

**John Carnes**  
John@MapTools.com

MapTools.com  
Wilderness Navigation Instructor, West Valley College  
Search and Rescue Volunteer

Popocatepetl, outside of Mexico City, 1990ish





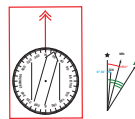
## 20 years ago...



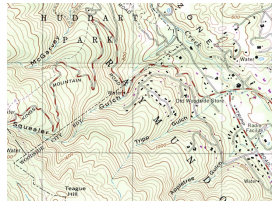
Maps from USGS, USFS, BLM. Maps would be hard to acquire, might be quite old  
They tended to be reliable and accurate. Paper was the only medium

## The issues were...

- Can I find the maps I need? 7.5 min or 15 min?
- How old will they be?
- What compass do I use?
- Should I adjust my compass for magnetic declination?
- Do I fold my maps? How?



Now...



Maps - Proliferation of map sources. Entering the age of desktop mapping, where small organizations and individuals can make maps. Some maps are excellent, some dangerously bad.

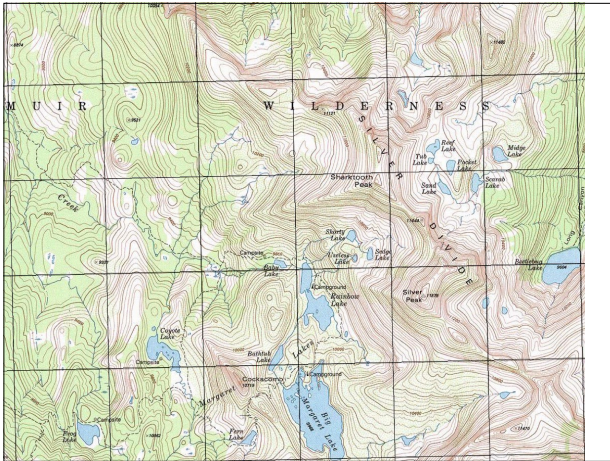
There are more mediums than paper for maps. Some are still a bit “scary”

GPS - The best way to answer the “Where am I?” Requires some new concepts and skills

Still faces a good bit of resistance from traditionalists



Knowledge, Experience, Paying attention



Sheet music of navigation. Takes some skill to read. Allows use to go to new places and to plan ahead.



Best way to answer “Where am I?”

Works in the dark, in a whiteout, in a deep forest, all places where it would be difficult to use your compass to answer “Where am I?”

I still run into folks that say “GPS Can’t be trusted.” My answer is this analogy...

**Just because a car could breakdown,  
is no reason to only use a horse and buggy.**



**But it is a good reason  
to not forget how to walk.**



Now it gets hard – compass or altimeter?



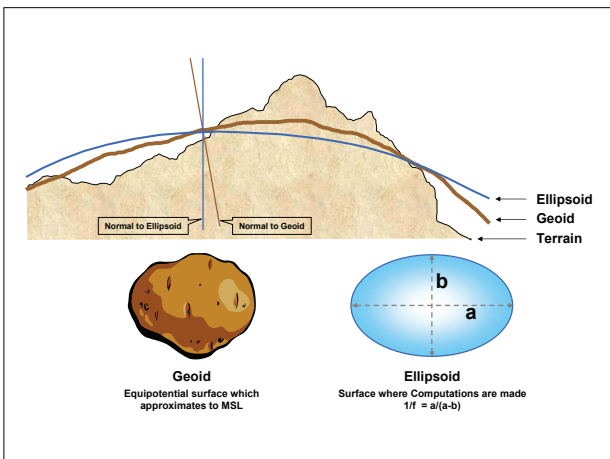
### Altimeter

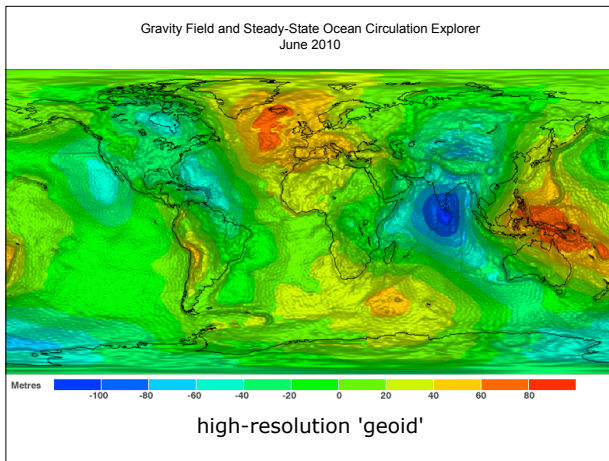
We are peak baggers, so we're addicted to altitude.

