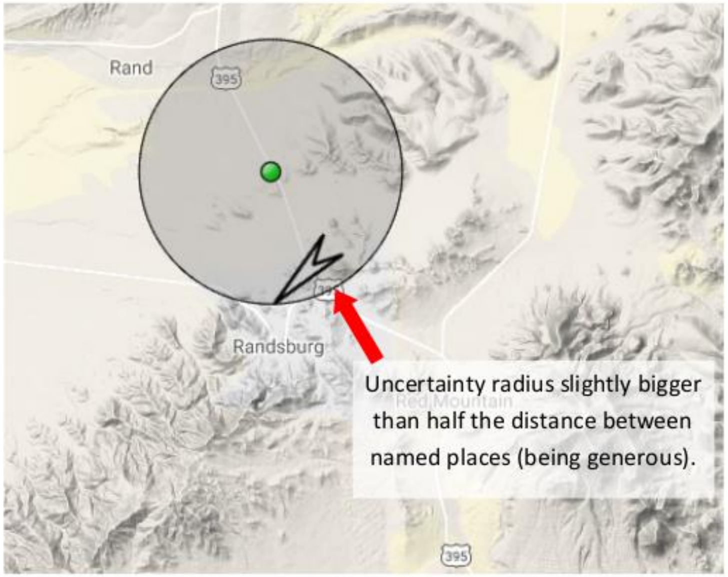
Coordinates

Use the midpoint between the centers of the specified feature and the nearest named feature, where the nearest named feature to use is in the specified direction. The nearest named feature should be, for the first example, the nearest named place somewhere between NW and NE of Berkeley.

Error radius

Use half the distance between the centers of both features. Be generous in the size of this error radius (i.e., err on the side of making it larger than usual) due to the high level of uncertainty.

Example: "N of Randsburg"



DISTANCE IN UNNAMED DIRECTION

Examples:

- “5 km outside Calgary ”
- “2 mi from Cambria”

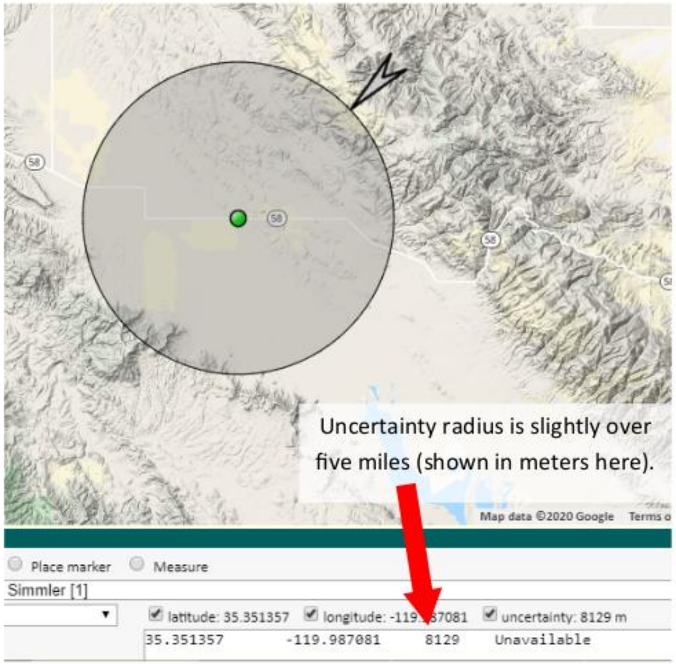
Coordinates

Determine the coordinates as either a BOUNDED AREA or UNDEFINED AREA, as appropriate.

Error radius

The length of the radius should be the same as the distance given in the locality description

Example: “5 mi from Simmler”



SPECIFIED DISTANCE IN A DIRECTION, NO PATH GIVEN

Examples:

- "50 miles W of Las Vegas"
- "3 km E of Sacramento"

Coordinates	
	Find the center of the named feature and measure the provided distance in the direction provided in the locality description.

Error radius	
	Use half the measured distance from the selected coordinates to the center of the nearest named feature. Make note of the named feature that you measured to in the "Georeference Remarks" or "Remarks" field.

Example 1:"7 mi N of Freeman Junction"

SPECIFIED DISTANCE IN A DIRECTION, PATH GIVEN

Examples:

- "7.9 mi N Beatty, on US 95"
- "7 mi. W Santa Barbara on 101 "

