Land Navigation I: Topography

Unit 4, Land Navigation I: Topography
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Map and Air Photo

Teaching map reading used to be simple, all about learning to read topographic maps.

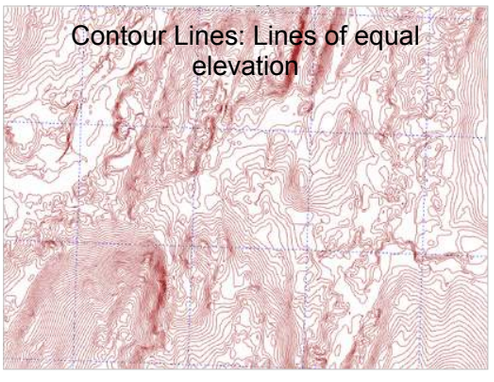
No longer true. There are all kinds of map and GIS products readily available in SAR – including air photos and satellite imagery.

Learning to work with all kinds of cartographic products is important, as is understanding what you can get from one sort that you can't get from another.

What can we see in the map?

What can we see in the air photo?

Contour Lines: Lines of equal elevation

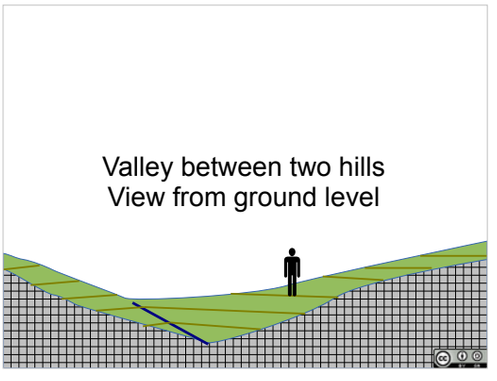


Key thing that is on topographic maps is a representation of – the topography.

Represented with contour lines.

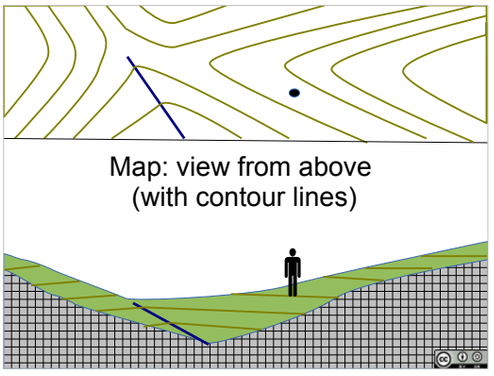
All the points on a contour line are at the same elevation.

Valley between two hills View from ground level



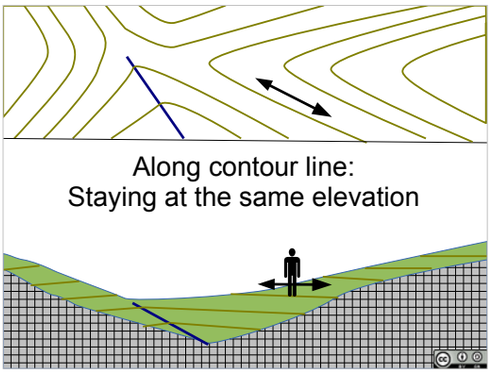
Let's visualize this.

Lets look from the side at a valley between two hills.

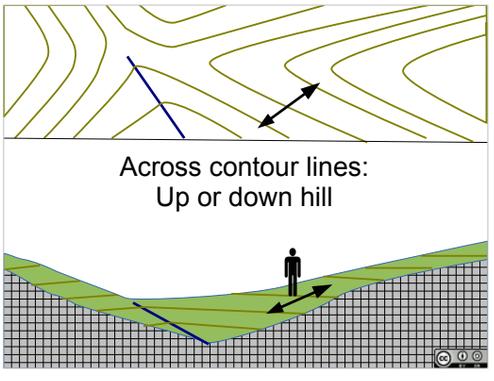


Now, lets look at it from above – in map view.

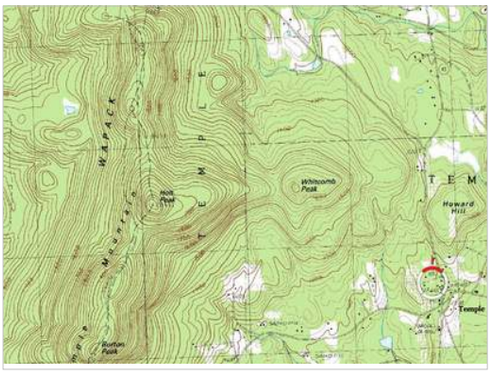
We can see the point where the person is, the stream, and the terrain (a saddle)



If the person walks back and forth on the hill staying at the same elevation they will be walking on a contour line.



If the person walks up or down hill, they will be crossing contour lines.

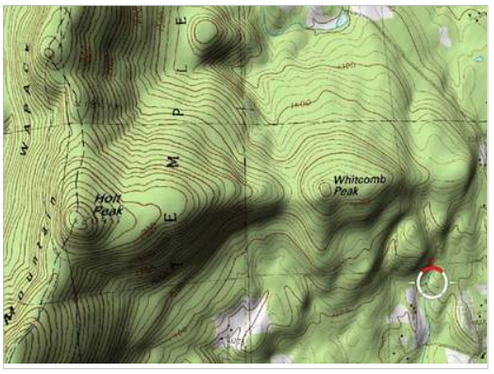


Topographic map

Where are the high points?

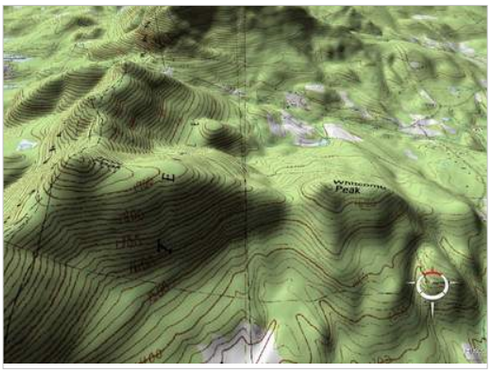
Where is it steep?

Where is it flat?



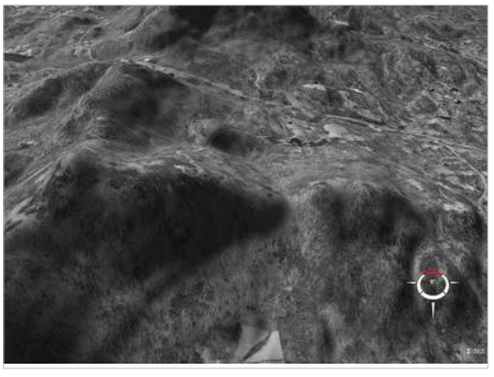
With shaded relief – easier to see the terrain.

Some maps add contour lines and shaded relief – much easier for most people to easily see the terrain.

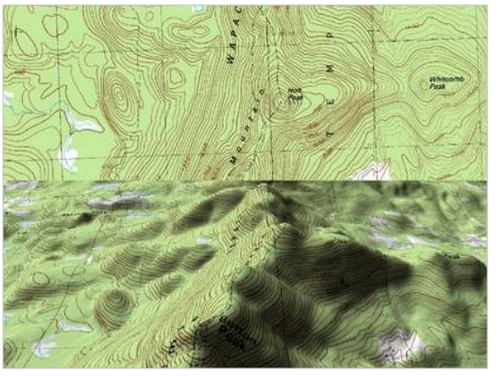


Not looking straight down anymore – tilted to a perspective view as looking out the side window of an airplane

(Visualization in NASA WorldWind, similar view available in Google Earth).

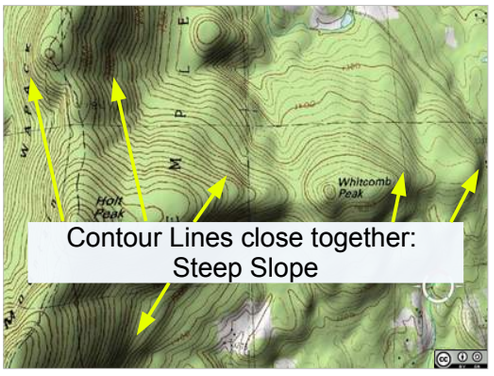


Air photo draped over the terrain. In perspective, with shaded relief.

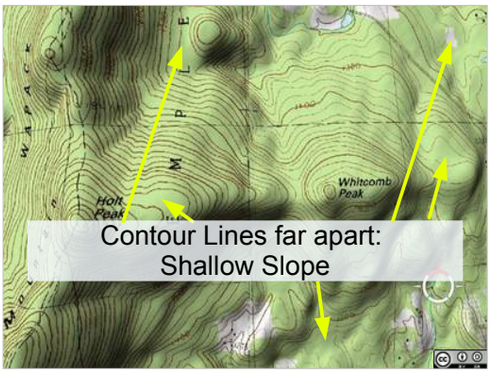


When you look at a topographic map you should be able to visualize what the terrain looks like: Where are the high points, where are the valleys, where is the terrain steep, where is it flat, where are the streams flowing....