Combined with a map, and some knowledge of where you are on the mountain, it's a good way to answer "Where am I?"

Needs to be regularly calibrated at known elevations, especially with changing weather.

Why is the GPS altitude reading different?





World wide there is about a 200m (600ft) difference between geoid and ellipsoid elevations. In North America, we see a 40–60 meter difference. On a given trip, the difference is mostly a constant. You can “calibrate” by knowing the difference.



Perhaps this is why you came tonight. To see if I am brash enough to tell you to leave your compass home. Maybe I am... First a review of what a compass is good for...

### Orientation to the Cardinal Directions

- The cardinal directions  
North , South, East and West

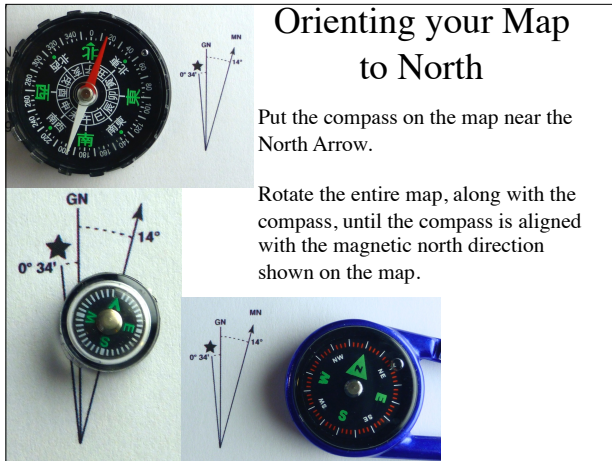
The image shows a standard magnetic compass on the left and a simple cross diagram on the right. The cross diagram has 'N' at the top, 'S' at the bottom, 'E' on the right, and 'W' on the left.

North (and east and west if you're dyslexic about which is which.)  
Most of the time you can get close enough without a compass

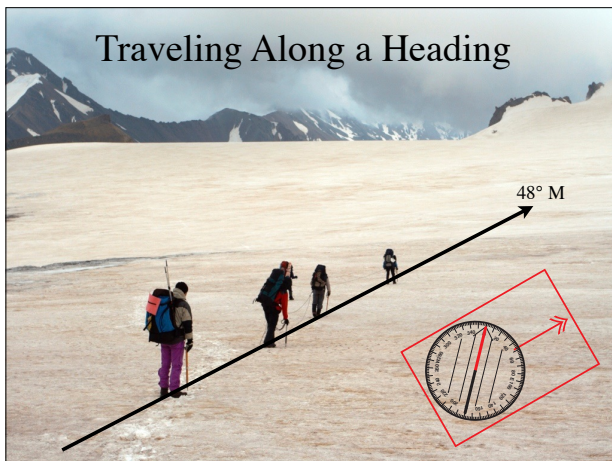
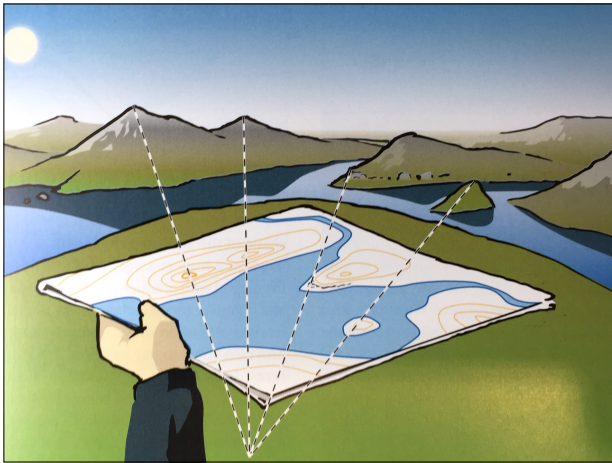
## Orienting your Map to North

