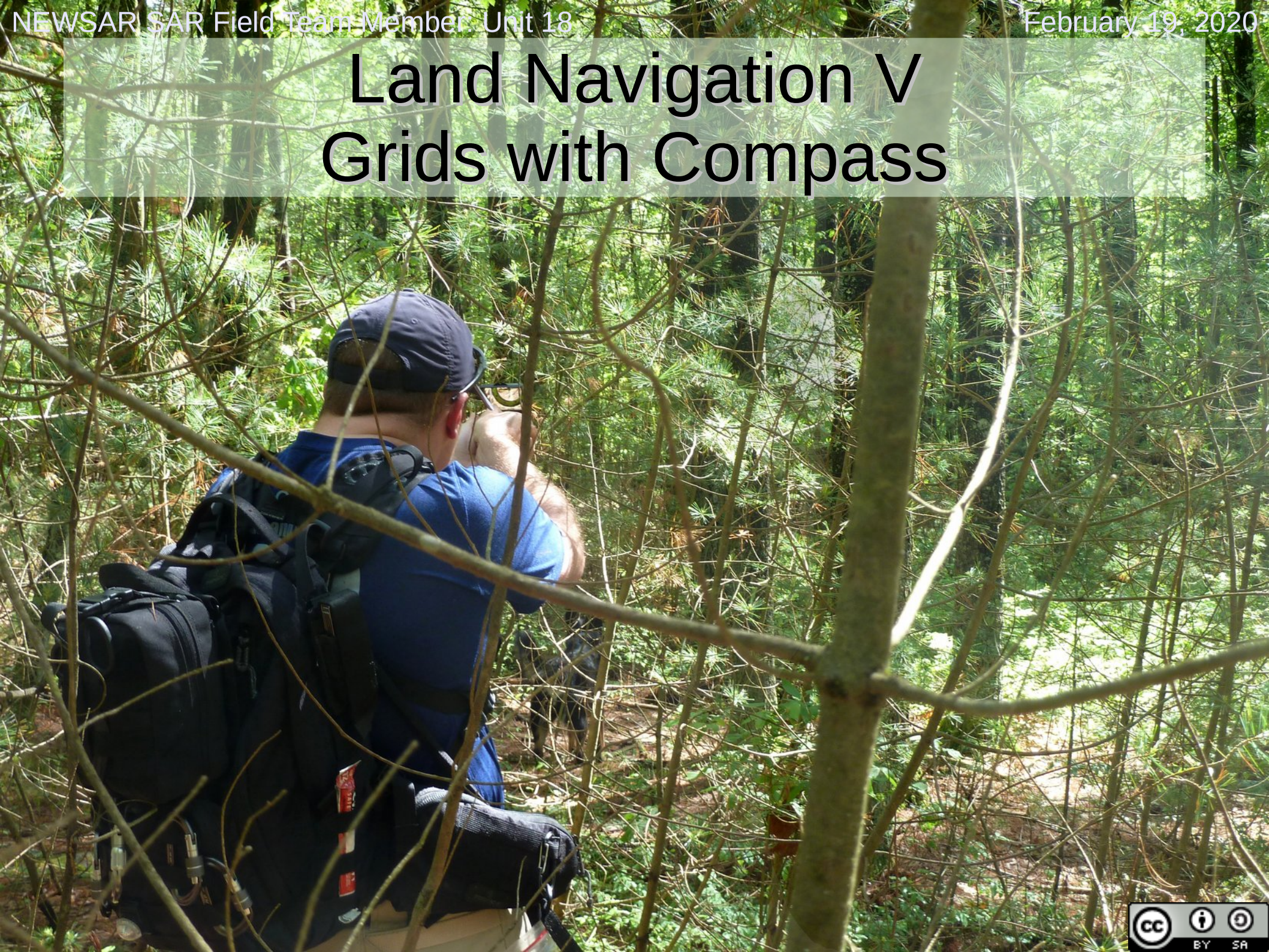
Land Navigation V
Grids with Compass



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Unit 18, Land Navigation V: Grid with Compass.
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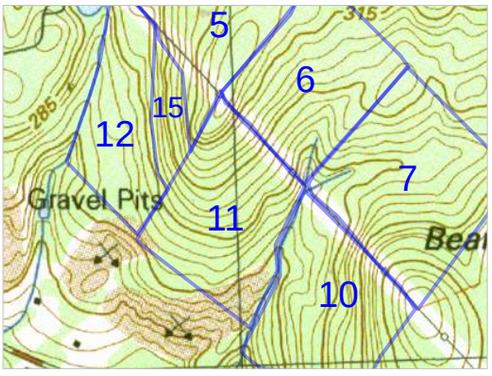


Consider this set of segments.

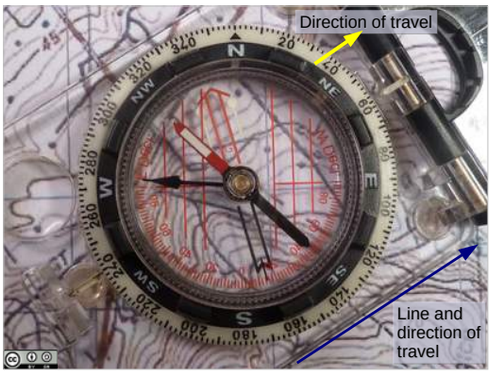
What skills do you need to accurately search one these segments? (Discuss (for example, 6), consider segments, handrails. boundaries, landmarks, marking segment boundaries). [map area is about 1km across]

Determine distances on the map and the ground.

Identify landmarks on the map and the ground.

Travel accurately along compass bearings determined from the map.

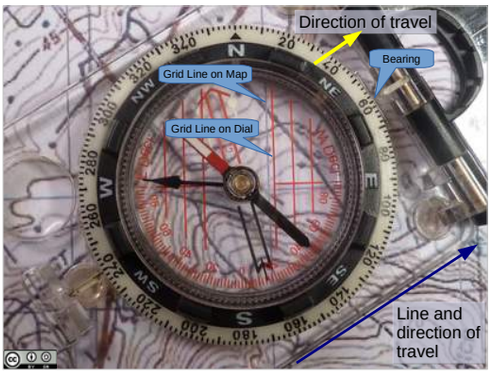
Accurately travel defined distances along compass bearings. Let's start with the compass bearings.



Let's review how to obtain a bearing from a map:

Draw a line on the map for your intended travel route.

Line the compass up with the line, point the direction of travel for the compass in the direction you want to travel.



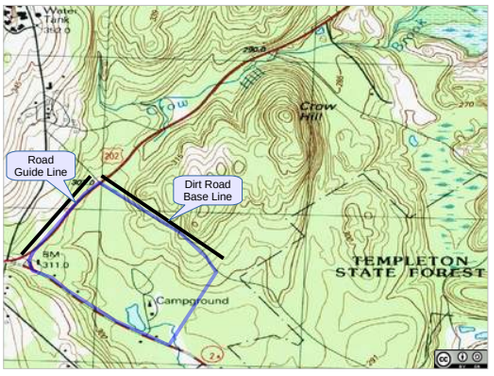
Line the lines in the back of the dial up with the grid lines on the map.

Make sure that the north arrow on the dial is pointed to north on the map (ignore the north magnetic needle).

Read the bearing off the compass. (true or magnetic?)

Here, 60 degrees true (there's a declination dialed in (how can you tell?)). (What's the declination?)

What is the backbearing?

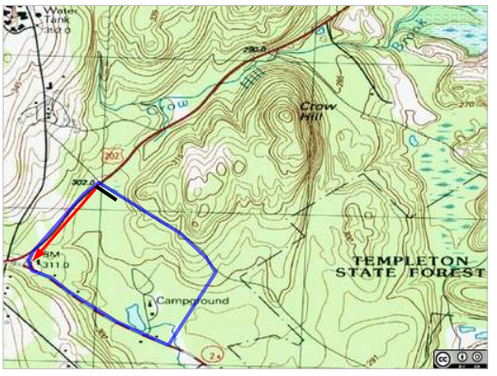


Here we have a Segment, and an Assignment: grid this segment with with a Type III grid.

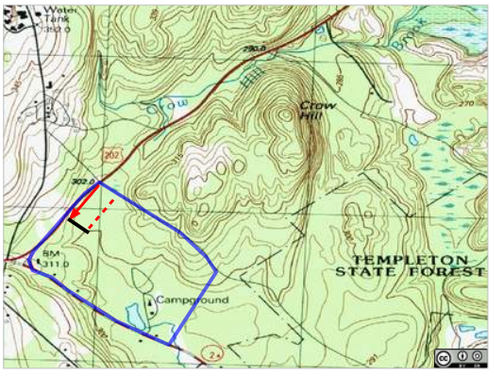
First, look for boundaries that are visible on the map and should be on the ground (a good search manager will look for segment boundaries that can be found on the ground (not grid lines or political boundary lines)).

How many firm boundaries does this segment have? (3)

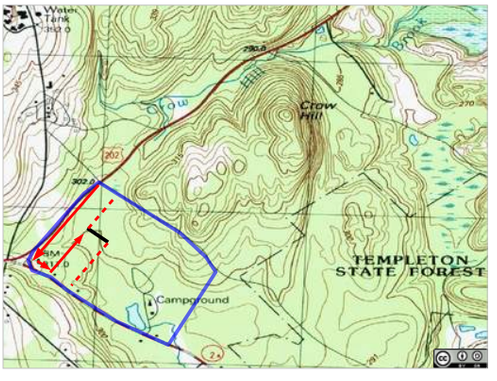
You have a clear guide line – the road down the West boundary of the segment, and a clear base line, a dirt road on the North boundary of the segment, and a clear far boundary, the road along the South end of the segment.



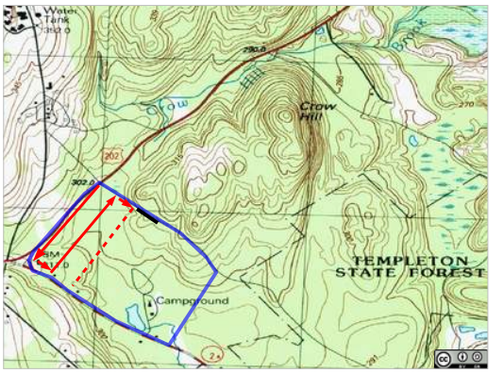
Searchers can start lined up along the dirt road base line, navigating off a guide person along the road.



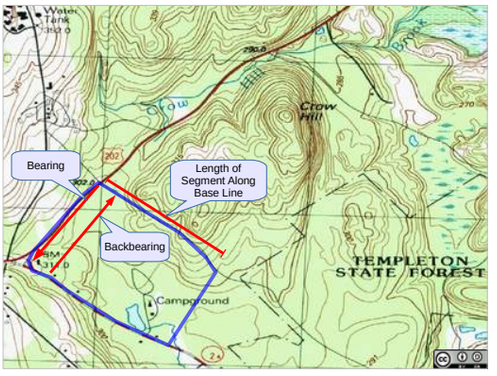
As the grid line advances, someone at the East end of the line can be tasked with flagging the line that will become the guide line for the next sweep.



When the grid line reaches the far boundary, shift over to the next sweep, and start back, the guide person following the flagging as the guide line.



And repeat.



To navigate this well bounded segment, you need three pieces of information: Which are?

How far down the dirt road is it from the start point to the end of the segment? What is the bearing for gridding South from the base line? What is the backbearing for gridding North back to the baseline?

For a Type II grid where everyone has a compass in their own lane, everyone would need both bearings to navigate.

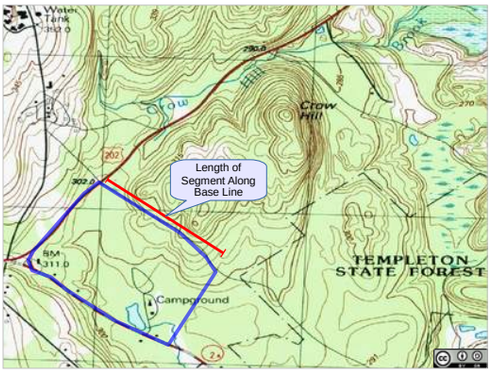
For a Type II grid or a Type III grid that is navigating by distance from a guide person, the guide person has the road and flagging guide lines to work from, but needs the bearings as a backup (what if they can't see the next flagging) and as a sanity check.

So, measure bearings with compass, and distance against the map scale.

So, let's measure those bearings and distances.

Practical Evolution 1: Measure bearings and distances for Segment 1 on map.

(Measure distance of base line along N segment boundary. Measure bearing along guide line and calculate backbearing.)



How far is it down the dirt road on the north end of the segment from the NW segment corner on the road to the NE segment corner?

How do we measure this distance on the ground?.

How do we know that we have reached the end of the assigned segment?

How Far?

- How do we know we've walked 800 meters on the ground?

Pace counting.

Measure out 100 meters (with tape measure or rangefinder). Mark start and end points.

Walk it, counting paces (number of times one foot (e.g. left) hits the ground).

Typically 60-70 paces to 100 meters.

Repeat.

Repeat at different locations on different terrain.

Key: Walk with constant stride.

To count paces, pick a foot. **Each time that foot hits the ground add 1.**
Typically around 60-70 paces in 100 meters, but people vary.
Measure paces in different ground covers – open, brush, snow, and different terrains (flat, up hill, down hill).

Keys to accurate pacing:
Try to maintain a constant stride length.
Keep track of your pace count (tally counter, ranger beads, etc.

To use ranger beads – count some number of paces (e.g. your paces in 100 meters), then move a bead and start counting over from 1. When you stop, state your pace count out loud and then write it down before doing anything else.

How about this segment?
Only one marked boundary.
Everything else needs to be done by compass and pace count.

How do you navigate this? [Discuss]

How do you know where to start?
What landmarks tell you you've reached the N segment boundary?

Practical Evolution 2: Measure on map.
Distance from a landmark to a starting point on the base line.
Distance along base line. Distance from base line to N segment boundary.
Bearing N from base line, backbearing from N boundary back to base line.
Bearing along base line/N segment boundary.
Identify landmarks near NW and NE segment corners.

You've measured bearings on the map. Now how do you travel on those bearings on the ground?

To travel on a bearing (with a baseplate compass).