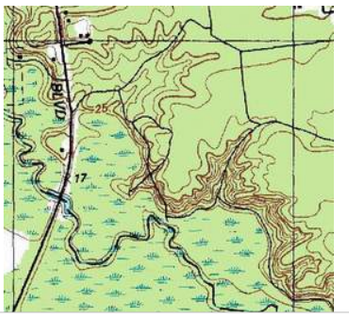
Comparison of topographic map, and perspective view of same area with shaded relief.



Some places are steep, some are flat.

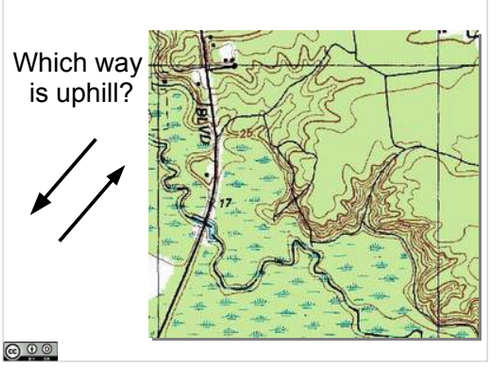


Where are the steep slopes?



Tightly spaced contour lines between the level ground in the upper right and the swamp in the lower left.

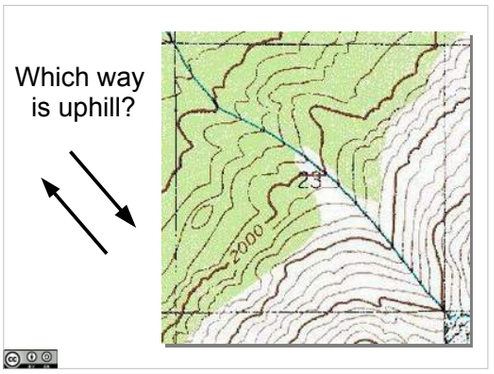
Which way is uphill?



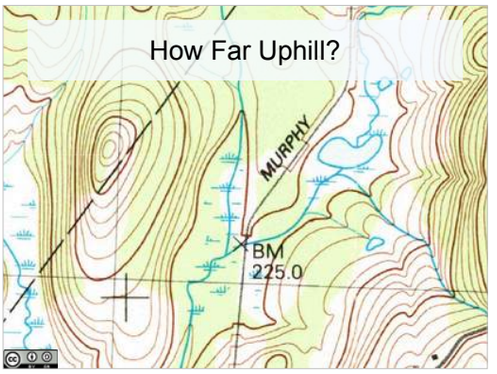
Do the streams drain out of the swamp to the north east (upper right is low ground), or into the swamp from the north east (upper right is high ground)?

Law of Vs – where a drainage crosses a contour line, the contour line makes a V with the point of the V pointing towards higher elevation.

High plateau to the upper right, with a steep break and drainages down into the swamp.

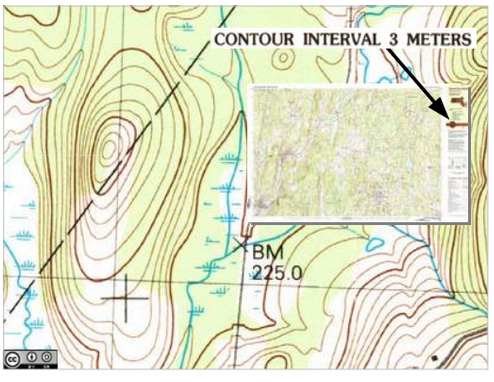


Vs point up hill. Uphill is above the tree line, and has a glacier at the top of the drainage (lower right corner).

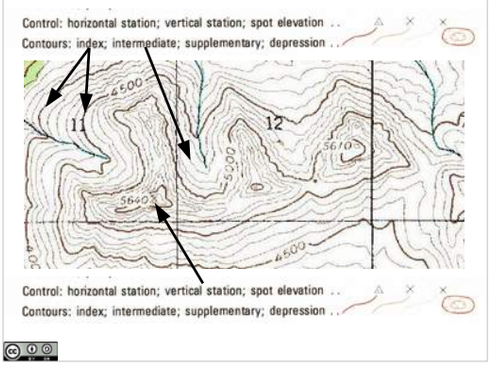


Contour lines also tell us how tall hills are.

(Here there's a benchmark at 225.0 [something], but no other indication of how much relief is present).



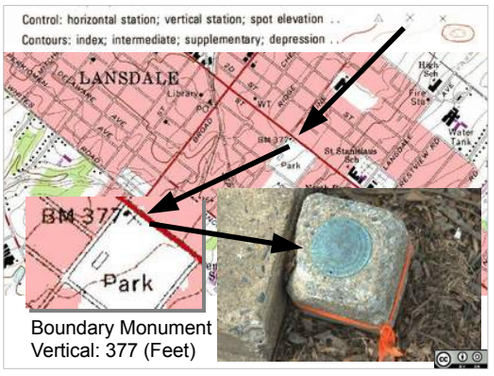
The metadata on the map border can tell us how far apart the contour lines are – what the contour interval is.



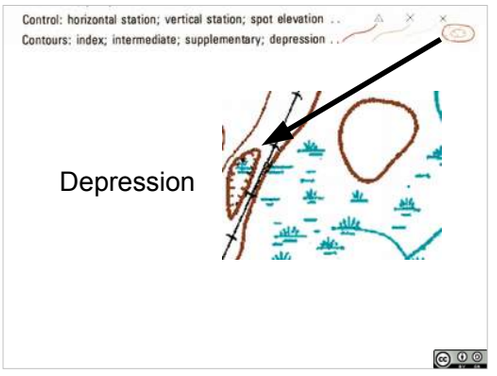
Contour lines are often of two line weights – thick lines with elevations on them (index contour lines), and thin lines without elevations (intermediate contour lines). The contour interval is the (vertical) distance between intermediate (thin) contour lines.

Points can also have elevations associated with them – spot elevations, and vertical survey stations.

[Very flat areas can get supplementary contour lines to show features that are smaller than the intermediate contour lines. Depressions get contour lines with tick marks pointing down (to tell them from peaks)]



Here is a vertical station, a boundary marker with a surveyed elevation of 377 feet. (Technically, this is a vertical control station, common parlance is “a benchmark”).

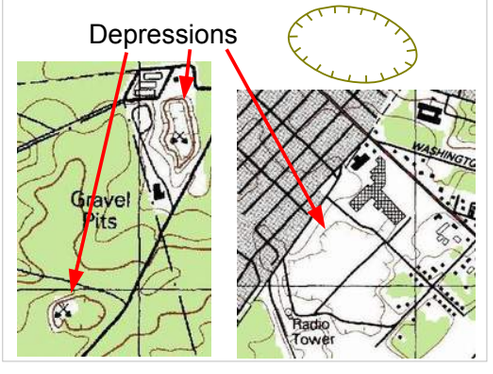


Depression: Tickmarks point down hill (to let you distinguish a depression from a small hill).

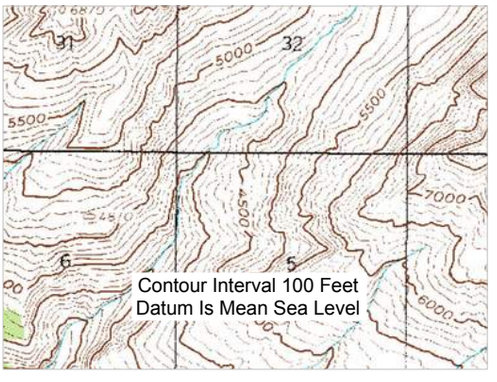
One contour line with tick marks – a depression shallower than the distance between two contour lines.

So what do we see here?

There’s a swamp, with a hill in it, then a railroad line (the black line with the cross ticks) running down along the edge of the swamp. An embankment was built up for the railway line, and left part of the swamp cut off as the depression.



Here are a couple more examples of depressions on topographic maps.



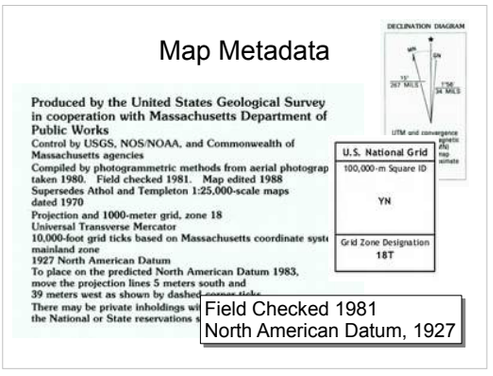
How steep is this?

How can we tell?