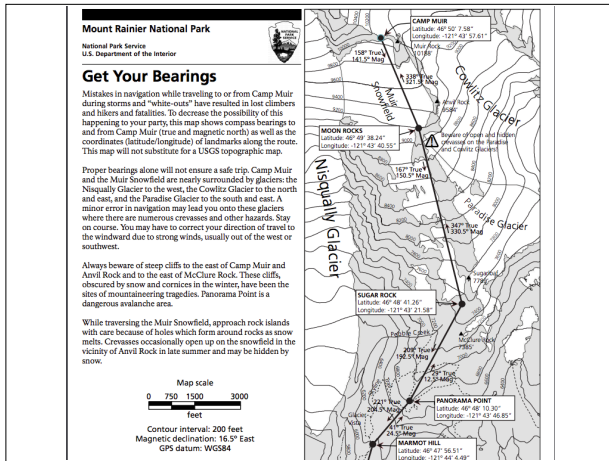
Put the compass on the map near the North Arrow.

Rotate the entire map, along with the compass, until the compass is aligned with the magnetic north direction shown on the map.



Vitally important, but again you can get close most of the time, without a compass

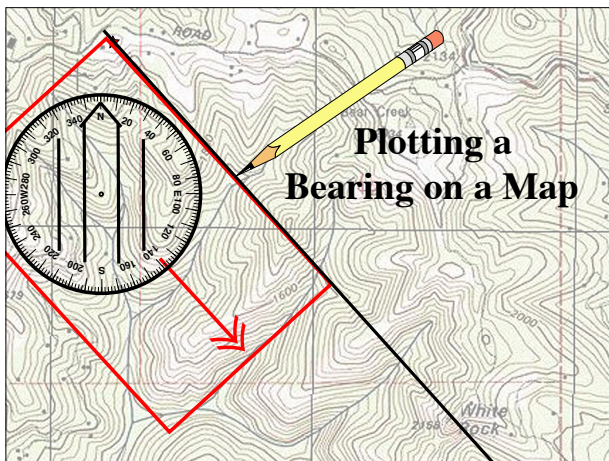




Mt Rainier, Camp Muir decent in a blizzard.  
Now days there are GPS coordinates for the key waypoints  
I can't imagine futzing with my touch screen smart device in those conditions. But I think I could have used a GPSr if it was set up in advance.

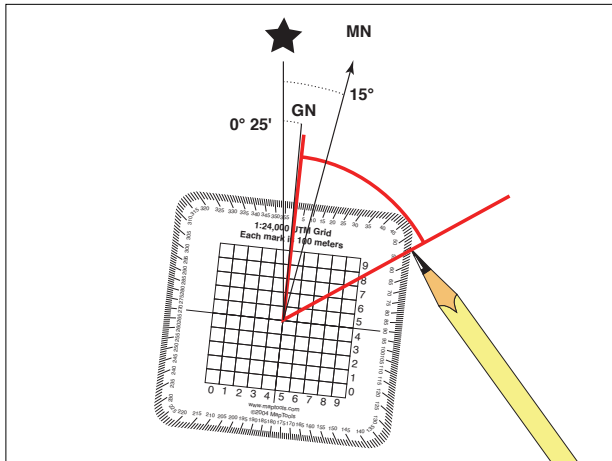


Answering "Where am I?" – Bearings sighted on known landmarks and plotted on a map



Using the compass as a protractor





Get a plastic protractor – no moving parts, much less likely to make an error.



The placebo effect – I've got a compass. I'll be ok.

## A quick survey...

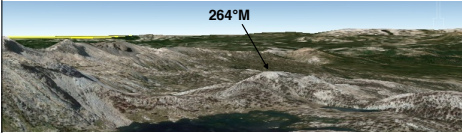
- Raise your hand if you are completely sure that you could:
  - Sight bearings on distant objects
  - Convert the north reference
  - Plot the bearings on a map and locate yourself with the intersecting lines.
- How many times have you relied on this technique as an important aspect of actual navigation? Don't include the times you were just teaching someone else how to do it.