Set the dial to the desired bearing (at the direction of travel end of the compass).

Then sight on the furthest thing you can clearly recognize on that bearing:

Hold the compass up at eye level.

Line down the middle of the compass passes through the pivot point of the needle.

Hold the compass level, turn right and left to make sure the compass needle swings free.

Turn so that the red end of the compass needle falls in the red “shed” box on the dial. (with a lensatic compass, you’d need to turn so that the magnetic bearing is in the direction of travel)

Identify the furthest thing you can clearly identify in the compass sight.

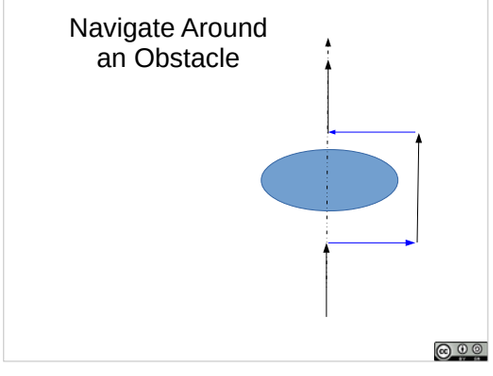
Then put the compass down, make sure you can still identify the thing you saw down bearing, and start pacing towards it.

When you get to that thing, repeat. Continue, repeating sighting on a distant object and walking towards it until you’ve paced out your distance of travel.

Ranger beads or a tally counter very handy to keep track of distance.

Ranger Beads: Move one bead for each 100 meters (e.g. 65 paces – you only need to keep track of numbers up to 65).

Move your 5th bead, you’ve traveled 500 meters...



To navigate around an obstacle

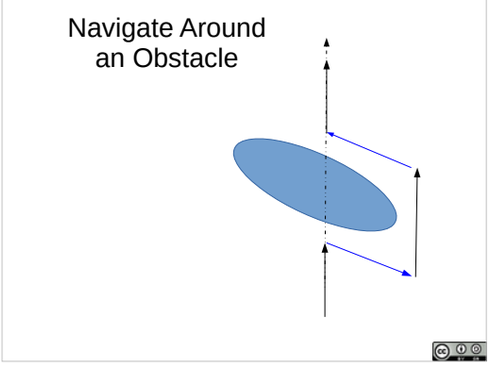
(Stop, write down your current pace count (draw a picture, write numbers on the picture)).

Pace a leg out on a bearing that takes you beyond the obstacle (count paces, but don’t add to total distance traveled).

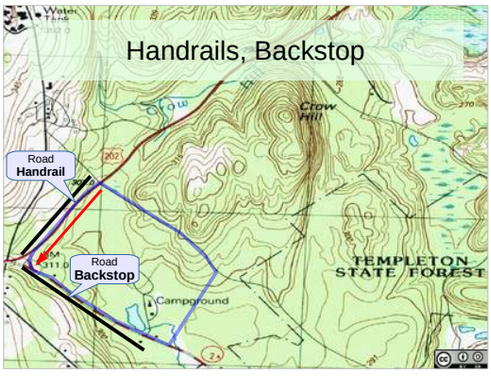
Pace on your original bearing past the obstacle (adding the distance paced to your total distance traveled).

Pace a leg back (the same distance you came out) on the back bearing of your first leg around the obstacle (don’t add this distance to the total distance traveled.

Now you are back on your original bearing, continue.



The side legs out around the obstacle and back don’t need to be at right angles to the direction of travel, they just need to be the same distance on a bearing out and the backbearing back to the line of travel.



When navigating the terrain, try to use a handrail – some terrain feature that you can follow along, and a backstop – some terrain feature that when you reach it you know you have reached the distance you want to travel (or have gone too far).

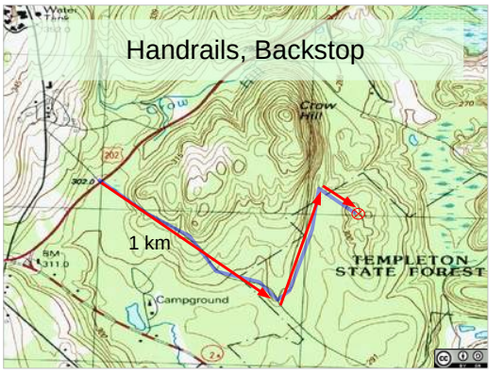
Here one road serves as a handrail for the first grid line, and a the other road as a backstop for the end of that gridline.

What will you use as a handrail for the next grid line? (flagging tape)

Use handrails and backstops when navigating through the terrain.

Here's a dropoff point and an IPP.

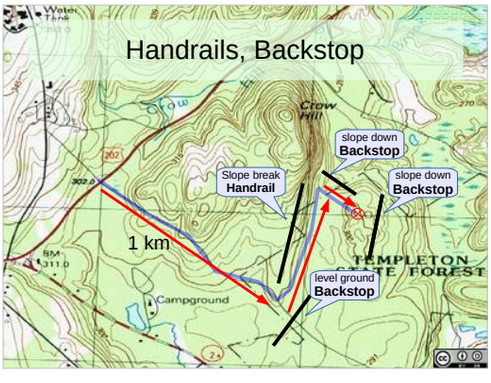
What terrain features can you use as handrails and backstops to plan a route that can reliably get you to the IPP, even if you make errors in your bearings and distances (or even use to navigate to the IPP from just the terrain)?



Here's a route using handrails and backstops.

To get to the IPP, go 1 km down the dirt road, then 500 meters North, then 200 meters East.

What terrain features can you use as handrails and backstops on this route?



Go down the road 1km (pace counting), near the end down into a valley then up a small hill – level ground after that is your backstop.

Then travel along the edge of the slope break (handrail) about 500 meters until the ground drops in front of you (backstop), then about 200 meters to the crest of the small hill – ground dropping off to the swamp is your backstop.

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Practical Evolutions:

(3) Establish Pace Count for 100 meters.

(4) Navigation on bearings on an equilateral triangle with 100 meter sides, returning to the starting point.

(5) (Optional) Navigate on assigned bearings to marked targets, report distance traveled.

Land Navigation VI
Basic GPS/GNSS

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Unit 19, Land Navigation VI: Basic GNSS/GPS
Date Last Updated: February 20, 2020

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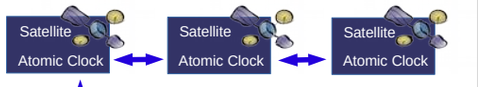
GNSS/GPS

- Global Navigation Satellite System
  - GPS (US)
  - GLONAS (Russia)
  - Galileo (EU)
  - BeiDou (China, regional, global by 2020)

GNSS: Global Navigation Satellite System, of which the US Global Positioning System (GPS) is one.

There are multiple such systems. Newer receivers listen to more than one of them (and give a more precise and accurate position).

How GPS Works



Each satellite carries an atomic clock
These are synchronized from a master atomic clock on Earth.

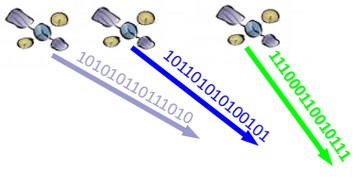
Satellites transmit on 15475.42 MHz Navigation signal and C/A signal

Ground Station
Master Atomic Clock

The GPS system is a marvel. It depends on very precisely synchronized atomic clocks carried on each GPS satellite. The satellites transmit a variety of spread spectrum signals in the low microwave bands. The key civilian signals are the Navigation signal and the Coarse/Acquisition signal.

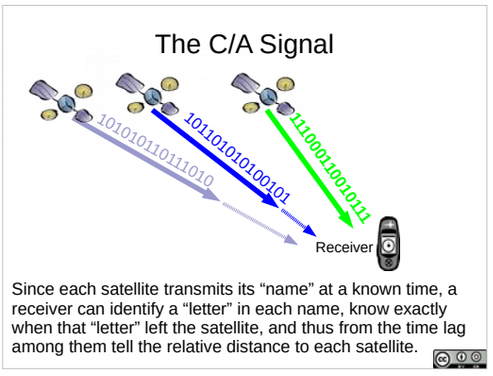
[The Navigation signal is transmitted at a low bitrate and takes 12.5 minutes for complete transmission. It is modulated with the Coarse/Acquisition signal running at high bitrate (repeated once per millisecond), in a CDMA spread spectrum signal, where all satellites transmit on the same frequency, and the code sharing allows receivers to separate the signals from different satellites.]

The C/A Signal

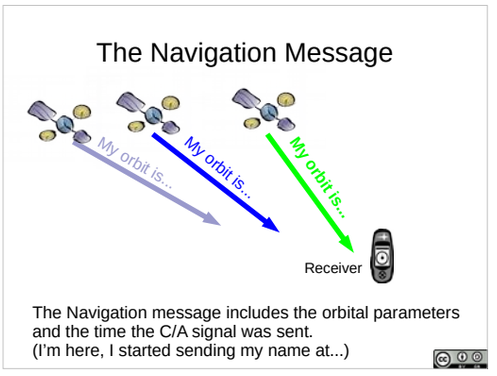


Each satellite transmits its own unique “name” a 1023 bit Pseudo Random Noise word.
All satellites start to send this signal at known times.

Each GPS satellite transmits a unique name in the form of a 1023 bit string (generated as a pseudo-random noise word, where each satellite’s pseudo random noise word is distinct (in a particular mathematical way known as Gold Code)). Each satellite transmits its Pseudo Random Noise name at a known time (once every millisecond). This information forms the Coarse/Acquisition signal.



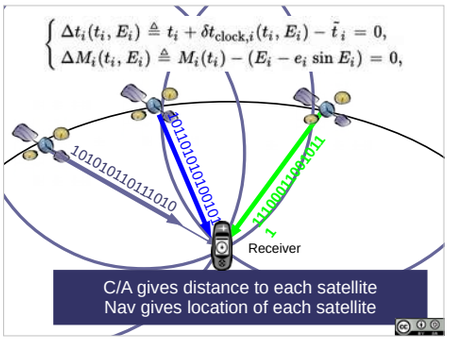
Because the names are transmitted at known times, a GPS receiver can listen for the time lag between signals transmitted by different satellites and calculate the relative distance to each satellite.



Each satellite also transmits a navigation message containing the information needed to calculate its orbit (and where in its orbit it is) and information needed to determine the exact time that the PRN name was sent.

The receiver can identify the particular part of the pseudo random noise signal (in the C/A) signal it is hearing, match it to a particular satellite, and know at exactly what time that part of the signal left the satellite. Knowing the speed of light, the receiver can calculate the distance to each satellite.

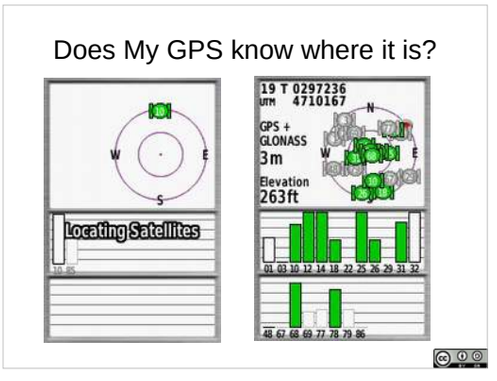
This is much like seeing a flash of lightning, counting seconds to the clap of thunder, knowing that sound travels at about 1000 feet per second, and being able to say how distant the lightning was.



Then it is just math...

Triangulating to 4 or more satellites gives a reasonable solution in both position on Earth’s surface and elevation.

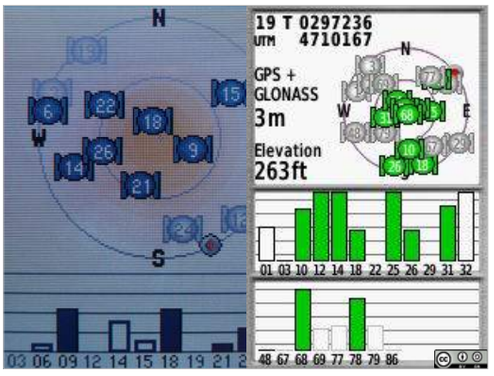
Position is more precise than Elevation.



Turn on your GNSS/GPS receiver, it listens to satellites to figure out where it is. This takes time and a good enough view of the satellites in the sky.

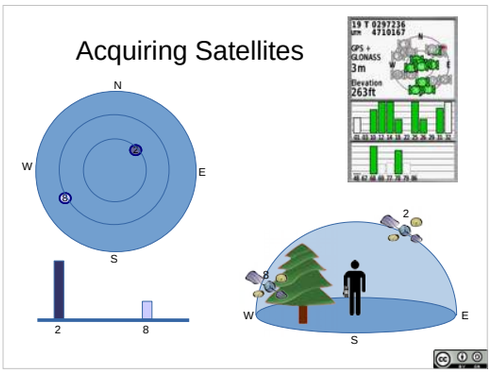
(1) The GPS will give you a position.
(2) The GPS will give you an estimated position error (in the horizontal, error in elevation will be greater).

This GNSS (reading both the GPS and GLONASS satellite constellations) claims a position accurate to about 3 meters.



Here's a couple of GNSS receiver's view of what satellites they are currently receiving.

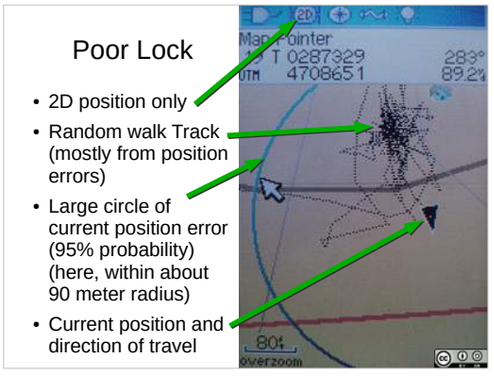
Typical view is a circle representing the sky, with satellite positions in it, and bars indicating signal strength and lock (have I got enough information from this satellite to use its signal to calculate a my position).



The concentric circles in the display represent the dome of the sky overhead (with North, South, East and West marked). A satellite in the center is right overhead. A satellite near the edge is near the horizon.

Here, satellite 8 is low to the horizon in the Southwest, while satellite 2 is higher in the Northeast.