Side note: Usual indication of elevation is labeled index contour lines along with metadata on the map border indicating the contour interval, the units (feed in this case), and the vertical datum – what is the basis for 0 elevation.

Numbers on the map are seldom enough – you will likely need some other indication of whether they are in feet or meters. Can be an issue with print on demand maps that may not include the contour interval.

Map Metadata



Lots more information in the map border:

How old is the map?

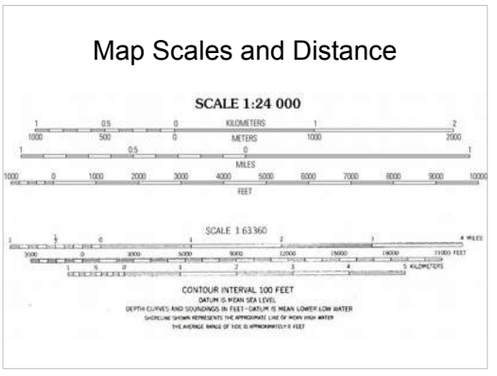
The datum (model of the shape of the Earth used in projecting the map onto a flat piece of paper). We'll come back to this.

What grid is printed on the map. We'll come back to this.

The vertical datum (0 for elevation, some meaning of sea level, quite important in coastal areas).

Which way is north (for different sorts of North). We'll come back to this.

Map Scales and Distance



Map metadata typically includes the scale of the map, and scale bars.

Use these to measure distance.

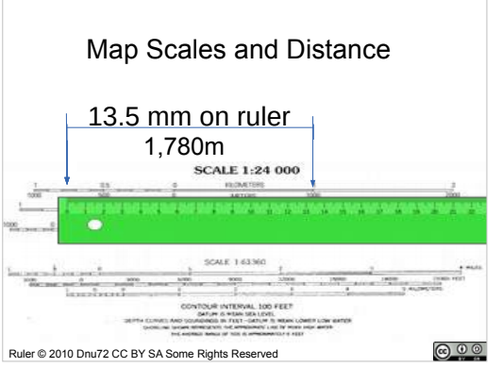
Scale of 1:24,000 means that 1 inch on the map is 24,000 inches on the ground.

Scale of 1:100,000 means that 1 inch on the map is lots more – 100,000 inches on the ground.

Larger number on the scale = less detail on the map.

Note that 0 on the scale bar usually isn't at the end of the scale bar.

Map Scales and Distance



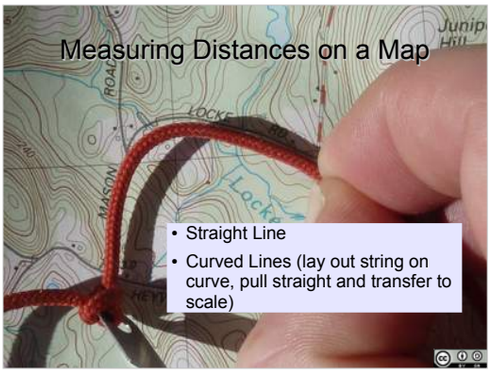
Don't "do the math" even if you are a math whiz (under normal low stress circumstances.)

Use simple methods:
"two-finger" the distance between two points and hold it next to the RIGHT scale.

Direct measurement. Measure the distance on the map, then put this distance next to the scale bar. Line up measurement on ruler next to a big mark (e.g. 1 km here) so that 0 of ruler is below 0 in the finely divided marks on the scale bar, then read off and add up on scale (1km, plus 700m, plus about 80 meters).

Ruler is from Dnu72, Dáni para los amigos:
https://commons.wikimedia.org/wiki/File:Regla_01.svg

Measuring Distances on a Map



With a ruler or the edge of your compass, you can measure straight line distances on the map easily using the scale.

You can also measure distances along trails and curving routes on the ground. Lay the lanyard on your compass along the trail, then transfer to the scale bar and measure the length of the straightened out string.

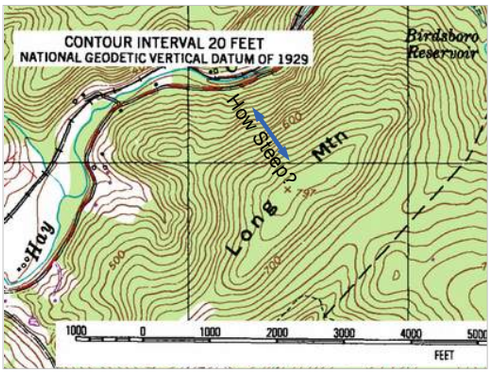
Practical Evolution 1 here. (Map for practical Evolution 1 is next slide)

Map for Practical Evolution 1 (and 2)

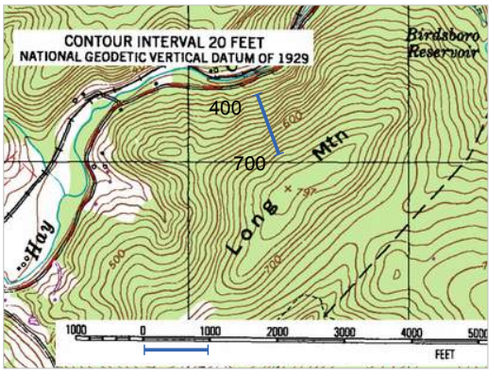
Point out scale bars, and that 0 point of scale is not at end.

Measure the straight line distance between two landmarks: (Measure the distance from the peak of Crow Hill to the Water Tank by the Fernald State School (~1350 meters)).

Measure the distance along a winding path (using the compass lanyard): (Measure the length of Norcross Hill Road (~2km)).

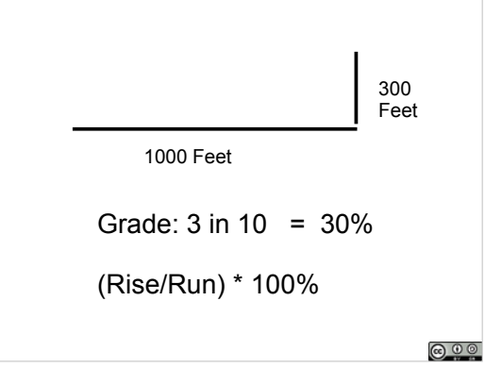


Contour intervals also let us find steep places and flat places – how steep is the NW face of Long Mountain?

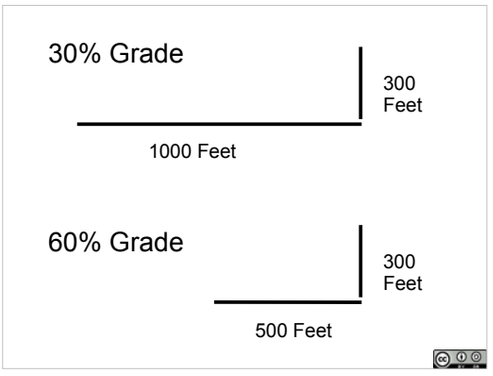


Vertical distance along the blue bar is 300 feet (400 foot contour line to 700 foot contour line)

Measure that horizontal distance on the scale – it is 1000 feet.

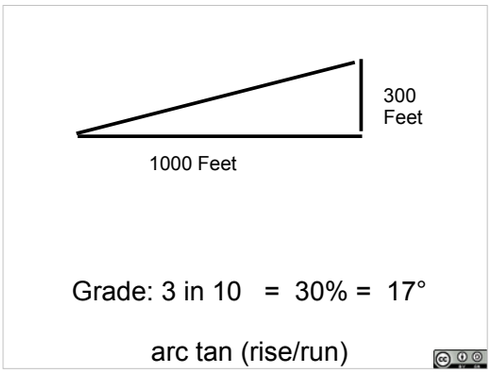


300 feet up a in a 1000 foot run, 3 in 10 grade, or 30% grade. Quite steep.



300 feet up in 1000 feet of run 30% grade

300 feet up in 500 feet of run, 60% grade



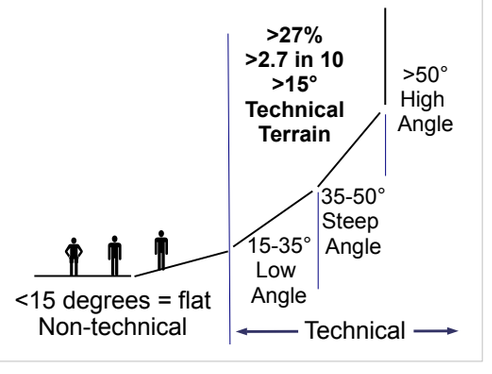
With a calculator we can work out the angle – arc tan of the grade, 17 degrees for a 30% grade.

For technical rescue, we think of high angle terrain – where you are dangling off a rope, and low angle terrain, where the ground is supporting your weight (but you may still be using ropes, particularly in rough ground).

More that about 35-40 degrees is high angle.

35 degrees is about 70% grade.

If the rise is more than about 3/4 of the run, you are looking at high angle terrain.