You are somewhere east of Big Margaret Lake.  
Plot some bearings to find your exact location

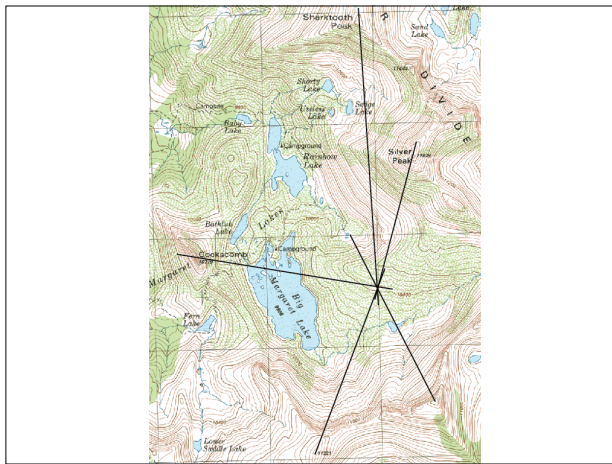
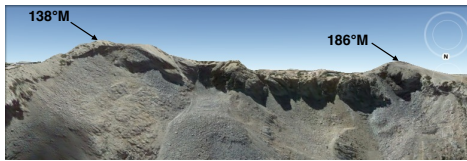
View North



View West



View South



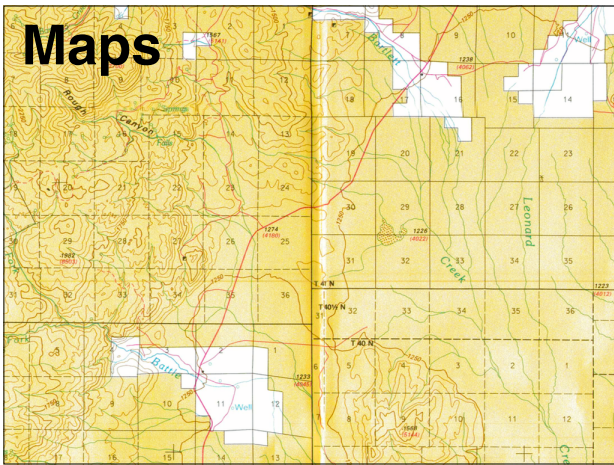
Maybe all you need is a zipper pull compass?

Maybe all you need is a zipper pull compass?

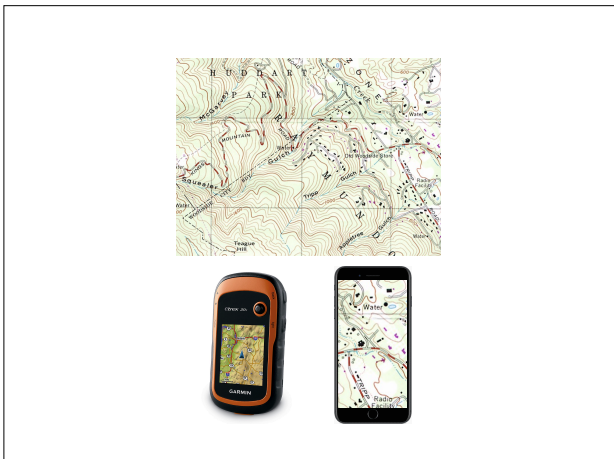




Denali



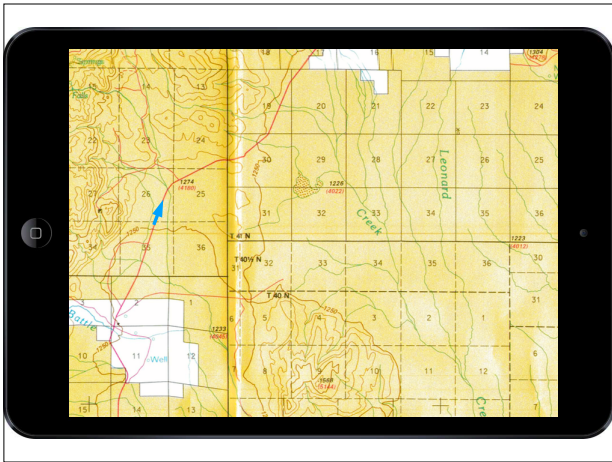
Let's go back to our maps



Today you are as likely to download your maps from the internet in a digital format than you are to buy a map on a sheet of paper. You will also have to decide if you will carry your maps into the field on a digital device, and if you will also carry paper maps as well.



Most of my trips have some component of “driving to the trailhead”. For me that often involves dirt roads on BLM or forest service land.