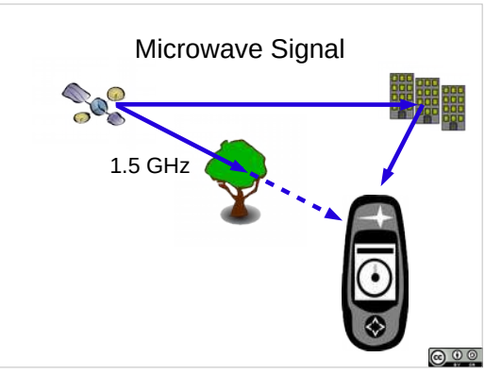
Satellite 8 has a weaker signal and hasn't got a lock yet. How could you improve this? (move to get a clear view of the satellite in the sky (not blocked by trees)).



You can also get hints of poor position accuracy in other displays of the GNSS receiver.

Here are some indications of a poor lock in the map display of on an (older) Garmin GPS 60 series receiver.

The map display may include a circle of position error (95% probability that you are somewhere inside that circle), or show a random walk from the GNSS changing its mind about its location.



The GPS signals are on microwave frequencies.

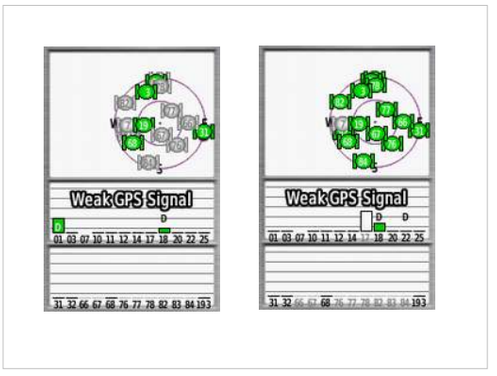
Tree leaves are good at attenuating microwave signals, thus GPS receivers get weaker signals from satellites under tree canopies.

Microwave signals can bounce off of buildings, canyon walls, etc, and travel on multiple paths to the GPS receiver (thus confusing it about distance and travel time).

(Rain drops attenuate higher frequency microwave signals in the 3-30GHz range, so rain (or snow) doesn't appreciably affect GPS reception).

Calculations of distance to each satellite are dependent on knowing the speed at which the microwave signals are traveling, assumes that that they travel straight paths, and assumes that the signals are not distorted. Large solar storms which stream charged particles into the high atmosphere can distort and disrupt microwave signals.

A GNSS receiver's ability to obtain a lock and its position accuracy are affected by space weather. A large solar storm (which results in lower latitude auroras) can produce degraded GNSS position accuracy.



Here's a GNSS receiver in New Zealand experiencing an episode of poor reception

Some Limitations of GNSS Receivers

- Need Batteries
- Altitude is lower accuracy than position
- Need Line of sight to 3+ satellites
  - Accuracy can be reduced under tree canopy
  - Accuracy can be reduced by multi-path in urban areas or canyons
  - Accuracy can be reduced by solar weather
- Many opportunities for human error

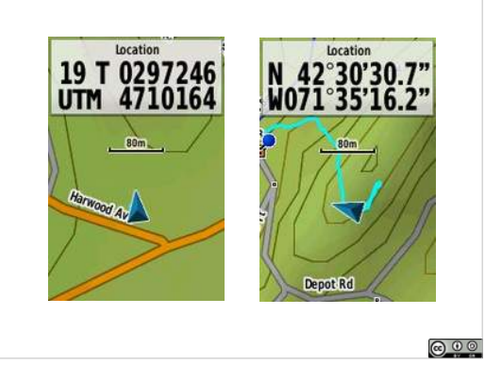
GNSS receivers have limitations.

They need batteries to work. What can you do to help mitigate the risks around batteries dying? (Carry spare batteries, change out the spares, check the battery charge before leaving staging, carry a compass...)

The receiver needs good signals from at least 4 satellites to calculate a precise location and elevation. Trees, buildings, things getting in the way of satellite reception can reduce accuracy.

Solar storms can affect the travel time of GPS signals, and thus GPS accuracy.

Complex tools, practice with them regularly.



Let's now look at how to use a GNSS receiver.

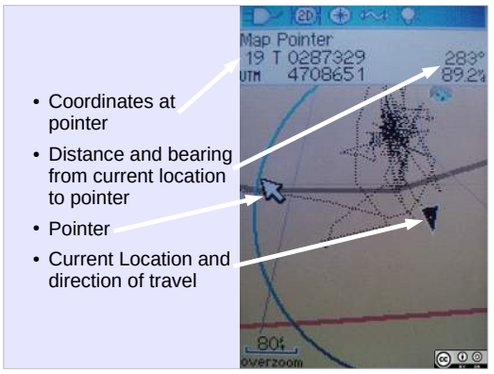
Here are two examples of a GNSS receiver displaying location on a map.

One claims its current location is just off the end of Harwood Ave.

And it is giving us a location (in UTM coordinates).

Another claims its is off Depot Road, and it is giving us a location (in Latitude/Longitude)

Both cases – triangle is current location (and heading).



Here's a display in a few years older GPS receiver
Get used to your GNSS's display (and how you can configure it).

What are we seeing here?

Pointer (left center)

Current position (black triangle, right center)

Circle: Estimated position error.

Black squiggly line – drifting position error by the GPS.

Displays Vary (Learn Yours)

Current Location (Blue Triangle)

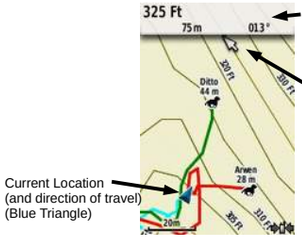
Distance and bearing to pointer (and label at pointer (Stream))

Here's a Garmin Astro (tracking two dogs), displaying the coordinate of the current location (configured to display the coordinate of the current location).

And a Garmin GPSMap64 scrolling the pointer on map, showing the distance and bearing to the pointer.

GNSS displays with a movable pointer can give you the distance and bearing to a feature you can see on the map(s) loaded into the GNSS (may need to purchase separately, fancy models include subscriptions and air photos, lots of variability in available maps, minimum can approximate 1:100k topo).

Displays Vary (Learn Yours)



If the pointer, as confusingly in this case, is on a labeled contour line the top of the display looks like a distance, it isn't, it is the label of the feature the pointer is on. (the pointer is on the line 325 Ft. This point is 75 meters away on a bearing of 13 degrees))

Simple Navigation

- Bearing and distance to a point
- Track
- Waypoints
- Go To a Waypoint

WE can do all kinds of fun things to help us with navigation using a GNSS, let's start with just a few.

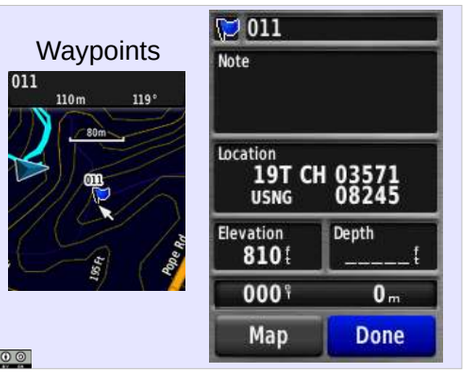
In a GNSS with a movable map pointer, we can obtain the bearing and distance to a point.

Pointer is on top of a ridge (how far at what bearing – 95 meters at 147 degrees) from our current position (triangle).

We can also see our track – where we've been recently (for user configurable values of recently).

Track meanders back to a waypoint we marked on getting out of the car.

Waypoints



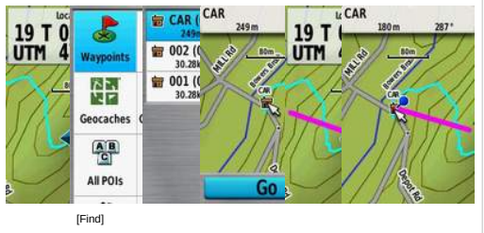
You can store a location. This is a waypoint (011).

You can give it a name (Truck, Clue, Staging, etc.) (in this case, when viewing the waypoint details, move the highlight to the waypoint name (011), then enter to edit).

Often created with a button “Mark” on the GNSS.

You may be able to tell your GNSS to listen to the satellites for longer and get a better position for the waypoint you’ve just created from your current position (Waypoint Averaging). Can be helpful to do this at a clue.

Go To Waypoint



You can ask your GPS to give you a bearing to an existing waypoint (e.g. waypoint manager, pick a waypoint, select Go).

You can navigate back to the dropoff point...

287 degrees (True)

180 meters.

If You Remembered To Store It

Assuming you remembered to mark the dropoff point.

Practice Good Habits:

- Before you start: Check your batteries.
- When you get out at the drop off point
  - Make sure your GPS has an accurate position.
  - Mark a waypoint with your GPS.
  - Save and clear the current track (dog’s too).
  - Make sure that your GPS is recording the track.
- When you start your assignment
  - Mark a waypoint
- When you complete your assignment
  - Save the track for the assignment.

Get into some good habits whenever you train:

Check your batteries (and spares).

Mark the point you get dropped off at (so you can get back there).

Save and clear the current track before you start your assignment, and save it when you complete your assignment (this makes it easy to download a track that just represents your assignment, not lots of other points that someone will need to exclude to put your assignment on the map.

Waypoints at the start and completion of your assignment document location and time.
(And of course, waypoint significant things you find)

And Calibrate the Compass (often)

When you are moving, your GPS may be able to calculate your heading based on your last position and your motion (this works better if you are moving faster than on foot).

When you are standing still or moving slowly, a GPS with a built in electronic compass can detect local magnetic north and determine your heading (and which way it is pointing).

Re-calibrate whenever you start an assignment.

Capabilities and battery draw vary.

Practical: Startup Sequence

Practical Evolution

(1) Actions on turning a GNSS receiver on.

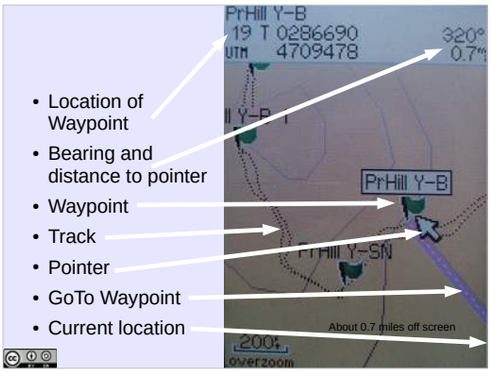
Altimeter Calibration

- Known Elevation
- Known Barometric Pressure

Some GNSS receivers also have an altimeter that can provide a better elevation than GNSS alone (mostly important for mountainous terrain, can also be display barometric pressure trends for weather forecasting).

Altimeter needs to be calibrated.

Typically need to know current elevation and barometric pressure for calibration.



Here's a GPS with the pointer hovering over a waypoint, displaying the name of the waypoint, the coordinate for the waypoint, and a distance and bearing from the current location (not on the map) to the waypoint.

We've told the GPS to go to the waypoint, so there's a heading line from the current location (off the map) to the waypoint.

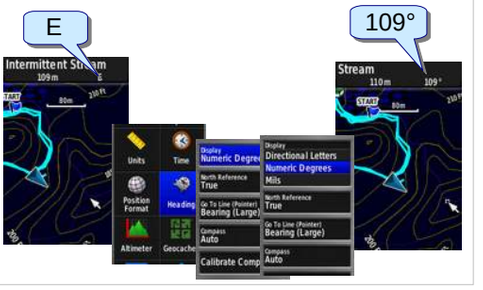
Customize Your Screen For Your Task

Your GNSS receiver may have a compass view and a current route view that display configurable information fields.

Configure the fields you want to see for the task at hand.

Here is a compass view, showing a current direction of travel to the SSE, without a Go To Waypoint (or route) selected, thus a current heading, but not the bearing to the next waypoint.

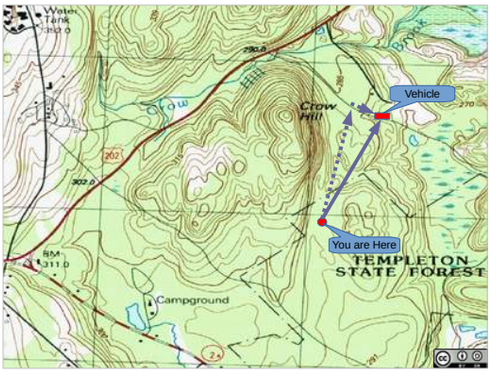
May need to change Heading Settings to see Bearing in Degrees



If you move the map pointer and see the distance from your current location to the pointer, but with letters for cardinal direction (e.g. N, or SE) instead of bearing in degrees, change the setting for the display of the Heading to give you the bearing in degrees (you can also set bearing relative to True or Magnetic north).

Fields on Map View

You may be able to configure your GNSS to display fields on the map view. Configure for your task (and your eyesight).



When navigating back to a waypoint on a (road, trail) linear feature, navigate off to one side or the other, rather than directly towards the waypoint.

Why?

When you hit the linear feature, you know which way to turn.

(Bearing back to vehicle on solid line, travel a few degrees west of that bearing, then you know to turn right when you hit the road.)

Also, note the distance, and pace count it – linear features can be easy to cross without noticing.

Ways to Create a Waypoint

- At your current location (Mark)
- At your current location, then edited to a given location (Mark/Edit).
- At your current location, then moved with the map pointer (Mark/Menu/Drag)
- Projected from your current location (Sight & Go).
- Projected from another waypoint. (Waypoint Manager/Waypoint/Menu/Project Waypoint)

There are multiple ways to create waypoints from the GNSS receiver. (Parentheses list typical Garmin means for carrying out each, receivers vary).

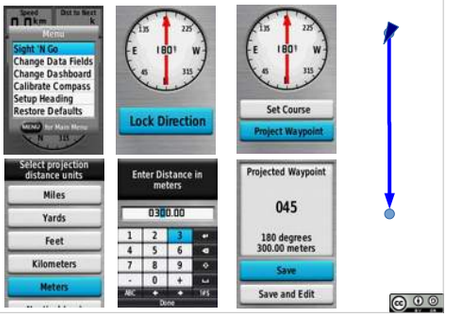
At current location – often a button on the receiver to do just this (e.g. “Mark”).