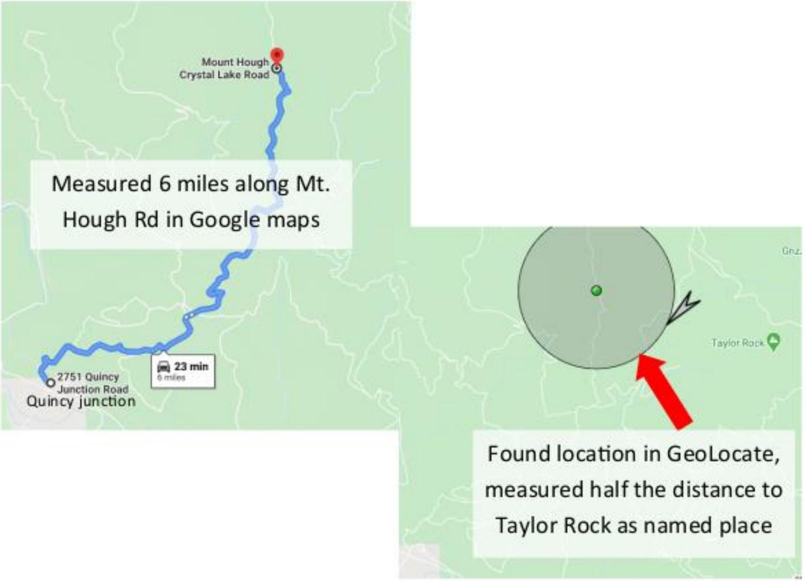
Coordinates

Find the geographic center of the named feature as either a Bounded area or Undefined area, as appropriate. Use the measuring tool to follow the specified route for the given distance. Use the end point as the coordinates.

Error radius

Use half the measured distance from the selected coordinates to the center of the nearest named feature. Make note of the named feature that you measured to in the "Georeferencing Remarks" or "Remarks" field.

Example 1:"Mt. Hough Rd, 6 mi N of Quincy Junction"



Default geographic radial (formerly “extent”) to use per Feature Type

Table 1. List of feature types and the default geographic radial to use. If the feature type you are looking for isn't on the list, use one that is most like the feature type you seek and be sure to document your choice

Feature Type	Default geographic radial
spring, bore, tank, well, or waterhole	3 m
small stream	3 m
two-lane city streets, two-lane highways intersections	10 m
four-lane highways intersections	20 m
highway intersection, unknown type	15 m
PLSS Township	6828 m
PLSS Section	1138 m
PLSS ¼ Section	570 m
Grid (e.g. UTM), 1 m precision	1 m
Grid (e.g. UTM), 10 m precision	7 m
Grid (e.g. UTM), 100 m precision	71 m
Grid (e.g. UTM), 1 km precision	707 m
Grid, ¼ degree precision (at equator)†	39226 m

† Grids based on geographic coordinates, such as Quarter Degree Squares, are not square, nor are they constant. They vary in size and shape by latitude. See table in Uncertainty Related to Coordinate Precision in Georeferencing Best Practices (Chapman & Wieczorek 2020).

GBIF Quick Georeferencing Guide:
https://docs.gbif.org/georeferencing-quick-reference-guide/1.0/en/

GENERAL TIPS AND TRICKS

- **Always** explain your choice of coordinates and uncertainty radius estimation using the Georeference Remarks fields. This makes the data more reproducible and verifiable.
- Look for additional information in the **habitat** and **elevation** fields that may help you find the specific locality of a specimen. For example, knowing that a specimen was collected at 1000 ft. with "NE exposure" can help you understand which side of a mountain/hill the specimen was collected on.
- Not all specimens are georeference-able! If there is considerable uncertainty about a location, or if the locality data is suspect or potentially flawed/incomplete, make a note of the uncertainty in Georeference Remarks and do not apply coordinates to the record.
- Some areas are too large to georeference. Do not georeference areas to the county level or with an uncertainty radius of 8000m or greater.
- A **feature** is a geographical or political feature, such as a mountain or city, that has a name on a map.

References:

Wieczorek J, Guo Q, Hijmans RJ. 2004. The point-radius method for georeferencing locality descriptions and calculating associated uncertainty. International Journal of Geographical Information Science. 18(8):745-767.

Zermoglio PF, Chapman AD, Wieczorek JR, Luna MC, Bloom DA. 2020. Georeferencing quick reference guide [community review draft]. Version b5a20b5.

More General Tips and Tricks

Regarding **Accuracy**: “The true value is not known, but only estimated; the accuracy of the measured quantity is also unknown. Therefore, accuracy of coordinate information can only be estimated.” (Geodetic Survey Division 1998, quoted in Georeferencing Quick Reference Guide, Zermoglio, PF et al., 2002, Version 4ac9d96)

Basic Steps:

1) Determine what the “Feature” or “Named Place” is
2) Determine the “geographic radial” of the feature (formerly, the “extent”). **NOTE: remember to use a “nearest feature” or “nearest named place” of a similar scale or class as the one mentioned in the locality, when calculating the radial**
3) The uncertainty radius cannot be smaller than this radial

“Corrected Center”: the point within a location that minimizes the geographic radial that encloses the entire feature.