I like having a tablet with the BLM or forest service map on the display, with the tablets GPS keeping the map centered on my position



The trip I've used as an example, was a week long trip to the Black Rock Desert in NW Nevada. June 2015

## Maps



- It takes 3-6 BLM 30' x 1° 1:100,000 maps to cover the area I planned to visit.
- There are 32 7.5' 1:24,000 scale maps for each BLM sheet.
- I decided to just preload the BLM maps.
- But all I could get were folded paper copies:
- Kinko's Office to scan
- Georeferenced by hand
- Loaded onto my iPad as GeoPDFs

You must load all of the maps you need in advance.  
You're not likely to be able to download map data in the field.  
It can be a lot of maps. You can drive across a BLM 1:100k map pretty quickly.  
Don't even try to use the 1:24,000 maps for the driving part.



High Rock Canyon

## Apps

- Avenza PDF Maps 
  - Moving map, with track recording
  - One map at a time (when I did this)
    - They now have map collections feature
  - Free version limits you to 3 of your own maps.
- Gaia GPS 
  - Able to pre-load some 1:24,000 map data.
  - Little support for smaller scale maps
  - I seldom had enough map data



One of the many hot springs.

## Power and Battery

- I was mostly driving on back roads. Still I had trouble keeping the iPad charged.
- Know your charging system
  - Ignition switched?
  - USB Adapter Current rating?
  - The “right” cable
- Know your phone and GPS settings
  - Airplane mode.
  - Dim the screen
  - No GPS until activated
  - Disable location service for other apps

Even in the power rich and climate controlled cab of my truck, keeping the iPad going can still be a challenge.

Continuous use of the GPS and display is a power hungry mode of operation.

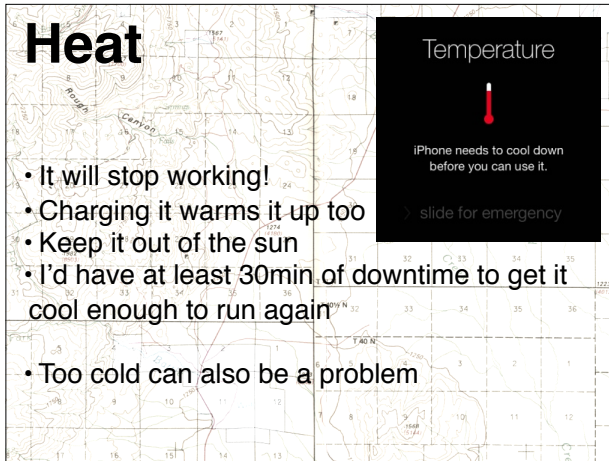
Know your charging tools. Don't get stuck with an adapter or cable that can't provide the maximum charging current.

Find a power jack that works when the ignition is off.

If you're camping, and using your vehicle to keep all of your digital stuff charged, be careful that you leave enough juice to get the vehicle started again.



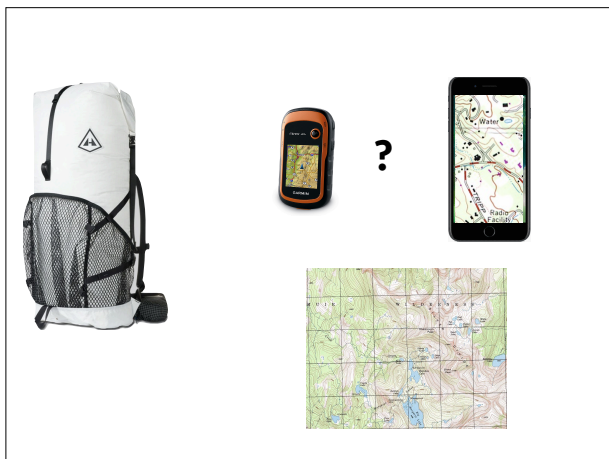
# Heat



- It will stop working!
- Charging it warms it up too
- Keep it out of the sun
- I'd have at least 30min of downtime to get it cool enough to run again
- Too cold can also be a problem

Heat can be a problem

Add some desert heat to the heat from charging and running with the GPS and display on, and you may have an unhappy device.



If it's gotta work out of my backpack

The digital device could be my GPSr or my smart phone



- It will be turned off most of the time.
- It will be on, only briefly, for position and map checks.
- It will be in airplane mode when it on.
- The backlight will be dimmed, and it will likely be in "low power use" mode
- Maps will have to be loaded before the trip.



- Reliable enough
- Tolerant of the environmental issues.
- With replaceable batteries, I'm not afraid of running out of power.
- It will also be turned off most of the time
- It's a horrible interface to a map.
- It's easy to have a small scale state maps
  - You can load larger scale maps,
  - but you choices, sources and storage are limited.
- Garmin is not Apple.
- Don't expect the UI to be as nice.