Once you have created a waypoint, you can edit it (either directly on creation, or by finding it in the waypoint manager). Given a location over the air, write it down, then create a waypoint and edit the waypoint to match the given coordinates (then sanity check, you may have copied it down incorrectly or entered it incorrectly, or it might be across a grid square or zone boundary...).

A waypoint may be able to be selected, then dragged to a new location.

Waypoints may be projected.

Project a Waypoint from current location



At a location, you can project a waypoint some distance on a bearing.

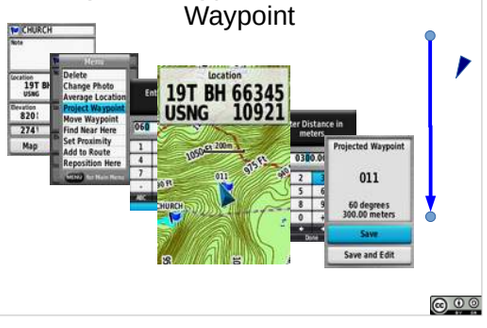
You need to:

Be at a known point.

Have a known distance you want to travel.

Have a known bearing you want to travel on.

Project a Waypoint from another Waypoint



You can also project a waypoint from any other waypoint.

Select the start waypoint. Menu -> Project waypoint.

Enter bearing, units, distance, then project the waypoint.

You don’t need to be at the start location.

You can use this (carefully) to set up waypoints for the grid for an area (make sure you sanity check).

Practical: Waypoints

Practical Evolutions:

(2) Determine bearing and distance from current location to point on display..

(3) Mark Waypoint, Edit and Project Waypoints.

(4) Record waypoint, navigate back to waypoint with a compass.

You have some plan about how tactically you want to search some segment.

While working it, look at the map view in your GNSS.

You can see how the execution of your plan is playing out. How neat are your grid lines? Are they spaced as you planned? Have you left gaps?

Building Your Own Map

- Waypoints
- Routes
- Tracks

- Finding your way back to a pickup point
- Documenting where you have searched
- Documenting a flagline segment boundary
- Documenting a clue

A GNSS can show your location (and can show you a map), but you can also, conceptually, build your own map with a GNSS.

You have three tools for this:

Waypoints: Stored Locations.

Routes: Linked sets of waypoints that make up a travel route.

Tracks: The record of where you've been with the GNSS (e.g. along a trail).

All of these capabilities can be exploited in SAR.

Finding Your Way Back to a Pickup Point

- Create a waypoint at the place you are dropped off for a search segment.
- Create a waypoint at the point you enter a search segment.

We already touched on one of these – if you remember to mark a waypoint at the dropoff point, and you mark a waypoint when starting to search a segment, you've got information in your GNSS to help you get back to the dropoff point.

Documenting Where You Have Searched

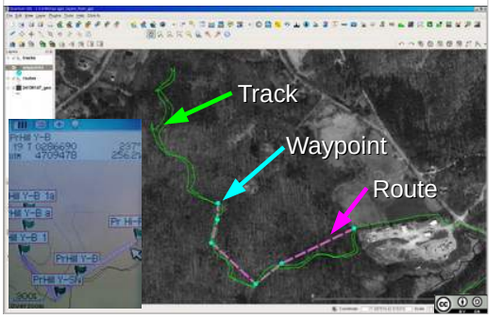
- If your GPS can store tracks:
  - Record your track with your GPS.
  - Start recording the track when you start a search segment
  - Stop and save the track when you finish a segment.
- If your GPS can't store tracks:
  - Carry a GPS logger.
  - Record Waypoints at extreme points in your search segment (e.g. when your grid hits a segment boundary).

Your GPS can help document where you searched.

Were you in your assigned segment? Were there any parts of your assigned segment that you didn't search?

Tracks are usually not easy to edit with either your GNSS receiver or mapping applications used in the command post – make life easier for everyone, start recording a new track when you start an assignment, and save that track when you complete the assignment.

Tracks, Waypoints and Routes



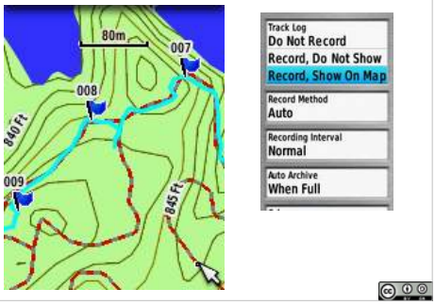
Tracks are the GPS's record of where it has been.

Waypoints are point locations that you store in the GPS.

Routes are connected sets of waypoints that can be followed one to the next.

Here's a track, waypoints, and a route on a GNSS receiver and imported into a GIS application with an air photo.

Tracks



Tracks record the sequence of positions recorded by the GPS.

If you have poor GPS reception: Track won't reflect actual route taken.

Following exactly the same track back and forth on the ground will show the wandering error in the GPS's position.

Your GNSS is probably configurable to record and show your current track.

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Applying Search Tactics

Image: BSAR (Brush Search And Rescue Victoria) searchers on Mt. Dom Dom
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Unit 20: Applying Search Tactics
Date Last Updated: February 20, 2020

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Search Crucials

- **Search is an Emergency**
- **Search is a classic mystery**
- **Search for clues not just the subject**
- **Know if the subject leaves the search area**
- **Close grid search as a last resort**
- Manage by objectives
- Search management is information management

Tactics bring us right back to the search crucials.

It is an emergency, so we want to use efficient tactics early on.

It is a classic mystery – we are searching for clues.

Containment is a tactic to know if the subject has left the search area.

Most of the time, close grid search isn't a tactic to use early on.

Tactics

- Direct/Active
  Go find the subject.
  - Type I to Type IV search (human, canine, equine)
  - Aerial search
- Indirect/(Passive)
  Make the subject come to you.
  - Investigation
  - Containment
  - Attraction
    - Sound
    - Lights
  - "Limited Continuing Search"

We can divide tactics into two categories:

Direct: We go and find the Subject.

Indirect: We make the subject come to us.

We usually think of search as the direct tactics, but you might be tasked with containment or attraction assignments

Attraction

- Lookouts/Road blocks with lights/siren
  - Attractor shouldn't move.
- Places with a view:
  - High points
  - Scenic views
  - Fire towers
  - Fire Department aerial platform.

General principle of attraction: The attractor doesn't move.

Great stories of missing people walking towards vehicle sirens and PA systems, then have them move somewhere else, walking towards the new source of the sounds, then...

Lost person behavior profile will suggest whether attractors making noise or lights are likely tactics.

Also: High points make great vantages for observing the search area.

Fire department aerial apparatus (particularly aerial platforms) can make excellent movable high points.

Loud, bright flashing lights.

What lost person behavioral categories might this be a very good attractor for?

Containment

- Road/Trail blocks
- Road patrols
- Track Traps (existing or constructed)
- Perimeter Sign Cutting
- Lookouts (binoculars, thermal imaging)
- Camp-ins

Multiple tactics can be used to establish containment.

Sound Sweep

- Stop
- Pause and listen
- Call Subject's name (or whistle)
- Wait and **listen**
- Continue

As an attractor, you can make noise and listen.

While performing a search, you can also perform a sound sweep.

Important bit is to listen after you call out.

Can also be coordinated across multiple search assignments.

Not advisable to whistle while working with your canine.

Type I - Hasty

Type II – Purposeful Wandering

Type III - Grid

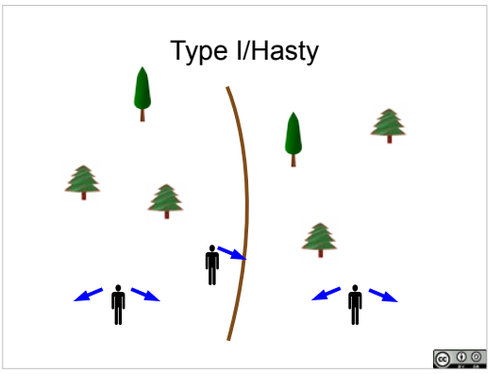
Type IV - Evidence

Efficient
Least Destructive

Thorough
Destructive

We talked about the range of tactics from Efficient/Less destructive to Thorough/Destructive.

That's a range from hasty searches to evidence searches, with open grid searches by trained searchers and closed grid searches by untrained searchers in the middle.



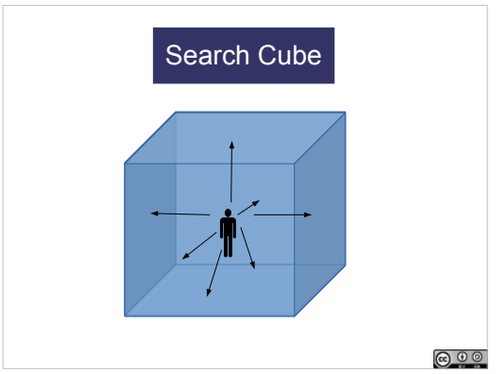
A hasty search assignment could involve an efficient search down a travel route.

What are we looking for? (clues and the subject, discuss).

What are particular sorts of clues to be watching for along a travel route?

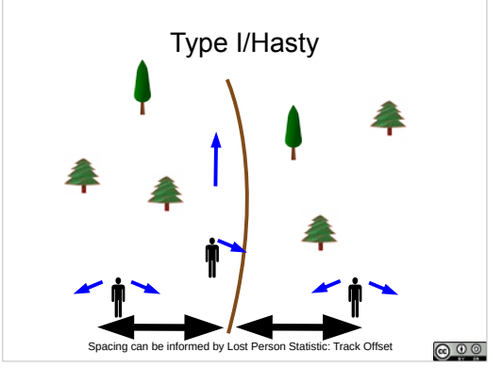
What can searchers look for in the winter?

What happens if we do this search more than once on the same trail in the winter?



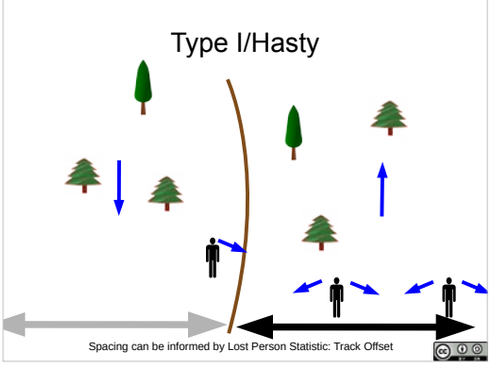
And all of the searchers should be clue aware, and checking all 6 faces of the search cube as they move along.

Search for___ ?



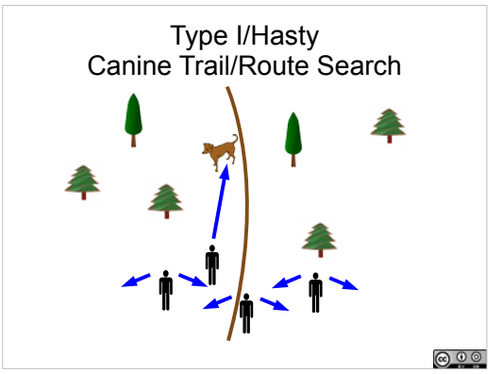
One searcher can travel just off the side (which side? - away from the sun) of the travel route, two (or three) off on either side, searching the area just off the travel route. Sweeping the trail in one direction.

Spacing of searchers can be informed by track offsets from Lost Person Behavior.



Behavioral categories with large offsets, could put everyone on one side going out, on the other returning.

Sweep one side out, one back.



Type I searches can use canines – trail or route searches.

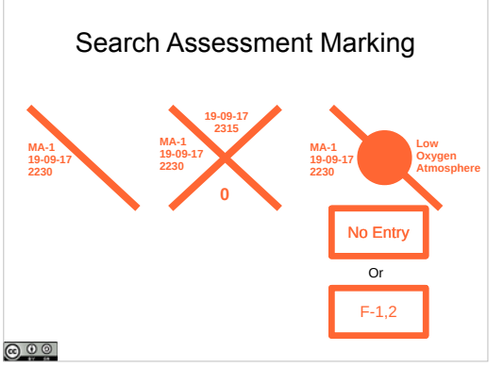
4 person team, handler can focus on the dog, others can focus on clue detection.

Hasty can be to attractors – points of high probability or high risk.

Where is a very common place for lost persons to be found?

Structures – check structures.

There's a standard method for marking structures.



FEMA Search Assessment Marking

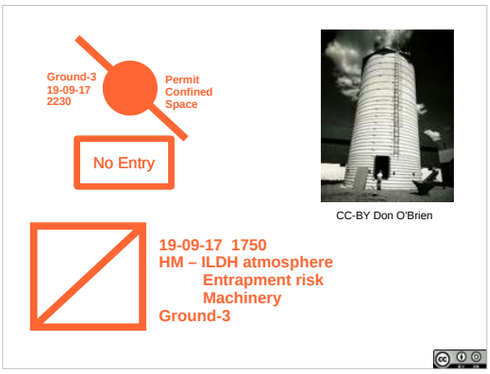
On Entry: One slash. To Left: resource identifier and entry date/time.

On Exit: Crossing slash. Top: Time/date of exit. Right: Hazards. Bottom: Number of Live (L-) and Dead (D-) victims. (0=none).

No Entry or incomplete search: Solid Circle on slash. Describe effort in box below F- floors searched. No Entry if No entry was made.

With an orange grease pencil or lumber pencil, use the Search Assessment Marking for marking abandoned vehicles, outbuildings, etc. in your search segment.

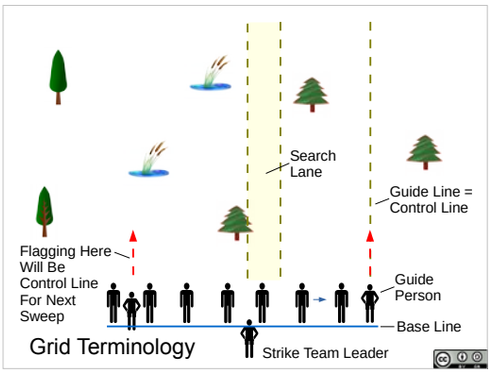
What does this marking indicate? (ground team 4 made entry/started searching at 17:30, searched for 10 minutes, didn't find anyone or any hazards).



What are these markings indicating?

Top: Search Assessment Marking: No entry was made to the silo by Ground team 3.