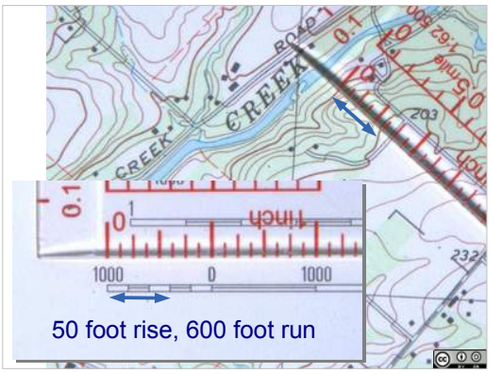
Definitions for high/low angle conditions vary:

NFPA: High Angle = Weight supported by rope system. Low Angle = Weight supported by ground.

Common (but slightly variable definition) we'll use here:
Flat ground: 0-15 degrees
Low angle: 15-35 degrees
Steep angle: 35-50 degrees (most dangerous)
High angle: 50-90 degrees

Quality of footing also factors in – poor footing, loose scree, etc, makes for more dangerous conditions.

Anything more that 15 degrees calls for support from technical rescue resources. 15 degrees is about 27% grade, or rise of 2.7 in run of 10.



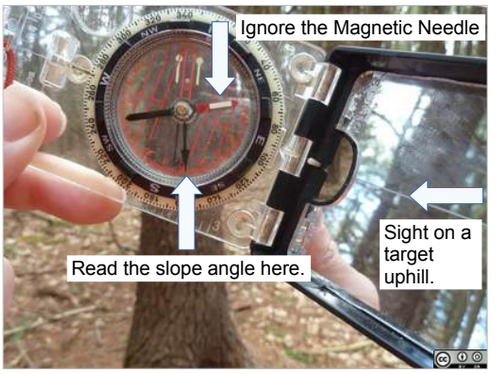
How steep is this?

Do you need technical rescue assets to work on this terrain?

Approximate
60/600 = .1
around 10% grade, not very steep.

More precicely
50/600 = .08
about 8% grade, about 5 degrees.

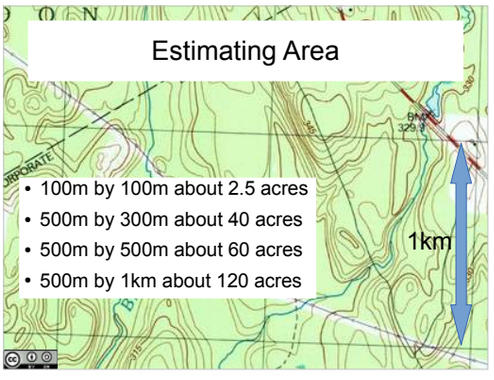
Less than 15 degrees or 27% grade, so probably can operate here without technical rescue assets.
But, note the contour lines aren't uniform, steeper in the bottom 100 feet, could be 30% grade there.



Some compasses have a free hanging needle that allows the compass to be used as an inclinometer – to measure a slope.

Ignore the magnetic needle. Sight on something uphill (or downhill), tilting the compass to line up the sights, and read off the angle from the free hanging needle on the inclinometer scale (which can also serve as the declination scale).

Practical Evolution 2 here, measure slope on map.



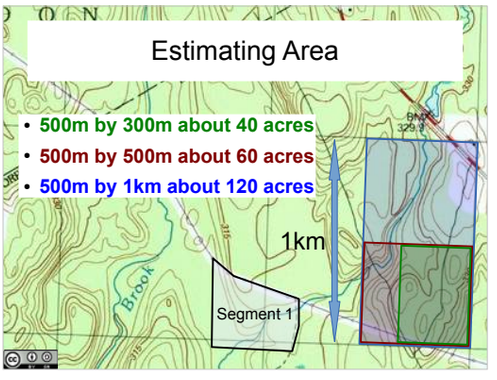
We often think of land area in terms of acres, and think about whether an area is a large area to search or not based on the number of acres.

But, our maps generally don't have acres drawn out on them.

They do tend to have grid lines drawn on them at 1 km intervals.

If we know how many acres are in a few subdivisions of a 1 km square, we can easily estimate the number of acres of some segment on the map.

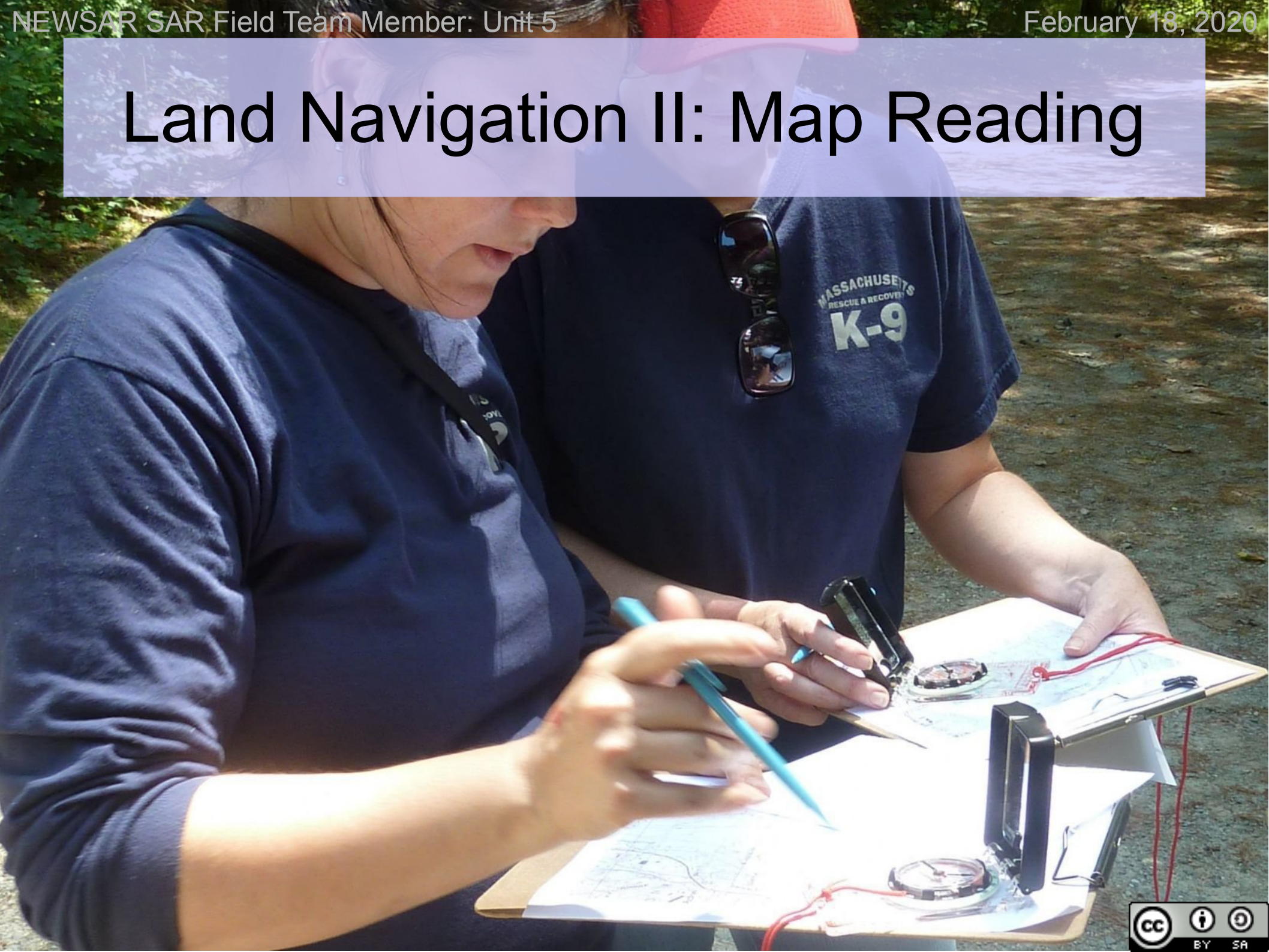
Here's a few useful acreages



With a 1km grid on a map, it is easy to develop a a mental scale get a rough estimate of the size of typical segments.

About how large is segment 1?

Land Navigation II: Map Reading



Unit 5: Land Navigation II, Map Reading
Date Last Updated February 20, 2020

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Map and Air Photo

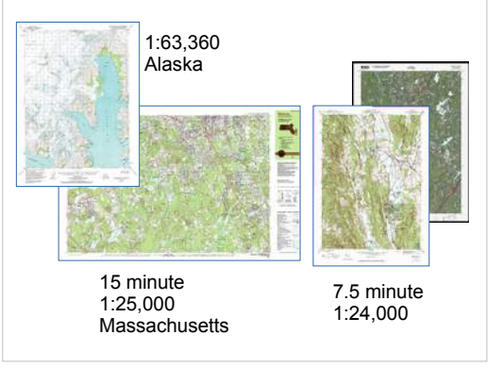
Teaching map reading used to be simple, all about learning to read topographic maps.