## Maps Purchased on Paper



USGS, BLM, USFS seem to be harder and harder to come by.

Good alternatives from commercial map publishers

Nat Geo Trails Illustrated, Tom Harrison, etc.

Outdoor retailers like REI, and online retailers like Amazon are good sources

MyTopo.com will custom print maps based on the USGS 7.5 minute series for you.





mytopo.com

Printed & Online Topo Maps,  
Aerial Photos, TopoPhotos, and Hunting Maps

Step 2: Build your map

Select a Base Map

- Topo Maps
- Show 1995 quad grid
- Standard Aerial
- Premium Satellite
- Hybrid Topo/Photo

Add Premium Overlays

- Private Property Lines
- Public Land Boundaries
- Public Land Roads

Choose Map Area

Paper Size

24" x 36"

Paper Orientation

Wide  Tall

Map Zoom

1:24,000 USGS Standard

View a full map preview

See the full detail of your map

before you order.

[Preview now >](#)

[Continue to Step 3 >](#)

[< Back to Step 1](#)



Step 3: Choose map finish

Waterproof "Outdoor" Map

MyTopo waterproof maps are printed with UV fade-resistant and waterproof inks on a special waterproof and tear-resistant paper. Waterproof maps are available rolled or folded for rugged outdoor use.

\$14.95

Folded  Rolled

Laminated Map

Full-seam laminated map printed with UV fade-resistant inks. The lamination protects the map from water and dirt and is writable/erasable with standard dry-erase markers. Available rolled.

\$29.95

[< back to step 2](#)

[Continue to Step 4 >](#)

**Step 4: Personalize**

**Title and Subtitle**  
 You can personalize your myTopo.com map with your own title and subtitle.

Title:   
Please do not use an ampersand "&" in your customized titles, subtitles, and owner names.

Subtitle:

**Owner's Name**  
 We'll print your name (or a friend's) on your map as the "map owner". You do not have to provide an owner name... we'll just leave it blank for you.

Owner's Name:

**Navigational Grids**

**Lat/Lon**  
 Lat/Lon grids are in degree/minute/second coordinates.

No Grid  Tic Marks  Full Grid Lines




**UTM / MGRS (Military Grid) / USNG (US National Grid)**  
 UTM/MGRS grid spacing 1000 meters.

No Grid  Tic Marks  Full Grid Lines

**Datum/GPS Setting**  
 Choose the navigation grid to match your GPS. Note that most GPS devices default to WGS84/WGS84, so you only need to change this setting if you're using older NAD27 coordinates.

**Shaded Relief**

Standard topo, no relief shading  Enhanced topo, add relief shading

## Downloading Maps with the intent to print them

CalTopo.com  
 AvenzaMaps.com  
 USGS "The National Map"

[CalTopo.com](http://CalTopo.com) - My current favorite pdf topo map source. Free option is good enough for most folks.

[AvenzaMaps.com](http://AvenzaMaps.com) - Full sheet geoPDFs of wide variety of maps some free, some for sale. A bit tricky to print. Great for use in their app.

USGS "The National Map" - Full 7.5 minute quads as geoPDFs. Follow their instruction to print on letter sized sheets.