Bottom: Structure Assessment Marking: Assessed potential hazards are an immediately dangerous to life and health atmosphere, entrapment risk (from silage), and machinery. Mitigation needed (technical rescue resources) for search.



Type II, III, and IV searches involve Grids.

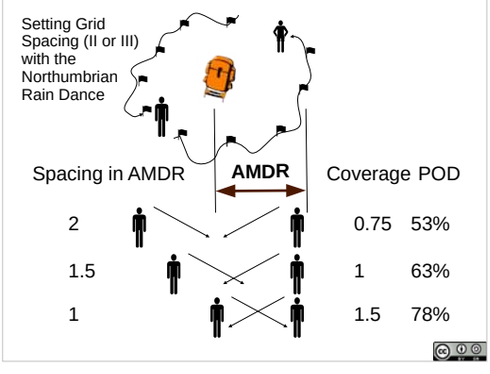
Grids have a base line. A guide person working on a Guide like, and search lanes for each searcher.

What is the span of control?

How do you manage this?

Maintain span of control.

Use a relatively small number of untrained searchers mixed with trained searchers.



The Northumbrian Rain Dance can be used as a means for setting the grid spacing for either Type II or Type III grids.

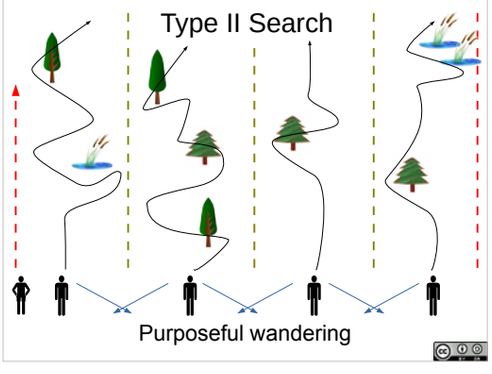
Covered in the NEWSAR POD/POD Factoring class.

Simple rule of thumb (for coverage of 1): Space searchers at 1 and one half times the Average Maxiumum Detection Range (AMDR).

Use an object the size of a person to determine POD (the POD reported will be that of finding the subject).

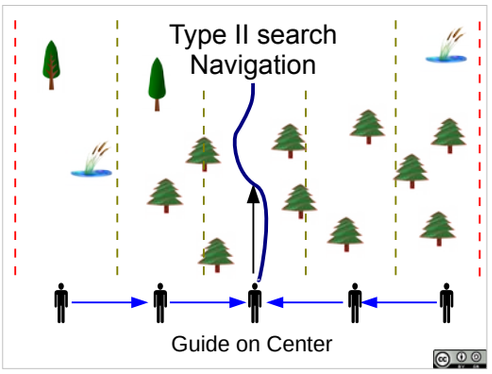
Practical Evolution (if a suitable place right outside the classroom)

(1) Northumbrian rain dance.



In a Type II search, Searchers can wander purposefully in their search lanes.

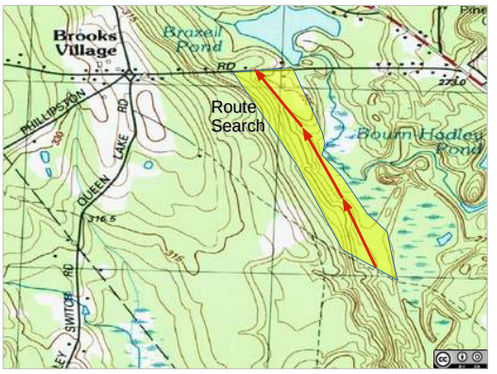
Move within the search lane to look behind things, to look under things, to look more thoroughly through locally dense vegetation, etc.



Type II searchers can hang off a guide person (who is navigating) in the center of the line. Everyone keeps a constant distance between themselves and the person closer to the center.

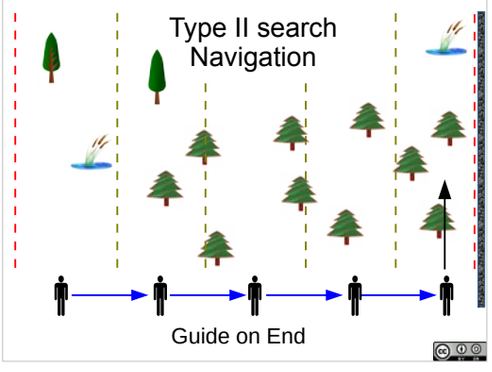
Effective for a corridor search (e.g. the guide person is following a terrain feature)

As this is type II: Purposeful wandering while searching – the guide wandering can make everyone else drift as well.



Guide on center with a Type II grid can work effectively for a route search, where the guide person follows a terrain feature, and the search line spans out on either side, making one sweep along the travel route.

Harder to use guide on center to sweep back and forth to grid search an area.



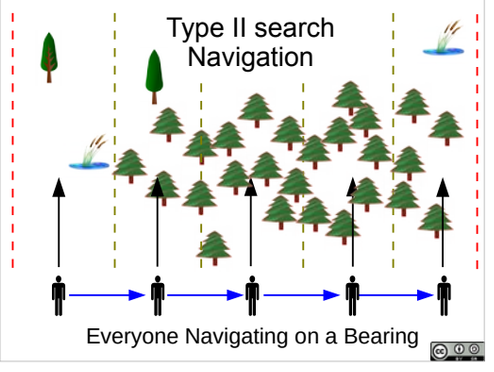
Or, the guide person can be on the edge of the grid line – particularly if there is a boundary (road, trail, flag line, etc) to use as a control line (or the guide person just navigating on a compass bearing).

Everyone else keeps a constant distance between themselves and the person closer to the control line.

Constant, within the purposeful wandering in the search lane.

Person on far end from guide can flag edge of sweep.

Typical for Type II search of an area – flagging at far end of line can be control line for next sweep.

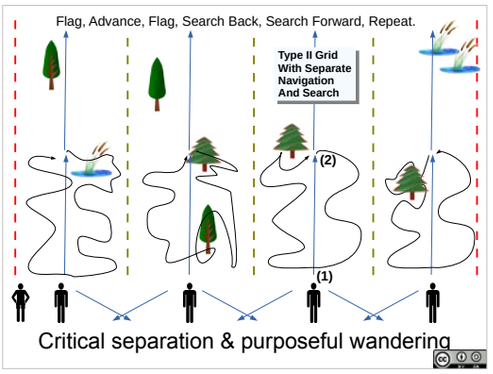


Skilled Type II searchers can navigate independently – particularly in dense vegetation (if it varies, like here, you may want to adjust spacing to maintain POD).

Everyone **also** seeks to maintain a constant distance between themselves and the person closer to an edge (or the center).

Navigation techniques are about **navigation** and about maintaining **control** of the people, and about **not leaving gaps** between grid sweeps. It is possible to navigate on just independent bearings, but then in sweep back you need extra care to avoid leaving a gap between search lanes.

Easiest to do by separating the searching from the navigation.

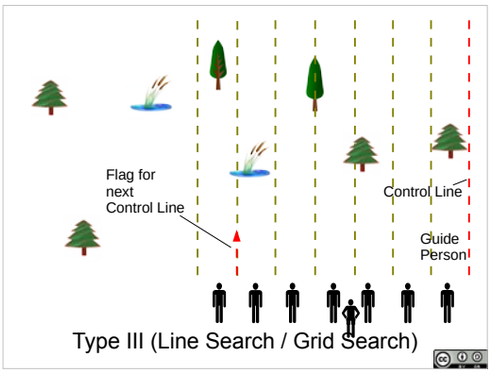


In a Type II search, Searchers can wander purposefully in their search lanes.

Here is a highly effective method which separates the navigation from the searching and purposeful wandering.

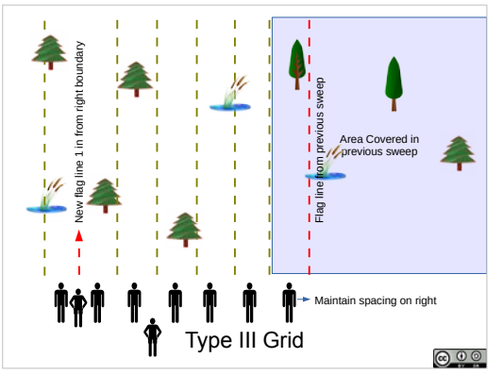
Flag location (1), advance. Flag location (2), purposeful wander back to first flagging (1), purposeful wander to next flagging (2). Advance and Repeat.

Key bit: This separates the navigation from the searching. Everyone advances together in a line for navigation, everyone searches a discrete section of their search lane independently.



Then we have Type III grids – tight control, everyone stays in the center of their search lane.

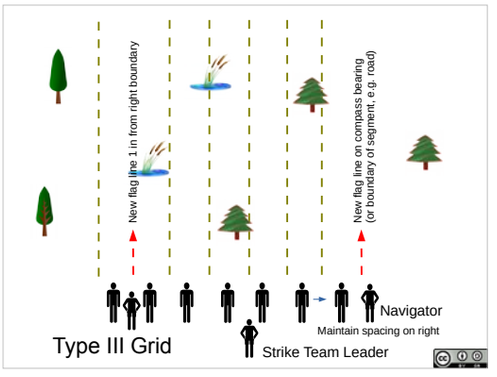
In general, close spaced grids are inefficient, require large numbers of people, (are resource intensive), and destroy clues. They use closely spaced subject finders to produce a high probability of detecting a subject in an area.



Have one end of the line follow a marked boundary. Instruct each person on the line maintain a constant distance from the person on that side. In this case, everyone walks forward staying six feet from the person on their right.

Set the grid spacing with the northumbrian rain dance (1.5 AMDR approximates a coverage of 1).

Have one person on the far end of the line flag the boundary of the sweep. In brush, it may be necessary to dedicate this person to flagging rather than searching.

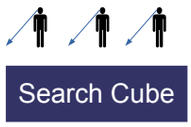


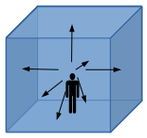
Maintain span of control. And maintain tight control.

Preferably, use a relatively small number of untrained searchers mixed with trained searchers.

Type III Grid Commands

- Stop
- Look Up, Look Down
- Look Left, Look Right
- Turn Around and Look Behind you
- Look Up, Look Down
- Look Left, Look Right
- Turn Around
- Advance





To maintain control, separate the motion from the searching. Have everyone advance in unison, then stop them, direct them, to look at all of the faces of the search cube (one direction at a time, telling them look up, look left, etc,), including turning around and looking behind them. Then have them turn to all face forward and advance again. Keep repeating.

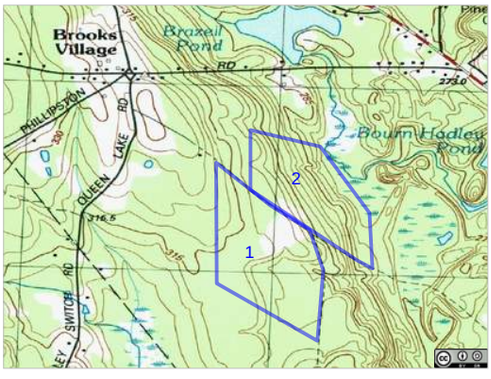
Area Search Patterns

- Area Search (II or III)
- Route (Area) Search (I or II)
- Parallel Route Search (II)
- Expanding Circle Search (II)
- Contour search (II or III)

Spacing of grid searchers for type II or type III grids can both be set with the northumbrian rain dance.

Various sorts of search patterns lend themselves better to type I, II, or III searches.

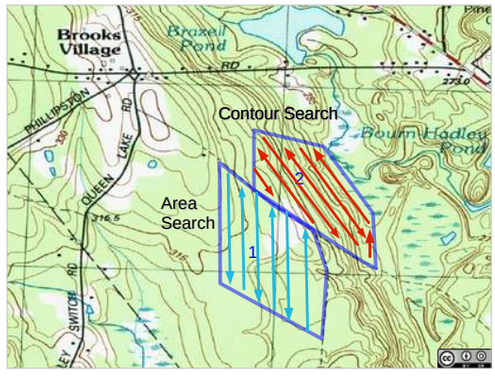
Let's look a these.



What is the terrain like in these two segments?

What tactics (patterns) might you want to apply to these two segments?

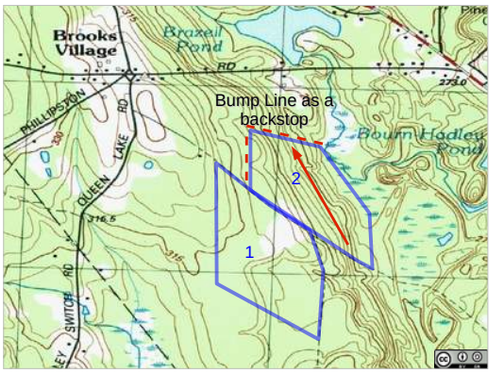
What identifiable boundaries (potential guide or bump lines) do you have for the two segments?



2 might be a good candidate for a contour search: grid sweeps along the contour lines (noting that detection may be higher if you just sweep up hill).

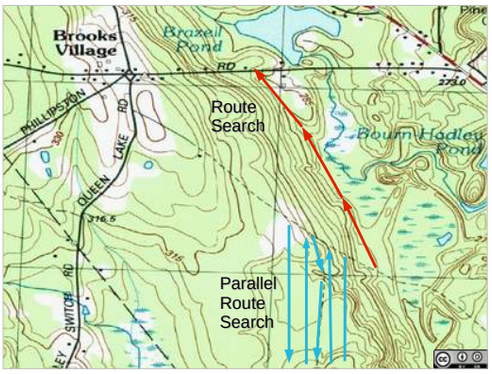
1 is a good candidate for a simple area search.
You could enter a GPS waypoint for the SW corner of 1, or send flag the West or South boundaries prior to starting, or **just pace**.

How do you know when you've reached the the N boundary of 2? (the grid lines are of different lengths, and there isn't an obvious backstop).



The N boundary of 2 would be a good candidate for flagging a bump line as a backstop – send a small group in to lay flagging to mark the western and northern boundaries of the segment – N about 200 m off the dirt road to the small drainage, then east down the drainage.