More often than not, **original (provided) coordinates are used to find the general vicinity** of the location on a map, after which the process of determining the **corrected center provides the new coordinates.**

General Tips and Tricks

Regarding **GPS:** "We recommend using a value that is at least TWICE the value given by the GPS unit at the time the coordinates were captured. If unknown, enter 100 m. for handheld units prior to 2000-05-01 (when Selective Availability was discontinued), or 30 m. (a conservative default value) after that date.

GPS coordinates do not substitute a good locality description.

Uncertainty radius should be large enough to ensure (95% ~ 100%) that the locality is located within. **When in doubt, it's better to be generous/conservative. (new georeferencers tend to make uncertainty radii too small).**

"Try to get into the mind of the person who recorded the locality." What is "reasonable"? "Assume nothing!" – but if you do, then document rationale in the georeferenceRemarks field.

Remember that different features on a map will be visible at different scales, and/or not all maps will show the same features. You may need to really zoom in to find what you're looking for.

General Tips and Tricks

For quality georeferences, prefer (in this order):

1) Original collector
2) Someone who is familiar with the locality and has boots-on-the-ground experience
3) Detailed field notes by the original collector
4) Label data, which tends to be scant

Quality of the georeferences will depend on:

1) Quality and amount of locality data available
2) Quality of resources (contemporary maps and field notes) available
3) How persevering/dogged the georeferencer is
4) How much time the georeferencer is willing/able to spend

"Sleuthing" will be required, but try not to spend too much time on a single locality (can "flag it" with controlled vocabulary and come back to it later).

General Tips and Tricks

Do not despair if you’re just starting to georeferenced localities in an area that is unknown to you. Georeferencing is a bit like putting together a jigsaw puzzle, and the more you “stare” at the map, the more you will become familiar with it, and the easier it will become (new localities will “click” in your brain, since you’ve seen them before).

Non-exhaustive list of resources

https://www.geo-locate.org/web/webcomgeoref.aspx (GeoLocate CoGe)
https://www.youtube.com/watch?v=h1JfJuSC-eg (Georeferencing in CoGe, CCH2)
https://docs.gbif.org/georeferencing-quick-reference-guide/1.0/en/
https://docs.gbif.org/georeferencing-best-practices/1.0/en/

earth.google.com

nationalmap.gov (GNIS)

earthpoint.us

gpsvisualizer.com

maps.lib.utexas.edu (Perry-Castaneda Map Library at UT-Austin)

www.bl.uk/collection-guides/digital-mapping (British Library)

Tarrant County Plat Maps
https://tad.maps.arcgis.com/apps/mapviewer/index.html

Acknowledgments

Most of the material in this presentation was graciously provided by **Katelin D. Pearson** of the Symbiota Support Hub, who created it for Georeferencing Training during her time as Project and Data Manager with the **California Phenology Network TCN** and the **CCH2** Portal. Thank you!

Georeferencing in CCH2 Training Course (capturingcaliforniasflowers.org)

Another huge thanks goes to **Nelson Rios**, creator of **Geolocate**, for the creation of that georeferencing platform and for the corresponding training videos on Vimeo:

GeoLocate Basics
https://vimeo.com/showcase/2163673/video/65222791

Batch Processing Using GeoLocate
https://vimeo.com/65222618

Last but not least, thank you to **Miranda Zwingelberg** (GLOBAL TCN Project Manager) and **Julie Smith** (GLOBAL TCN Georeferencing Manager) for helpful discussions and advice on setting up a collaborative georeferencing project.

Epilogue

WHAT THE NUMBER OF DIGITS IN YOUR COORDINATES MEANS

LAT/LON PRECISION	MEANING
28°N, 80°W	YOU'RE PROBABLY DOING SOMETHING SPACE-RELATED
28.5°N, 80.6°W	YOU'RE POINTING OUT A SPECIFIC CITY
28.52°N, 80.68°W	YOU'RE POINTING OUT A NEIGHBORHOOD
28.523°N, 80.683°W	YOU'RE POINTING OUT A SPECIFIC SUBURBAN CUL-DE-SAC
28.5234°N, 80.6830°W	YOU'RE POINTING TO A PARTICULAR CORNER OF A HOUSE
28.52345°N, 80.68309°W	YOU'RE POINTING TO A SPECIFIC PERSON IN A ROOM, BUT SINCE YOU DIDN'T INCLUDE DATUM INFORMATION, WE CAN'T TELL WHO
28.5234571°N, 80.6830941°W	YOU'RE POINTING TO WALDO ON A PAGE
28.523457182°N, 80.683094159°W	"HEY, CHECK OUT THIS SPECIFIC SAND GRAIN!"
28.523457182818284°N, 80.683094159265358°W	EITHER YOU'RE HANDING OUT RAW FLOATING POINT VARIABLES, OR YOU'VE BUILT A DATABASE TO TRACK INDIVIDUAL ATOMS. IN EITHER CASE, PLEASE STOP.

“Coordinate Precision,” https://xkcd.com/2170/