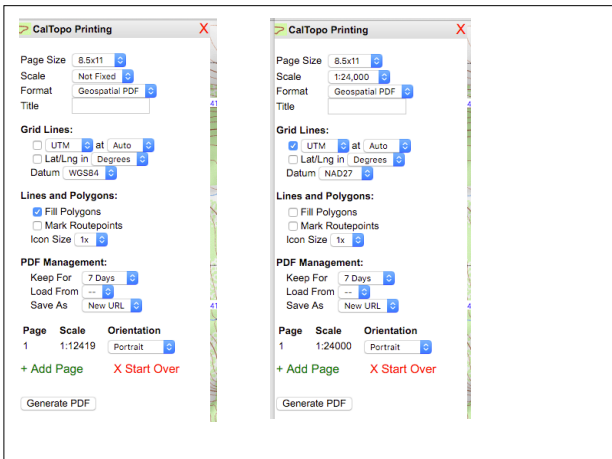
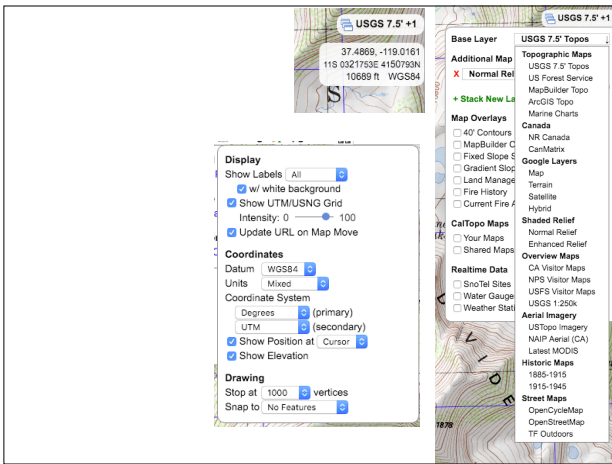
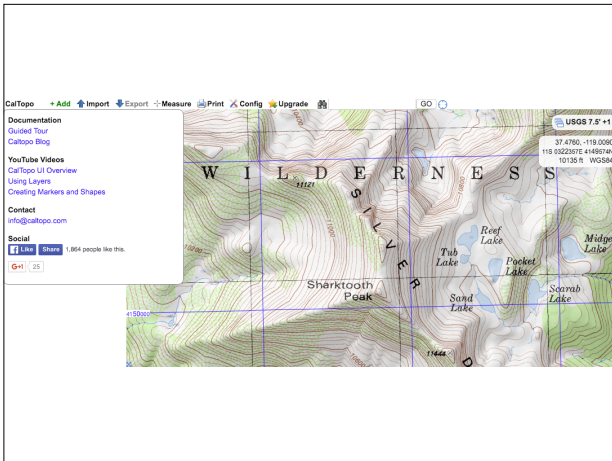
[CalTopo.com](http://CalTopo.com)



- Matt Jacobs  
 – BAMRU

**Membership Types**

	Free	Basic	Pro
Cost	--	\$20/yr	\$50/yr
Private Maps <small>(get them as private maps)</small>	5	20	200
Largest PDF Size	8.5x11	13x19	36x48
PDF Page Limit <small>(8.5x11 1000, 13x19 2000)</small>	5	15	40
Keep PDFs For	7 days	30 days	1 year
KMZ Images	16	50	200
MBTiles Images <small>256x256 px</small>	256	800	3200
KML Super-Overlays	No	Yes	Yes
WMS/WMTS Access	No	No	Yes
Custom MapBuilder Layers	No	No	Yes



**AvenzaMaps.com**

FIND MAPS NEAR  BY

**San Francisco and USA Maps Pack** Bookmarks  
 By: [AvenzaMaps.com](#)  
 10+ Downloads  
 Size: 448.1 MB  
 Published 2015  
[Full Details](#) [Zoom to Map](#) [Maps Nearby](#)

**Midgen Preserves (Bundle)** Bookmarks  
 By: [AvenzaMaps.com](#)  
 100+ Downloads  
 Size: 180.6 MB  
 Published 2018  
[Full Details](#) [Zoom to Map](#) [Maps Nearby](#)

**New York, San Francisco and USA Maps Pack** Bookmarks  
 By: [AvenzaMaps.com](#)  
 10+ Downloads  
 Size: 825.7 MB  
 Published 2015  
[Full Details](#) [Zoom to Map](#) [Maps Nearby](#)

**Skyline Ridge bundle** Bookmarks  
 By: [AvenzaMaps.com](#)  
 50+ Downloads  
 Size: 32.7 MB  
 Published 2017  
[Full Details](#) [Zoom to Map](#) [Maps Nearby](#)

**815 : Skyline Boulevard** Bookmarks  
 By: [AvenzaMaps.com](#)  
 50+ Downloads  
 Size: 391.6 MB  
 Published 2017  
[Full Details](#) [Zoom to Map](#) [Maps Nearby](#)

77 maps found

Map:

Map data ©2018 Google - Terms of Use - Report a Map Error

## Tips for printing

- Don't scale, or shrink to fit page.
- Beware of water soluble ink.  
(or at least take precautions.)
- Small sheets, many pages.  
I like to use 11x17 paper.