No longer true. There are all kinds of map and GIS products readily available in SAR – including air photos and satellite imagery.

Learning to work with all kinds of cartographic products is important, as is understanding what you can get from one sort that you can't get from another.

What can we see in the map?

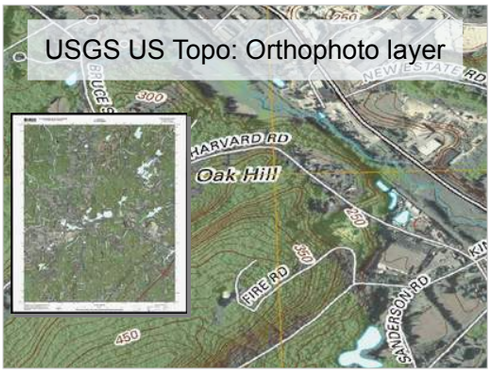
What can we see in the air photo?



Most of the US is covered by USGS 7.5 minute 1:24,000 scale maps: Topo quads.

Alaska is covered by a 1:63,000 series (big state, larger number, less detail).

In the 1980s and 1990s MA was covered by folded 15 minute 1:25,000 scale maps. Slightly different scale than the rest of the country.



The USGS has switched from producing topographic maps to producing 7.5 minute 1:24,000 scale US Topo products created automatically from GIS products without artistic input or ground truthing. These are distributed as GeoPDF files, and include an orthophoto layer – rectified to the map air photos, and have other layers with topographic contours, roads, and a few other map symbols printed on them. Lack some notable features of historical topographic maps including features that are very important for SAR such as boundaries, schools, churches, trails, occupied and unoccupied structures, etc.

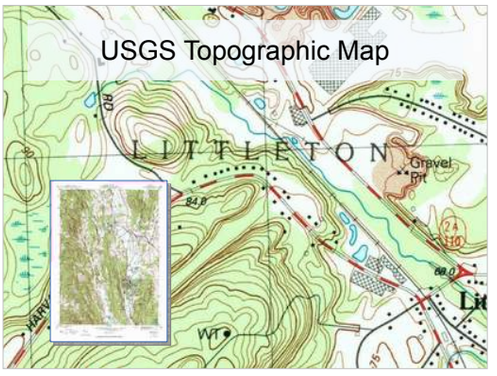
Much more current (updated on a 3 year cycle), and easier to keep current, than the topo quads, but not as abstract and require more photointerpretation.

So let's walk through some differences.

Here's part of an orthophoto quad of Littleton, MA

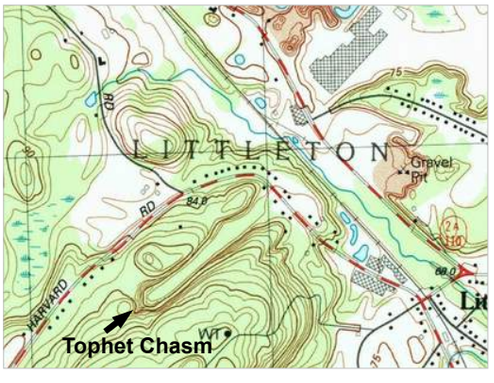
We can see oak hill, and in the center of the map, the long narrow valley cut into it (Tophet chasm, name isn't on the map).

We can identify built up areas, road,s open ground, wooded areas, a stream, some ponds, etc.



Here's the same area on a topographic map.

Abstraction, showing roads (of different types), railroad, structues (at the time the map was made), a gravel pit, streams, ponds, wetlands, wooded and open ground, etc.



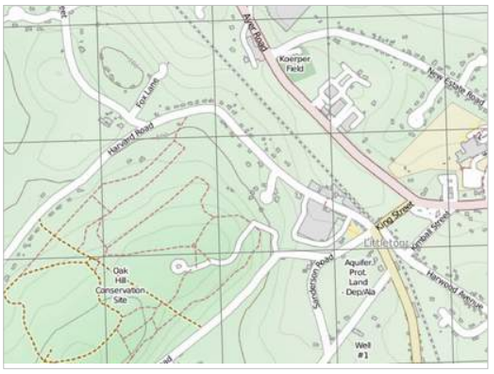
Tophet chasm is still evident.

Here's an Open Street Map rendering of the same area.

Open Street map is a global map that anyone can contribute to. Upload GPS traces, and then mark them up as roads, trails, railways, etc. Also draws in other public domain data sources (here MA GIS's structures and a global topography data set).

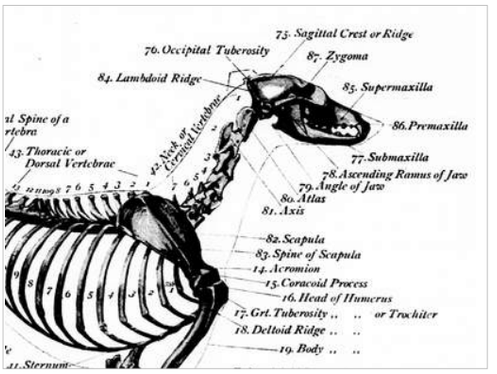
Oak hill is a conservation area – the trails have been mapped and contributed to Open Street Map.

Nice abstraction of roads, buildings, trails, railroads.



Where's Tophet chasm?

As of this rendering, the topography layer isn't good enough quality to see it (there's a bit on USGS maps – complies with national map accuracy standards that isn't necessarily met with Open Street Map, though information there can be very current and accurate and detailed, it may not be).



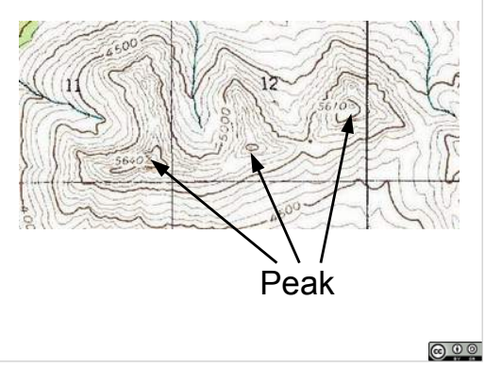
When we study anatomy, we put names on things to help us see, recognized, and observe them.

Terrain Features on Topographic Maps

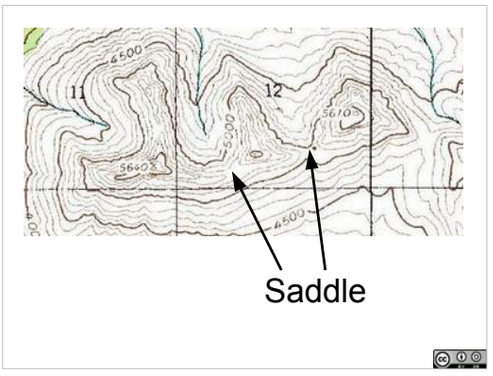
- Depression
- Cut
- Fill
- Hill
- Valley
- Ridge
- Saddle
- Draw
- Spur
- Cliff

Same thing with topography.

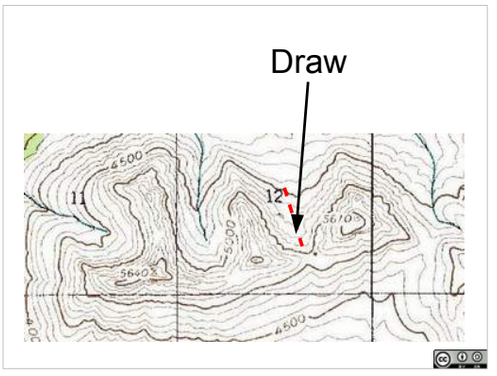
Putting names onto things can help us observe them. So, let's put some names to some terrain features.



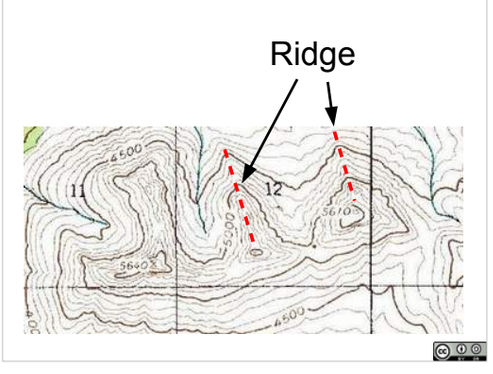
We've got peaks



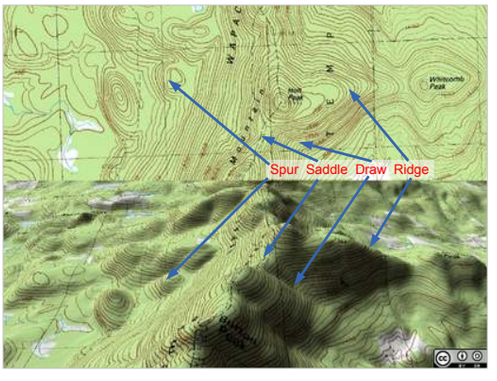
And saddles – things you could sit on with legs dangling down on each side and a high point infront and behind you.