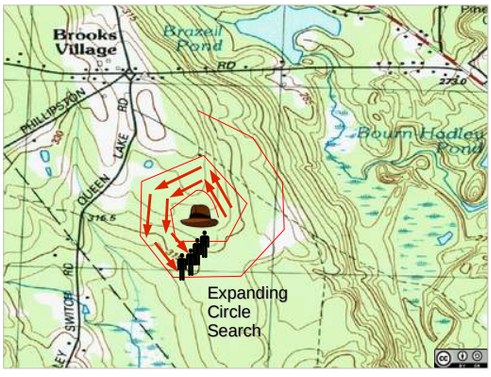
The southern boundary of segment 1 could get a bump line, but doesn't need one (just flagging from the searchers), as it is a constant distance south and parallel to the dirt road.



A route search follows a possible travel route.

A parallel route search has multiple grid sweeps parallel to a travel route.

What might cause you to chose one of these tactics or the other?



An Expanding Circle search might be applied with the location of a clue as a starting point.

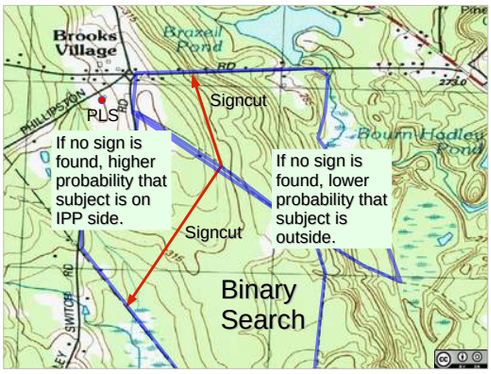
Area Search Patterns

- Area Search (II or III)
- Route (Area) Search (I or II)
- Parallel Route Search (II)
- Expanding Circle Search (II)
- Contour search (II or III)

Route/Corridor searches tend to be Type I or Type II searches.

Other search patterns tend to involve Type II for more complex navigation, Type III tends to be mostly limited to area and contour search.

Why?



There is also Binary Search.

Signcut perpendicular to likely direction of travel by the subject.

Look for sign, if none, subject might not have passed the signcut line.

Requires skilled signcutters.

Then we have type IV searches – shoulder to shoulder evidence searches.

What are the thoroughness, destructiveness, efficiency characteristics of a type IV search?

(Evidence search can also be done as a tight Type III grid search, with spacing set by a Northumbrian rain dance around an object the size of an expected clue, rather than an object the size of a subject).

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Practical Evolutions:

(1) Northumbrian rain dance (if not done earlier).

(2) Type II grid with purposeful wandering on bearing.

(3) Type II grid with cycles of advance and purposeful wandering.

(4) Type III grid off a base line.

Canine and Equine SAR

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NEWSAR SAR Field Team Member: Unit 21 February 19, 2020

Canine and Equine SAR

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Unit 21: Canine and Equine SAR
Date Last Updated: February 19, 2020

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Search Crucials

- Search is an Emergency
- Search is a classic mystery
- **Search for clues not just the subject**
- Know if the subject leaves the search area
- **Close grid search as a last resort**
- Manage by objectives
- Search management is information management

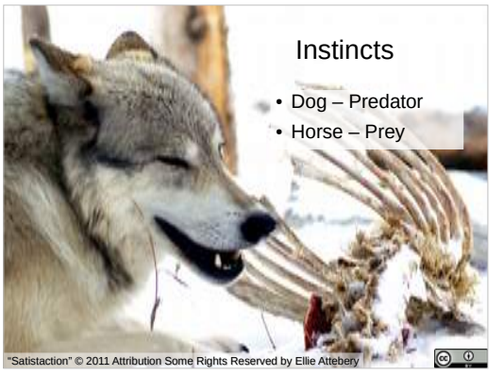
Dogs and Horses can be very effective resources for efficient, minimally destructive search.

Are there clues that dogs or horses can detect that human searchers can't?

What?

Why?

Instincts



- Dog – Predator
- Horse – Prey

"Satistaction" © 2011 Attribution Some Rights Reserved by Ellie Attebery

Dogs as sensors – they are predators.

Horses as sensors – they are prey.

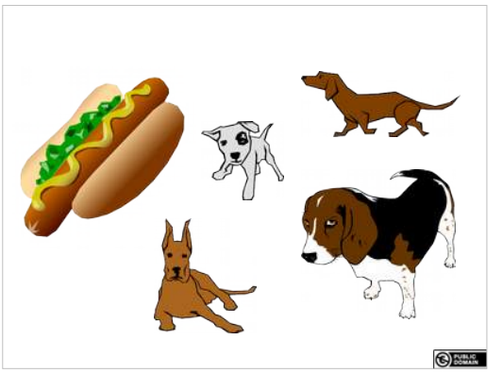
How do they differ from humans?

Are dogs just detecting with their noses?

Call out the dogs!

Requesting resources:

Call out the dogs...



What sort of dogs?

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FEMA Typed Canine SAR (ESF-9) Resources

- Canine Search and Rescue Team – Wilderness Air Scent
  - Type I, Type II, Type III, Type IV
- Canine Search and Rescue Team – Wilderness Tracking/Trailing
  - Type I, Type II, Type III, Type IV
- Canine Search and Rescue Team – Land Cadaver Air Scent
  - Type I – disaster, Type II - disaster
  - Type III – non-disaster, Type IV – non-disaster
- Canine Search and Rescue Team – Water Air Scent
  - Type I, Type II, Type III, Type IV
- Canine Search and Rescue Team – Avalanche Snow Air Scent
  - Type I, Type II
- Canine Search and Rescue Team – Disaster Response
  - Type I, Type II, Type III, Type IV

FEMA, as part of NIMS, has developed resource type descriptions for SAR.

These include 6 typed canine SAR resources.

Handout.

Some Canine Resource Types

- Wilderness Air Scent
- Tracking/Trailing
- Cadaver/HRD
- Water Search
- Article
- Avalanche
- Disaster: Live Find
- Disaster: Cadaver/HRD
- Patrol (ESF-13)

There's common names for these resource types. We'll focus on the top three.

Wilderness Air Scent dogs find any person in an assigned search area. Tracking/Trailing dogs follow the scent of a particular person. Human Remains Detection dogs search for the remains of deceased people. Water search dogs search for human remains in the water from shore or boats. Article dogs detect objects with human scent on them. Tracking dogs may also detect articles with the subject's scent on them. Avalanche dogs detect people under snow. Live find disaster dogs find living people buried in collapsed structures, Disaster HRD dogs find the remains of deceased people in collapsed structures. These ESF-9 resources should be distinguished from patrol dogs (with a law enforcement function).

Wilderness Air Scent

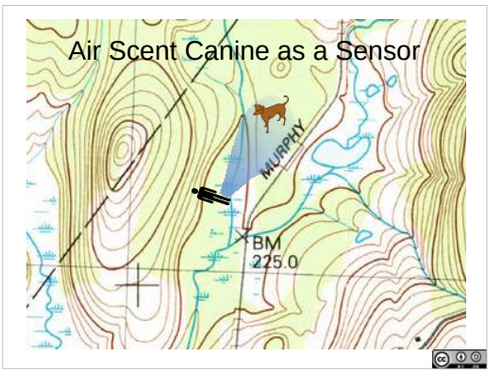
Air scent dogs. (Wilderness Air Scent, Live Find)

Air scent dogs are trained to detect and alert on any human.

Can work in urban parkland, suburban, and rural environments as well as wilderness. Can work inside structures.

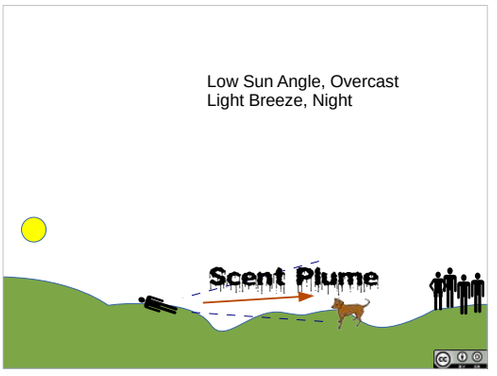
Work well with clue aware searchers.

Regionally, nationally, and globally, predominantly volunteer resources.



Wilderness air scent canines can be thought of as detecting a scent plume coming off of a subject.

How does this differ from a human searcher? [It isn't like the exponential detection function. Detection distance is influenced by how the air is transporting scent.]

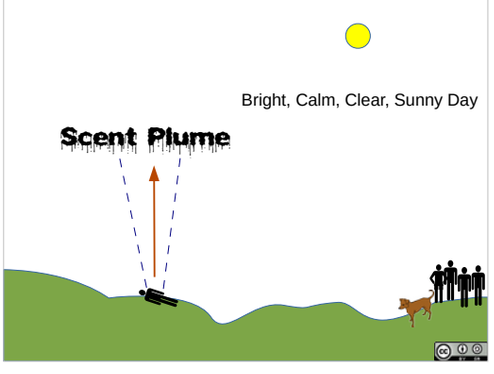


Best case – good conditions for working scent.

Atmospheric conditions are stable (air near the ground is remaining near the ground rather than rising). There's a light breeze, with a steady wind direction, making a long scent plume from the subject near the ground.

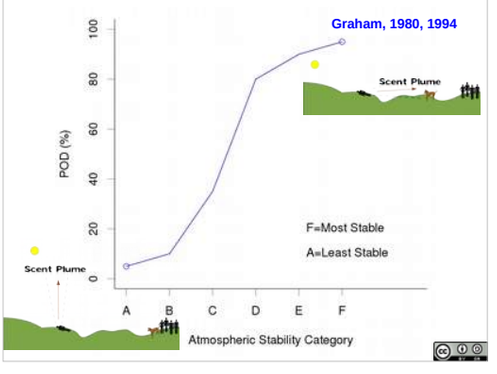
Night. Overcast. Low sun angle (morning/evening) – best conditions for stable atmosphere.

Search Crucial: Search at Night.



Worst case: Bright calm clear sunny day. Unstable atmosphere. Warm air near ground is rising up (carrying the scent with it).

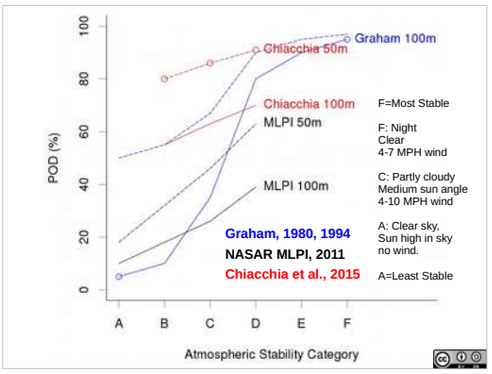
Search Crucial: Search at Night.



Canine handlers working a wilderness air scent area problem can estimate a POD.

Here's a graph translating the diagrams we just saw into POD values, with a handler gridding a segment at a 100 meter spacing.

Best understood factor for estimating canine POD is atmospheric stability. Unstable air rises, taking the scent with it, leaving little for the canine to detect. Stable air with some wind creates a scent plume near the ground that the canine can detect.



Unfortunately not quite that simple.
There are three different schemes for providing a canine POD value from atmospheric stability and grid spacing, mostly based on little data and many assumptions.

Here is a comparison of the 100 m and 50m grid spacing values from the NASAR MLPI text (black), from the original work by Graham (blue), and from a recent study by Chiacchia et al. (red). Circles are data points. Everything else is extrapolated. Dashed lines are POD for the handler working a grid at 50 meter spacing, solid lines for the handler working a grid at 100 meter spacing.

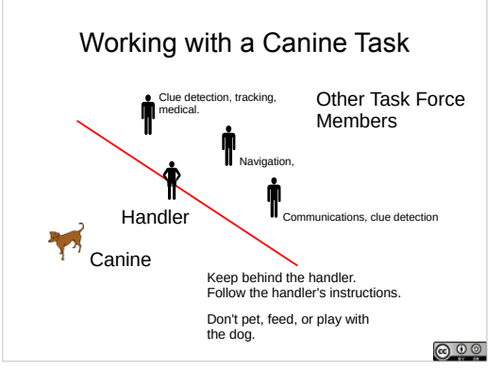
Poor conditions: Handler can adjust tactics by using closer grid spacing (50 m or 25 m) to get better POD.

It is more effective to split up the responsibilities in the assignment.

Best practice: 4 people on the assignment.

On a four person task force, the handler can focus on observing the behavior of the dog. The other members of the task force handle responsibilities for land navigation, communication, looking for clues, and medical care of the subject.

A four person team is the minimum size capable of splitting up without leaving anyone alone.
What are some circumstances that would lead to a task team splitting up? *[injury, discovery of a crime scene – situtations where incoming resources need to be met and guided in (on a marked route) to the site]*



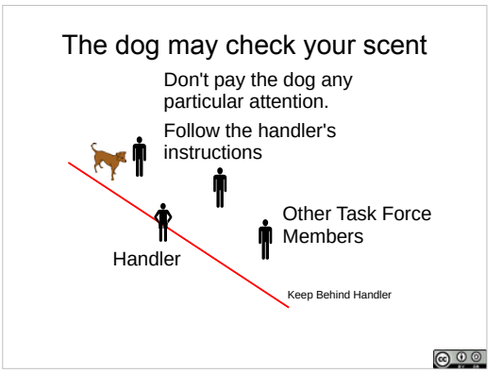
If on a canine task, a couple of ground rules:

Draw a line through the handler's shoulders. Everyone else on the task must remain behind this line at all times. No exceptions.

Don't pet the dog, play with the dog, or feed the dog.

A four person team is the minimum size capable of splitting up without leaving anyone alone.

What are some circumstances that would lead to a task team splitting up? [injury, discovery of a crime scene – where incoming resources need to be met and guided in (on a marked route) to the site]



An air scent dog may “take inventory”, coming up to each member of the task and checking their scent.

This may be an indication that the dog has encountered a new scent.

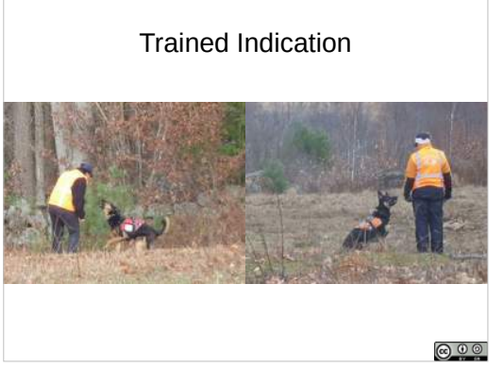
Just let the dog work, don't pet it or pay it any particular attention.