## What I look for...

- Map scale matters. I want a numeric scale ratio, preferable a common one or one that I can specify. A scale bar is good, but not enough by itself.
- Coordinates matter. I want labeled UTM Grids, the option for lat/lon grids. The map datum should be specified, bonus if I can choose between NAD27 and NAD83/WGS84.
- North reference matters. I want a declination diagram and current magnetic declination.
- Metadata matters. I care about the date of the original map, and who created it. (or what data was used to create it.)

**NATIONAL GEOGRAPHIC MAPS** PDF QUADS FREE USGS QUADS

PDF Quads **A bad example...**  
 Printable USGS PDF TOPO! Maps  
 A quick and easy way to download and print any USGS 7.5 minute topographic quad

- Sounds like you get a 1:100,000 scale index map, and letter sized 1:24,000 map sheets, but...  
 The scales are something else, there is no scale ratio, the scale varies with latitude.
- WGS 84 UTM tics, but not grid lines.
- It's just the quad sheet, no merging of adjacent sheets. (Murphy's law of maps.)
- Old declination data



My map sheets used to be precious thing to be preserved, cared for and reused  
 Now my maps are typically one time use, mark em up, and recycle them when I done.

**Map/GPS apps for your smart device**

Avenza  
 Gaia GPS  
 Topo Maps +



**PDF Maps**  
Get the App. Get the Map.®


Winner of multiple awards including  
 • Best Map Product Worldwide in 2011  
 • Best Maps for Multimedia Application  
 • New Technology & New Media Award  
 • Technology Innovation Award for Mobile Mapping



<http://www.avenza.com/pdf-maps>

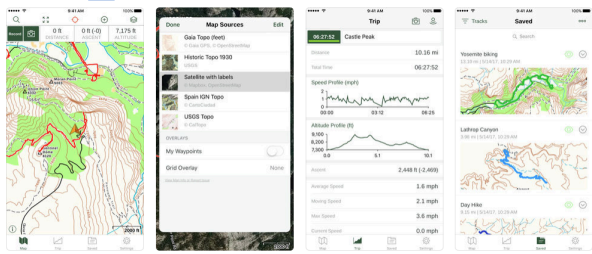
Free

IOS and Android  
 Moving map, track log, but not “full handheld gps features”  
 Maps from their map store, limited number of your own geoPDFs.




**Gaia GPS Hiking Maps, Hike App** 121  
 Making hikers safer.  
 TrailBehind  
 #31 in Navigation  
 ★★★★★ 1.1K Ratings  
 Free • Offers In-App Purchases

**Screenshots** iPhone iPad Apple Watch

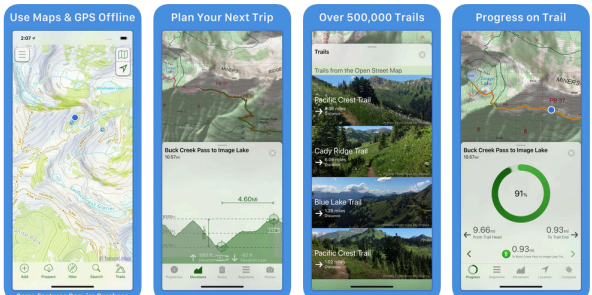


iOS and Android  
 Maps from CalTopo, Avenza, and some Nat Geo Trails Illustrated maps.



**Topo Maps+** 121  
 Use Maps & GPS Offline  
 Glacier Peak Studios LLC  
 #13 in Navigation  
 ★★★★★ 1.1K Ratings  
 Free • Offers In-App Purchases

**Screenshots** iPhone iPad Apple Watch



iOS only  
 Good trail support  
 Really Nice UI  
 Failing grade for printed maps

Just because it's on your map,  
doesn't mean you can or should go  
there!



What's in my kit?

### A Day Hike



For a day hike

My smartphone is plenty of map and GPS for a day hike.

I rarely take a paper map

I rarely take a compass



For a multi-day backpacking trip

Large scale paper maps for the expected route, in a zip top map bag

Garmin GPS with the state level topo map SD card

A set of spare batteries to share between my headlamp, GPS, etc.

Sometimes a compass and/or altimeter

My smart phone with what ever map/gps apps I'm currently evaluating



For a climb

Route specific info and maps, in a zip top map bag

Garmin GPS with the state level topo map SD card and large scale maps of the approach and climb.

Two sets of spare batteries to share between my headlamp, GPS, etc.

Wrist watch altimeter

Sometimes a compass

I'll usually have my smart phone, but typically am not playing with nav apps.