Sitting in the saddle, your leg goes down a draw.



Between two ridges



Saddle, Draw, and Ridge on a topographic map, and a perspective view.

Also a spur – a side peak part way up a slope.

Now, let's start looking at some air photos.

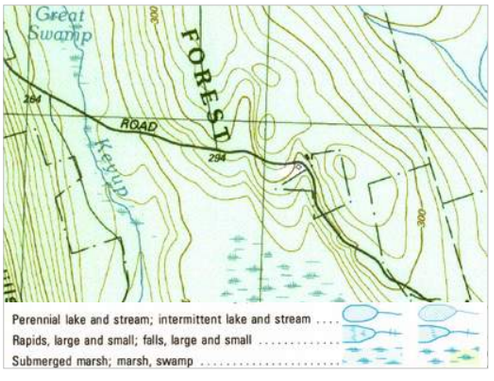
What do we see here?

Wetlands.

(and roads, parking lot, buildings, etc).

Here's an air photo of an area.

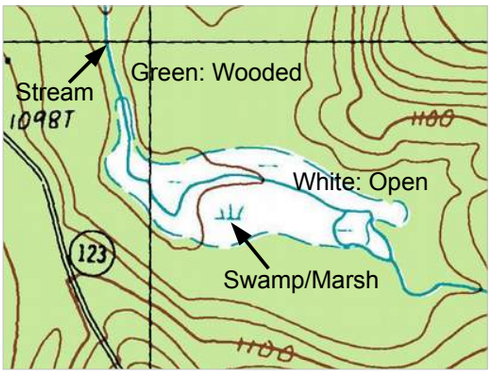
What jumps out at us?



Topographic map of the same area.

What can we see here?

What is evident here that wasn't evident on the air photo?



Wetlands indicated by blue horizontal line with three vertical strokes – wet ground with plants growing out of it.

Which way is the stream flowing?

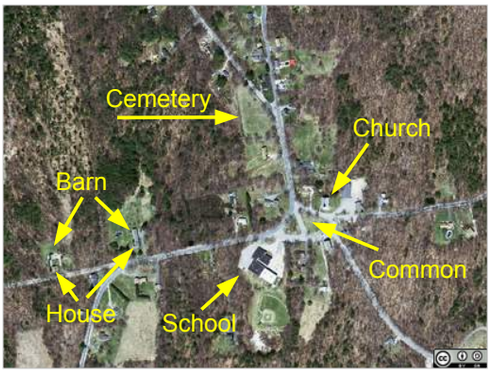
Wetlands – partly wooded, partly open, and a photograph of the same area.

All marshy/swampy/wet ground, but partly green on the map and wooded, and partly white on the map and open.

Cultural Features on Topographic maps

Lots of human features also on topographic maps.

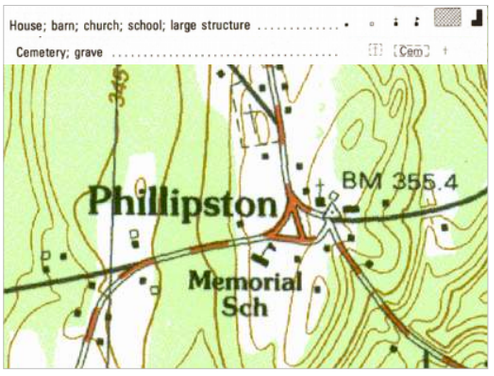
Let's look at a typical small New England town.



What can we identify?

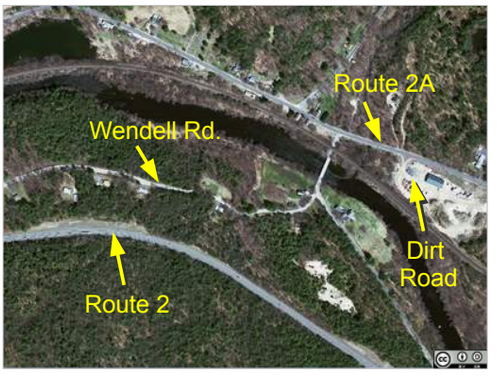
Knowing something about small New England towns, a lot.

We just saw the picture of the church off the common.



Here's the topographic map of the same area.

Things that we had to interpret are now mostly abstracted for us: The church, the school, cemetery, houses with barns behind them.

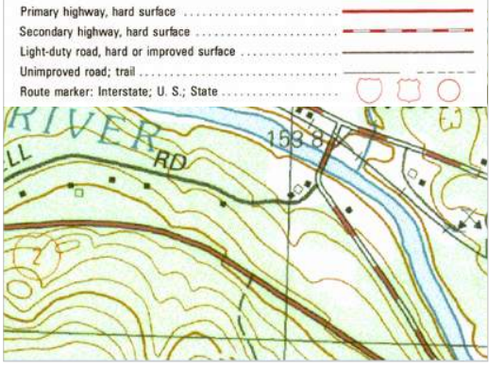


Here;s an air photo.

What do we see?

There are roads of different types.

What else do we see?

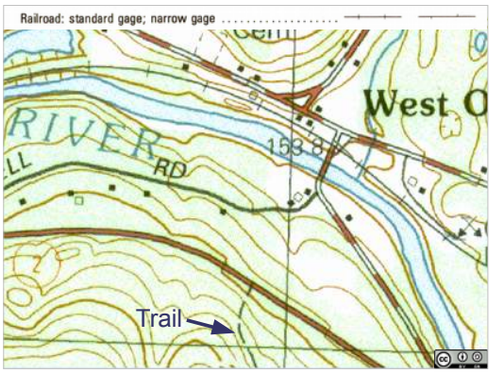


Roads of different types are evident on the map.

What else can we see on the map?

.

Here's the railroad – long gentle curves, sticks to the terrain, has fill in low spots.

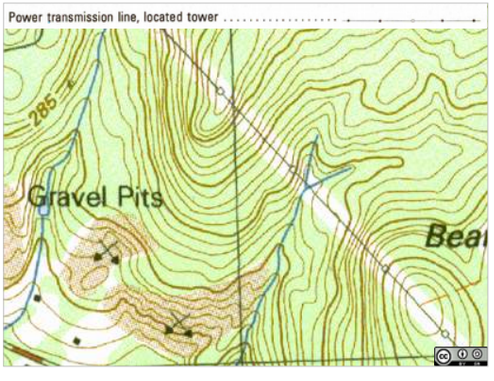


Railroad and fill evident on the map.

And there's a trail that we couldn't see on the air photo.

Another air photo.

What do we see?

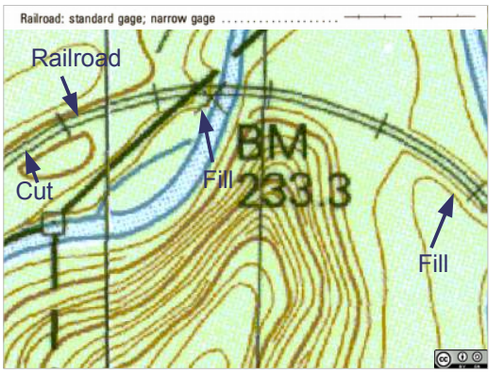


Where's the golf course?

What is the linear cleared feature?

Are the gravel pits still there?

What can we see here?



Same area on a topographic map

Air photo of largely forested area from April, with leaves off the deciduous trees, and only the conifers showing up in green. Same area in August, a couple of years later, with trees fully leafed out.

Note water tank in lower center – built between 2001 and 2003.

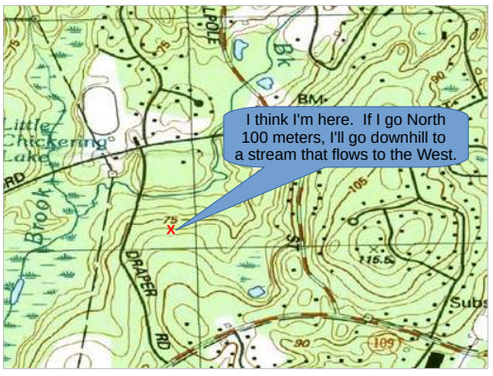
Some Search Related Symbols

PLS/LKP/IPP

C Clue

E ELT hit
(SARSAT Location,
PLB hit)

Practical Evolution 1: Map and Air Photo Reading



When reading a map treat your location as a hypothesis.

Identify landmarks you can see. Identify landmarks on the map that you should be able to see.

Ask what the map say should happen if you move in some direction if you are in the place you think you are. Does the terrain on the map match the actual terrain?