This dog is in scent – he smells a human.

There is a subject buried in the snow. The dog is showing untrained behaviors (e.g. changes in pace, posture, tail position, tail motions, breathing rate) characteristic for that dog that the handler learns to recognize when the dog detects human scent and starts trying to locate the source.

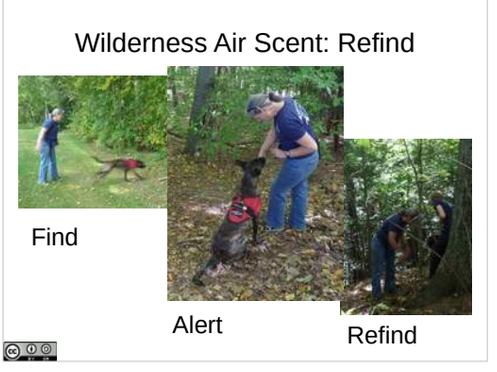
When handlers observe untrained alert behaviors they should record the location and wind direction **– or ask you to.**

The dog may work from the location it is getting into scent up to the subject, or the scent may be discontinuous, or the subject may be inaccessible.



A trained behavior that the dog exhibits on finding a subject (or in detection work, on locating the source of odor).

Sit is one typical trained indication, bark is another.

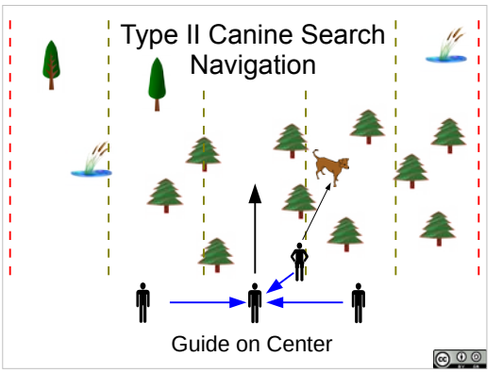


The trained indication may occur at the subject, or at the handler.

A trained indication may be a “bark alert”,at the subject's location. The dog stays and barks at the subject.

Or a trained indication may involve a find/alert/refind behavior chain. On finding the subject, the dog returns to the handler, performs a trained behavior (sit, bark, etc.) and then performs a refind to bring the handler back to the subject.

This dog has is finding a subject, returning to the handler to perform a trained indication (a sit), and then returning to the subject in a refind.



To best focus on watching for undrained alert behaviors, the wind, the terrain, etc, the handler can be most effective if they can focus on the dog, while:

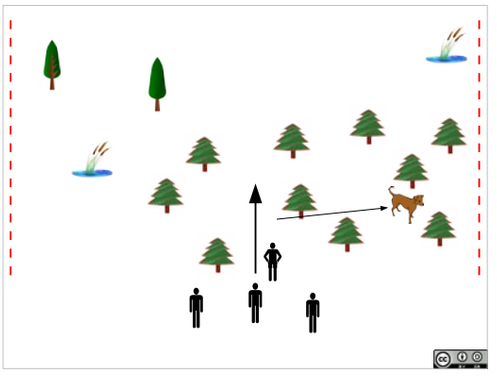
Someone else navigates and sets the control line.

Everyone else (including the handler, out front) positions themselves off of the guide person.

Searchers flanking the guide person can do purposeful wandering in their search lanes.

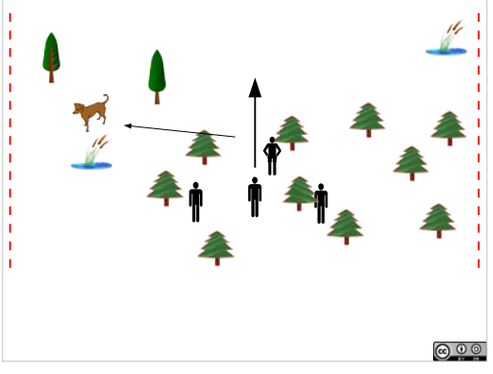
Everyone looks for clues.

Dog's sweep width will probably be wider than the human task's sweep width.

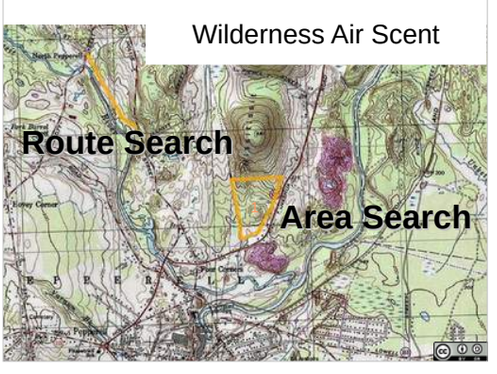


Dog typically ranges right and left of the handler's path.

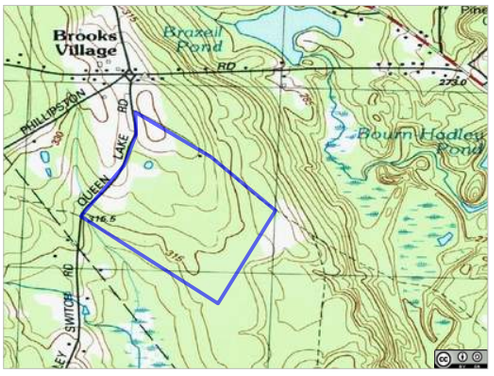
Dog's sweep width will probably be wider than the human task's sweep width.



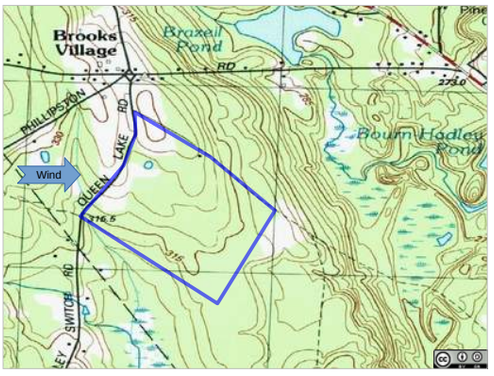
The dog's ranging may be very directed by the handler, or may not.



Air scent dogs can be assigned to search areas or routes (where routes can be trails, powerlines, drainages, or other travel corridors, not just trails).

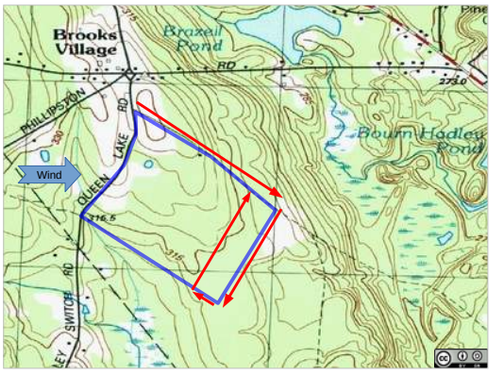


If given an area

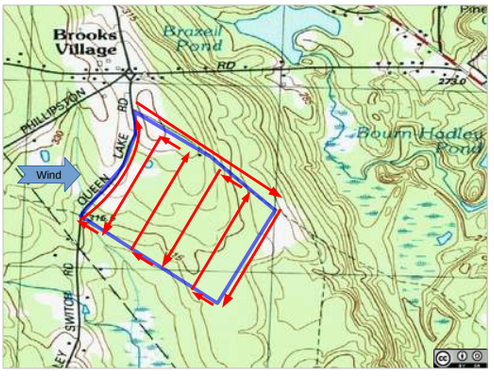


Where's the Wind?

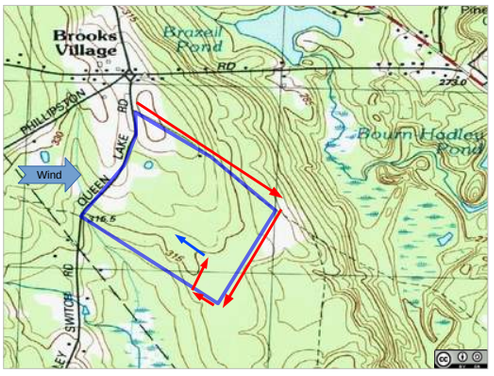
A wilderness air scent handler will ask how the air is moving – both the larger scale prevailing wind, and when they get out in the field, what the local flow of air is doing (and how it is varying (both near the ground where the dog's nose is, and higher up) – thus canine handlers tend to carry talcum powder or other fine powders for checking the wind).



The wilderness air scent canine handler with then usually try to work the segment by gridding from the downwind end up towards the upwind end – with the grid lines running cross wind. The goal is to get the most chances of putting the dog's nose into a scent plume from the subject. (This is the hander's track, the dog will probably range off of this track).



Traversing the entire segment in a grid running across the wind.



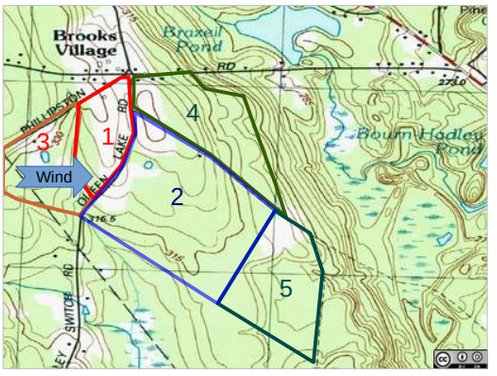
But, the dog might start showing untrained indication behaviors and start working away from the handler.

Here, the handler may ask you to record the location and get a bearing on the wind direction.

(About what is the wind direction here? [about 270 degrees – 'wind from'])

Or, the handler may leave the planned grid and follow the dog – what do you need to do? (flag the location, record the location and follow the handler).

The dog may stop working scent (there may be discontinuous scent pools rather than a clean scent cone to the subject) and the handler may want to return to the grid at the point you left it to continue the grid of the segment.



Dogs don't know where the segment boundaries are.

An air scent dog may detect searchers in an upwind segment (the dog is imprinted on any human odor).

Coordinate to try to avoid having searchers immediately up wind of a the boundary of a canine search segment (at least when the canine is near that boundary).

Example: coordinate searchers in Segment 1 with an air scent canine task in Segment 2.

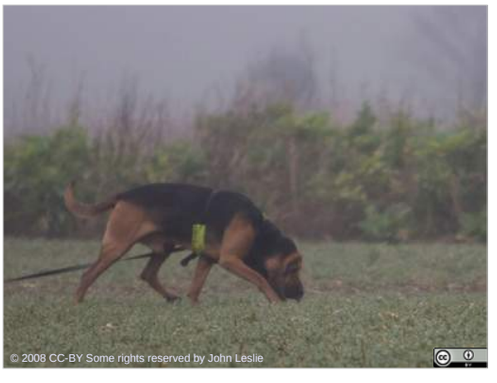
Practical Evolution (1) (Bearings and distances on map for marked segments).

Bloodhounds. May be that breed, or another breed.

Tracking dogs train to follow the subject's trail very closely, like mantrackers working step by step.

Trailing dogs train to follow the subject's scent trail more loosely.

Work well with mantrackers (who may be able to see corroborant, definitively human, or identifiable sign from the subject on the scent trail the dog is following).



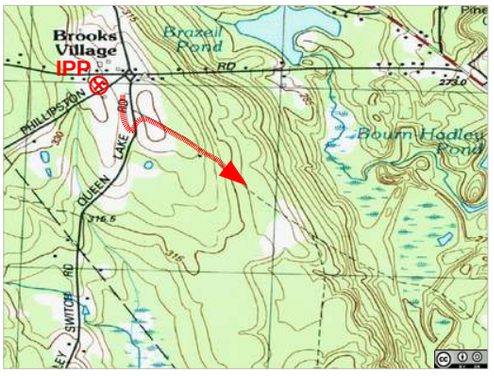
The handler will want to obtain an uncontaminated scent article.

Can be deployed at a PLS or LKP to determine direction of travel.

May follow a track that is not the subject's, treat a track, as with all other clues, as having some probability of being a red herring.

Tracking and Trailing dogs work effectively when combined with mantrackers.

Why? (A mantracker may be able to find identifiable sign along the dog's track – confirming the track is of the subject, as well as definitively human sign indicating that the dog is following a person, spot clues, etc.).



Navigation for a Tracking/Trailing task involves keeping track of where the dog is taking you.

Tracking dog is going this way. Where do you put searchers?

Consider leapfrogging some resources out ahead of the direction of travel.

Don't focus on just this track. Keep doing everything else. Protect the IPP, establish containment, investigate, search the area high probability area around the IPP, search travel corridors from the IPP to the containment boundary, search high risk and high probability places.

Tracking/Trailing dogs require a scent article with the subject's scent on it.

Easily contaminated – has a nice scent for the dog on it, but not the scent you think is on it.

Let the handler identify, collect, and handle an appropriate scent article.

"We've got the subject's pillowcase".....

What scent do you think is on that pillowcase? What track might the tracking dog be following?

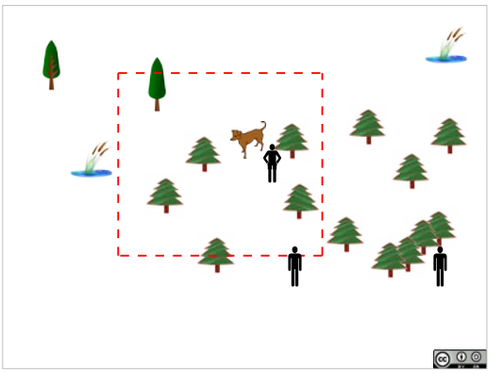
Then we've got Human Remains Detection/Cadaver dogs.

Imprinted on the scent of dead humans, proofed against the odors of dead animals.

Likely to show untrained alert behaviors while working into scent.

Trained final indication behavior at source.

Cadaver scent may travel with groundwater and the strongest source of scent (and the location of the trained indication) may be at a location different from where a body is buried.



HRD dogs tend to train towards detecting small scent sources in small areas (often 1-2 acres or less). Composition of tasks and support/navigation needs different from wilderness air scent.