If you move in that direction and you don't find what the map says you should find when you should find it, then either – you weren't where you thought you were, or you aren't traveling in the direction you thought you were traveling in, or both.

Behaviors on Terrain

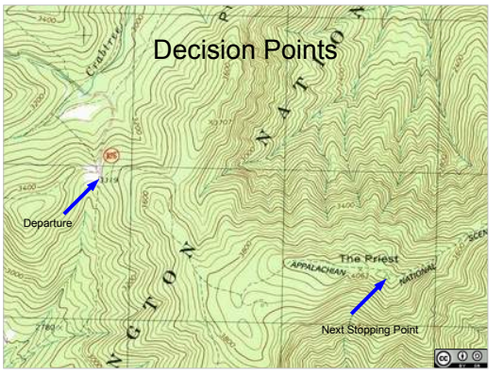
- Decision Points
- Paths of least resistance
  - Ridgelines
  - Remain in same watershed
- Goal directed behaviors
  - Route traveling to reorient (trails, roads, streams).
  - View enhancing: Going uphill in search of cell phone signal or view of landmarks.

People tend to be lazy...
People tend to behave in predictable ways on terrain.

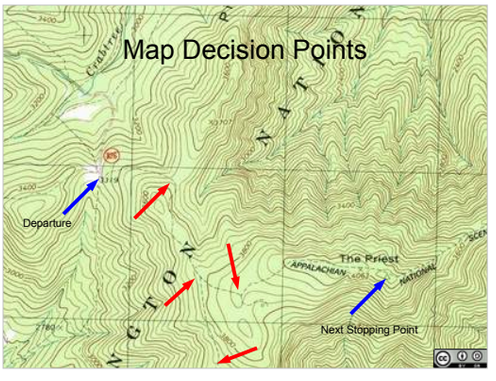
Key concept from Robert Koester and the study of lost person behavior is decision points – places on the terrain where a person may make a decision about navigation, and where they may make the wrong decision.

After making a wrong decision at a decision point people tend to (be lazy) follow paths of least resistance, and follow particular goal directed behaviors.

Understanding decision points, reading terrain, and understanding how people travel on terrain can help inform us where to look.



A party of hikers started off after a break from the marked departure point. They next stopped at a peak further down the trail, only to discover that one of the party was missing.



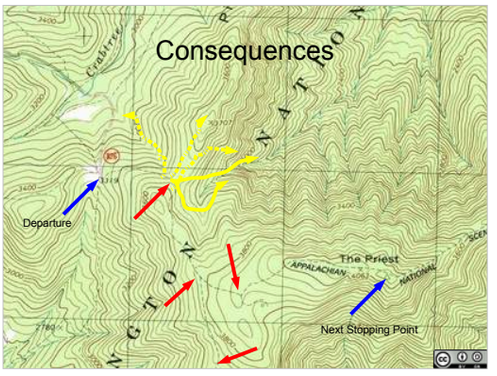
Where are places we can see on the map where this person may have made an incorrect navigation decision?

These are map decision points – we can see them on the map.

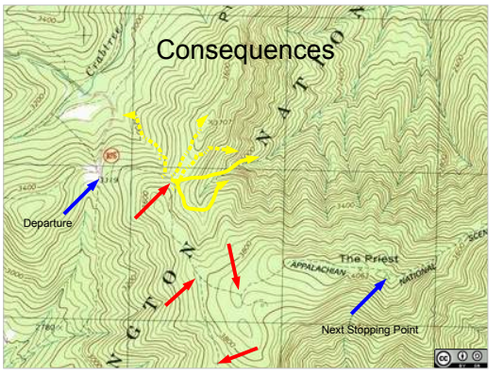
There are also field decision points – places on the ground where the route may not be evident – where a trail becomes faint, where it diverges into a set of herd paths, where it is cut by game trails, where it is overgrown, etc.

Here's a field decision point. In the rocks the trail makes a sharp right, but looks like it keeps going straight, and the next blaze isn't particularly evident at the turn.

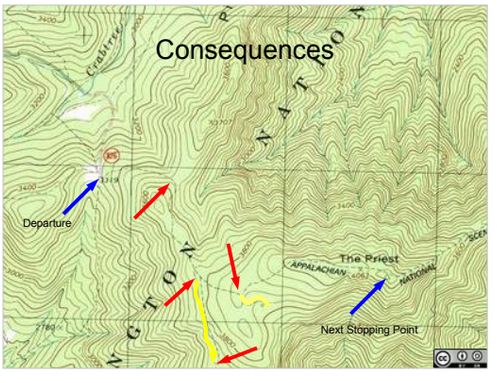
Very important to signcut field decision points, plot their location on the map, and report them in debriefing.



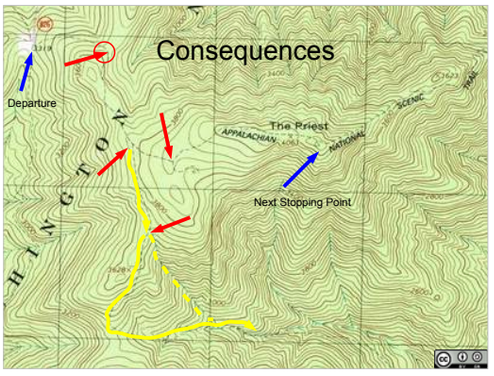
Now, what's the consequence of an incorrect decision at each decision point?



From the top point – most likely travel directions lead down into the steep valley toward the NE. Some lead back down NW towards civilization.

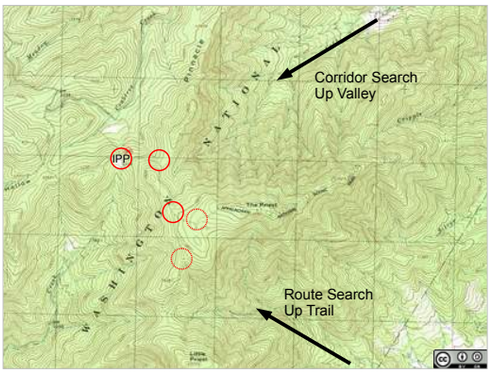


Points in the bottom center lead down into trails to the south. Point right center leads to a short spur trail. Consequence of taking a wrong turn there? Probably realizing it was a wrong turn and turning right around again.



Bit of the map just to the south – decision points lead into a trail down a valley to the east.

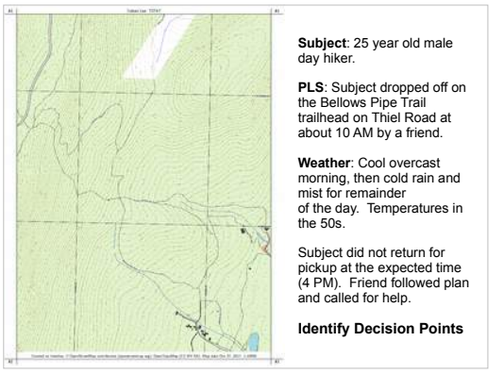
Where do you want to put resources?



Two key decision points are the turn at the top of the ridge, leading down the valley to the NE, and the trail junction leading down the trail to the SE.

Implication for some high priority assignments – put a corridor search up the valley to the NE and a route search up the trail from the SE.

Subject actually missed the turn at the top of the ridge, continued down into the valley and was found near the head of the upper arrow by a team searching up the valley.



Subject: 25 year old male day hiker.

PLS: Subject dropped off on the Bellows Pipe Trail trailhead on Thiel Road at about 10 AM by a friend.

Weather: Cool overcast morning, then cold rain and mist for remainder of the day. Temperatures in the 50s.

Subject did not return for pickup at the expected time (4 PM). Friend followed plan and called for help.

Identify Decision Points

Practical Evolution 2: Decision Points

Split into small groups, hand out map. Brief on scenario. Exersize: Identify Decision Points.

Additional details on scenario:
Subject wearing clothing appropriate for the weather, had a day pack usually containing water, trail snacks, extra clothing. Experienced trail hiker, good health. No known medical issues. No recent significant psyco-social events in his life. Cell phone is non-responsive.

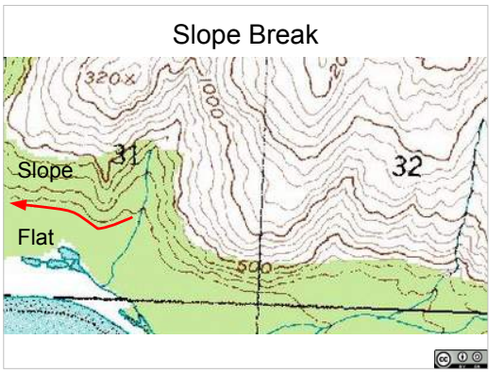
Subject's plan was to hike up the Bellows Pipe Trail to the Mt Greylock Summit, then return on the same route to get picked up at about 4PM. Subject did not return at the expected time.

How do people travel on terrain?