Typically work in pairs, one working an area, another out of sight brought in to work the same area after the first dog has finished. See if both indicate on the same locations. For small areas, may be just one handler and one observer working the area with another handler waiting out of sight.

Can work with ground searchers on probe lines (detecting areas of less compacted soil). Can work with ground searchers looking for surface bone, etc.

The dog's ranging may be very directed by the handler, or it may not.

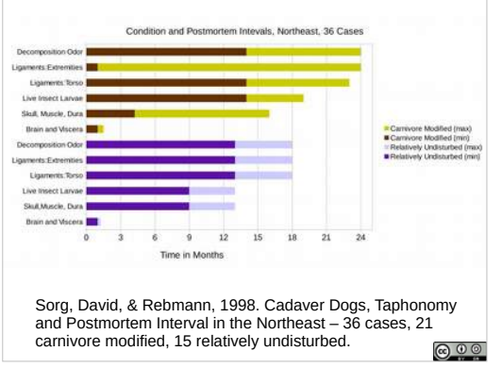
Human remains on the ground surface decay and are modified over time by scavengers.

Associated clothing and artifacts can decay and change over time.

How do changes to remains and artifiacts affect detection?

The fabric in this setting (Cambodia) has retained vivid color on a decade time scale, it may not and may quickly blend in with the environment.

What you (and dogs) are looking for changes over time.



Sorg, David, & Rebmann, 1998. Cadaver Dogs, Taphonomy and Postmortem Interval in the Northeast – 36 cases, 21 carnivore modified, 15 relatively undisturbed.

Some Regional data:
HRD and time. Data from the Northeast (Maine), only 36 cases, minimum and maximum times shown for carnivore (scavenger) modified and relatively undisturbed human remains.

Brain, Viscera, Finger & Toe bones < 1-1.5 months
Other soft tissues 4-15 months.
Ligaments, odor, 1-2 years.

Conditions of remains – time sensitive Less time, more odor.

(Carnivore (scavenger) modified larger than unmodified, could be effect of small sample sizes – take exact numbers with a grain of salt).

Then we have horses.

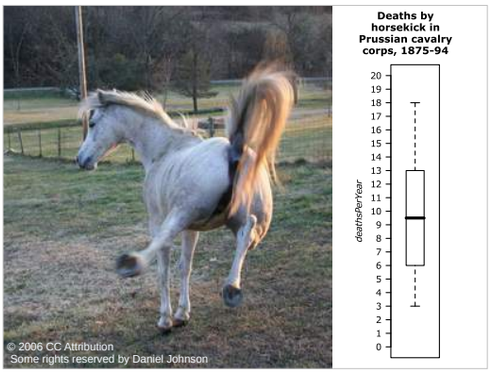
Horses can serve as sensors, as a high vantage point for searchers, and for transport.

As sensors, tapping into horses' alertness as prey animals.

[Mounted SAR Canine unit heading out on a task in training in James River State Park, VA]

Horses are large and powerful.

Need to exercise caution working around them.



There are dangers, even for those experienced and used to working around horses.

Horses can startle at things the horse doesn't expect or like.

ATV – pull over, turn off, remove your helmet, let the horse pass.

Why remove helmet? (don't look like a human)

Dog, bring the horse off the trail, sit/down let the horse pass.

[graph: about 10 deaths per year from horse kicks in the prussian cavalry in the late 1800s – that's folks working with horses who are experienced with horses.]

The ears are one of the things that can inform you about what a horse is thinking.

Left, Ears back: upset, unhappy. Be extra cautious

Right, relaxed.

Attentive and alert.

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What's going on here?

Horse is detecting an unfamiliar odor.

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Horses as sensors, as logistical support, and:

Under some limited conditions, it may be possible to use equines for transport and evacuation of an injured person.

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Practical evolution (2) Navigate three legs of the grid for a canine segment, including diverging to investigate.

Ties and Rope
(for non-technical terrain carry out)

CC BY SA

Unit 22: Ties and Rope
Date Last Updated: February 19, 2020 [Crosschecked, needs images]

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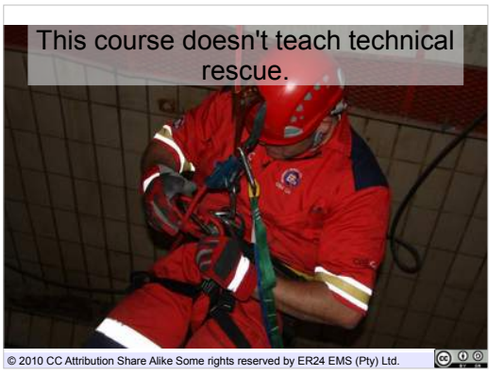
Gravity is dangerous.



This course doesn't teach technical rescue.

Only foundation knots.

This course doesn't teach you how to operate in the high angle environment, just how to recognize it.

Knot tying skills are a foundation you can build on later with more training.

There is hardware, metal things, and:

Software: Rope, Webbing.

Rope comes in lots of sorts. This is a natural fiber **laid rope**.

Fibers are twisted into bundles, which are then twisted into bundles. Fibers don't run the full length of the rope. Load bearing fibers are exposed to damage.

Natural fiber ropes can rot.

Neither laid rope nor natural fibers are used for life safety applications.

This is Kernmantle rope.

Outer mantle provides abrasion resistance. Inner core (kern) of fibers that run the length of the rope and provide its strength.

Almost all modern climbing rope and life safety rope is kernmantle (made of various synthetic fibers).

Static and Dynamic Rope

Rope can be low stretch (bottom) or high stretch (top).

Climbers use high stretch, dynamic rope. They climb, putting their weight on the rock. When they fall, they are caught by the rope, and the rope stretches to absorb the energy of the fall.

Technical rescue almost entirely on static or low stretch rope – the system is rigged to hold the rescuers' and victim's weight on the rope all the time. Anchors and system hold the load all the time.

In High stretch rope, fibers in kernel twisted to have lots of stretch.

In Low stretch rope, fibers in kernel run much more in line with the length of the rope.

[*Parenthetically, a distinction can be made between low stretch and static, not discussed here*]

Webbing

Software also includes webbing – flat or tubular.

Ropes are easily damaged

- Never step on a rope.
- Keep ropes away from battery acid.
- Never touch a loaded rope with something sharp.

Watch where you put your feet around ropes.

Never ever step on a rope. Why? (grinds sand grains into kernel, these undetectably cut the strands in the kernel and weaken the rope).

Rope under load cuts very easily – needs edge protection running over sharp edges. Avoid having knives around rope systems.

Nylon rope is damaged by exposure to battery acid.

Important to learn to wash rope, inspect rope, care for rope properly. Inspect after each use, maintain a rope log.

(Image is of damaged kernmantle rope. Outside mantle is damaged, exposing the white core within.)

Sand Grain *(probably around 1mm across, no scale in source image)*

Can have small very sharp edges.

Want this inside your rope?

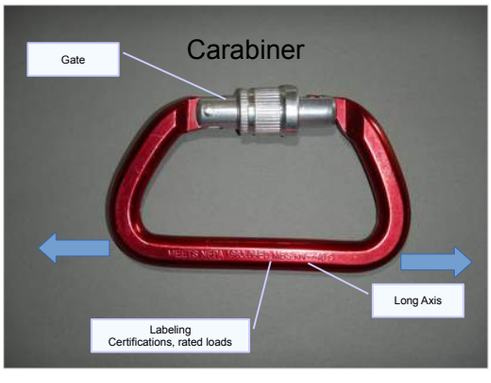
Stepping on a rope can grind sand grains (and such) into the rope. Sand grains in the core cut fibers in the core and weaken the rope.

Rope, webbing, harnesses are software.

Then there is hardware. Carabiners and all sorts of specialized hardware.

Designed for specific loads in specific directions. Will fail if you load it improperly.

(Example: Load carabiners on their long axis, ensure the gate is closed and locked.)

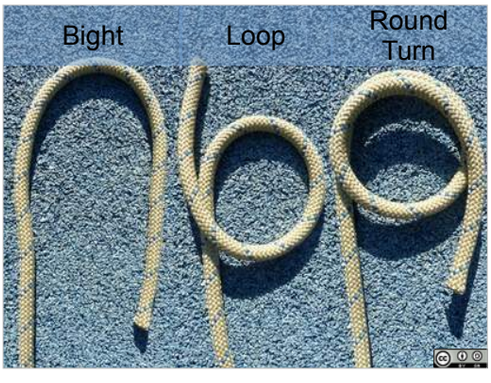


Parts of a locking Carabiner:

Gate.

Load along the long axis.

Labeling informs strength ratings, allowing rope technicians to choose appropriate hardware when designing and building a rope system.



Names (again) to help us see things.

Bight: just a 180 degree bend in the rope.

Loop: Keep going to form a closed loop, with the rope exiting the opposite direction from where it entered the loop.

Round turn: Keep going, there's a full loop, and the rope exits from the same direction that it came in on.

"Knots"

- Tie:
- Knot:
- Bend:
- Hitch:

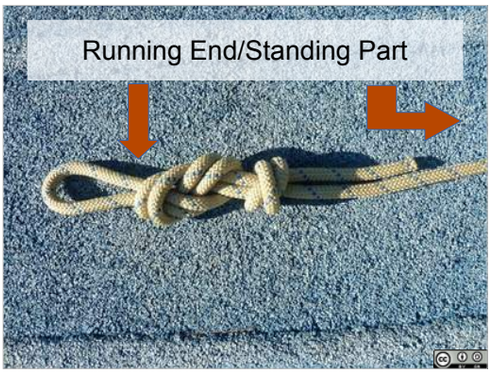
Tie = technical term for what we mean by knot in everyday language.

Three sorts of ties:

Knot = tie that forms a stopper knot.

Bend = a tie that joins two ropes (or two ends of the same rope) together.

Hitch = a tie that attaches a rope to something else.



Running End = Working End – the end you tie a knot in.

Standing part – the rest of the rope, usually the part under load.

Practice Ties

- Figure 8.
- Figure 8 on a bight.
- Figure 8 on a bight, with barrel knot safety.
- Figure 8 follow through (tie in), with barrel knot safety.
- Water knot.
- Half Hitch.
- Clove Hitch.
- Girth Hitch.

Hand out rope and webbing, demonstrate and have everyone tie each of these ties.

Images of each follow. *[You can use the images while teaching the knots if that is helpful, there are some comments on the knots in the speaker's notes]*

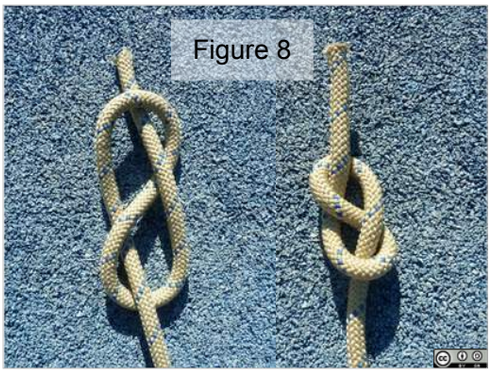


Figure 8 stopper knot.

Foundation life safety knot. Easy to recognize , easy to see that it has been tied correctly.

The Figure 8 family of knots all take a lot of rope, and can be hard to untie after being heavily loaded.

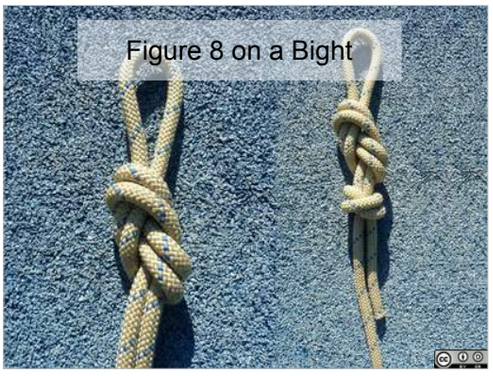


Figure 8 on a bight.

Dress your knots. That is important for their strength.

Barrell knot safety (on a figure 8 on a bight).

Make the loop on your figure 8 just large enough for its purpose.

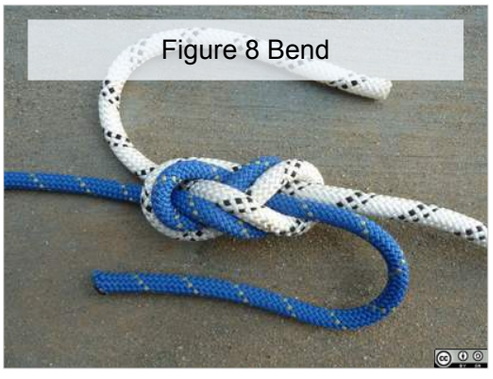


Figure 8 bend.

Bend – joins two ropes together

Figure 8 follow through

Exactly the same knot as the figure 8 on a bight, but tied in a follow through (to attach to a harness or some other closed ring).

Starts with a figure 8 in the working end, then pass the working end through the closed ring, then trace the 8.

Figure 8 follow through, finished knot

Exactly the same knot as the figure 8 on a bight, but tied in a follow through (to attach to a harness or some other closed ring).

Tied in webbing.

Overhand knot family.

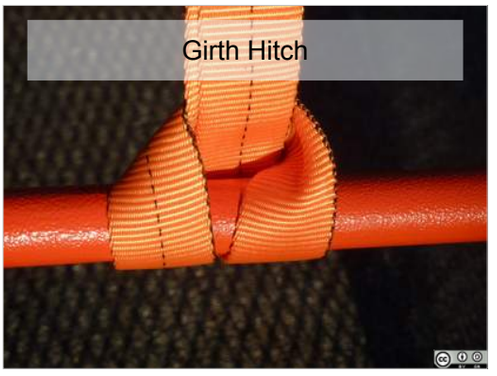
(can show:
overhand knot: stopper knot
half knot: binding knot (half of square knot)
half hitch: hitch
All same topology, but with object passing through tie in different places).

Water Knot – bend to tie in webbing.

Clove hitch tied in webbing.

Clove hitch slightly easier to see tied in rope.

Two ways to tie (in the air and drop onto something, or around something).



Girth hitch.

[*Girth Hitch and clove hitch can be used to attach webbing to a litter*]

NEWSAR SAR Field Team Member: Unit 22: Ties and Rope February 19, 2020

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