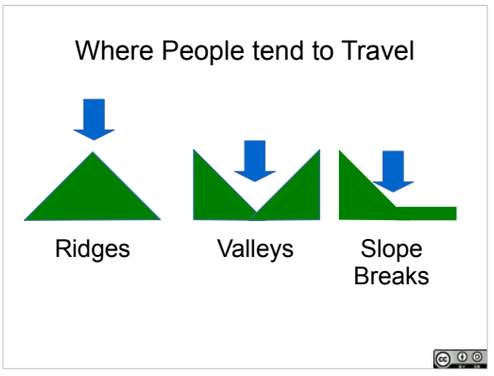
Yosemite Watershed Data

"129 hiker incidents (130 found locations), 63 people/groups (48%) were found within the same watershed in which they were reported last seen, and 15 of these were found at the IPP. Fifty (38%) people/groups were found in a watershed adjacent to the one in which they were reported last seen. Finally, 17 people/groups (13%) were found more than one watershed away."

Data from Yosemite (mostly hikers, more rugged terrain than New England) suggests that hikers tend to remain in the same watershed or cross over no more than one ridge into the next watershed.



People also tend to travel along slope breaks – between flat and steeper terrain.

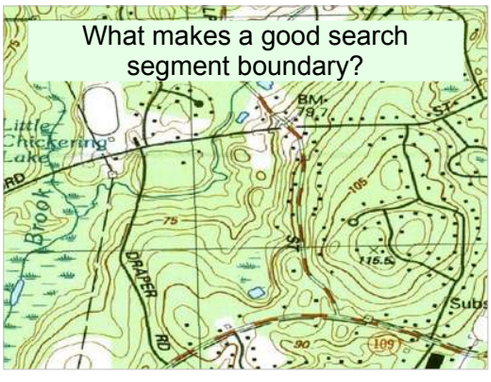


People tend to travel:

Along ridges.

Along valleys.

Along slope breaks.



What sort of map features make good segment boundaries? You've been assigned to search some area. How would you like that search segment to be marked on the map. Discuss.

Does it exist on the ground (grid lines don't (except PLSS sections))?

Does it exist on the map? Stone walls probably don't – but might line up with a property boundary overlay on a map produced by a GIS specialist.

Clearly identifiable baseline and a distance (e.g. baseline is Draper Rd, segment goes 300m to east) can work well.

Can have a resource put in a flagline on a bearing at on the ground to create a boundary.

NEWSAR SAR Field Team Member: Unit 5: Land Navigation: Maps February 20, 2020

Search Sensors and Tactics

Unit 6, Search sensors and Search tactics.
Date Last Updated: February 21, 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

Highlighting two search crucials: Search for clues and the subject, grid search as a last resort.

Search Sensors and Tactics

All about the distinction between resources that are only likely to detect the subject, and those that are likely to detect both clues and the missing subject.

What can you see?

Looking beneath the bush.

How about here?

Footprint: Transfer on the leaf, pattern (straight lines from the pattern on the sole, color change, impressed pine needles, etc...

Ground Search Resources

- Clue Aware Searchers
  - Volunteer SAR organizations
  - Civil Air Patrol
  - SAR trained Police, Fire, CERT personnel
  - Signcutters
  - Search Dogs
  - Horses
- Subject Finders
  - Firefighters (without SAR training)
  - Technical rescue resources (without SAR training)
  - CERT teams (without SAR training)
  - Spontaneous volunteers

Ground searchers clue aware and subject finders.

Search crucial: Search for clues and the subject.

Question: Why do spontaneous volunteers need to be managed? Discuss.

External Influences

There are also external influences to be managed.

Managing external influences (including politicians and psychics) is a concern of search managers.

Other Resources

- Search Managers
- Communications
- Hazardous Materials Response (Fire Service)
- Information Resources
- Sensors
  - Thermal Imaging
  - FLIR
  - Light Amplification
- Air resources
  - Helicopters, Drones, Aircraft

Other resources that can be brought in to the search.

Incident management resources, particularly those trained and experienced in search management.

Where can these sorts of resources be requested from?

What other resources might be available to support a search?

[Image is a NightSun spotlight on a Boston Medflight helicopter]

Fire Service Resources

- Wildland firefighters (local terrain knowledge)
- People to go door to door with flyers, resources for Containment
- Lights (scene lighting, attraction)
- Rehabilitation (mist fans)
- Communications
- Thermal imagers
- Technical rescue (high angle, confined space, water (wetsuits, drysuits))

Plenty of important resources in the fire service.

But not firefighters tramping through the woods in full structural firefighting turnout gear...

Water rescue and ice rescue resources may be effective assets to help in searching wetlands.

Then there are mechanized resources for transport and search. We'll come back to these.

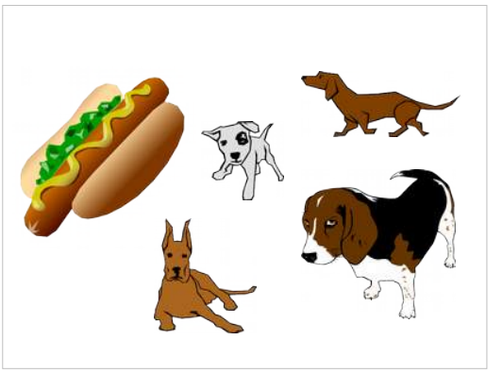
Are these typically clue finders or subject finders?

Then there are Search dogs.

Typed Resources

- Call out the dogs....

In asking for search resources, you need to be specific.



What sort of dogs?

FEMA Typed Canine SAR Resources

- 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
- Canine Search and Rescue Team – Land Cadaver Air Scent
  - Type I, Type II, Type III, Type IV
- Canine Search and Rescue Team – Water Air Scent
  - Type I, Type II, Type III, Type IV
- 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

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

Need to understand the general capabilities and how they interact with ground searchers.

Canines

- Wilderness Air Scent
- Trailing
- Tracking
- HRD
- Water
- Avalanche
- Disaster
  - Live Find
  - HRD

Some canine disciplines relevant to search.

Dogs may be cross trained or single discipline.

The bloodhound.

Or, tracking/trailing dogs in general.

Needs a scent article (collected by the handler) with the subject's scent on it.

Seeks to acquire and follow the subject's scent trail.

Detect the scent from skin cells shed by the subject, and the odors of damaged vegetation and disturbed ground.

Here's a trailing dog at work.

Tracking generally defined as working right on the track of the subject, trailing generally as more loosely following the scent left by the subject.

Tracking and trailing dogs work on lead. They are presented with a scent article carrying the scent of the missing subject, acquire the trail, and follow the scent of that particular subject.

Hint that this dog is trailing rather than tracking is the nose up posture.

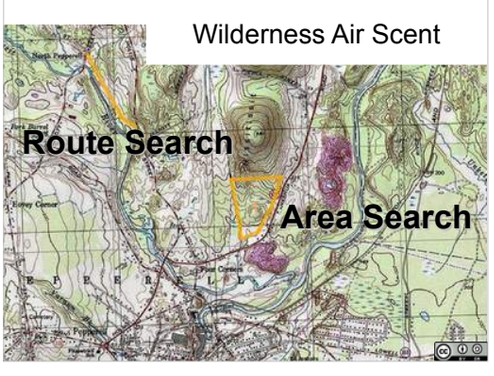
Then there are Wilderness Air Scent canines.

Not scent specific: Trained to find any person in the search segment.

Detect a plume of scent coming off of a live human.

Work off lead, get into the scent of a human, follow it to source, then return to tell the handler.

Wilderness Air Scent canines typically have a trained indication behavior of either stay and bark at the subject, or return to the handler, perform a trained behavior and bring the handler back to the subject (a refind).



Can efficiently search both areas and routes (trails, drainages, travel corridors).

Then we have humans that track humans.

Determining Direction of Travel

- Signcutters
  - Tracking from IPP
  - Binary Search
  - Track Traps
- Tracking Dogs
- Trailing Dogs
- Clues

Some resources are able to identify the subject's direction of travel.

As we saw earlier, for some subject categories, direction of travel is very predictive of find location.

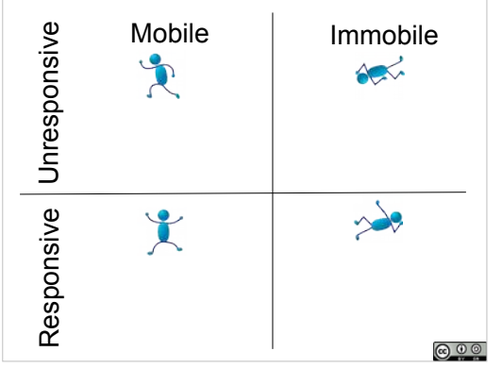
Tactics

- Direct (=Active)
  - Go and find the subject.
- Indirect (=Passive)
  - Make the subject come to you.

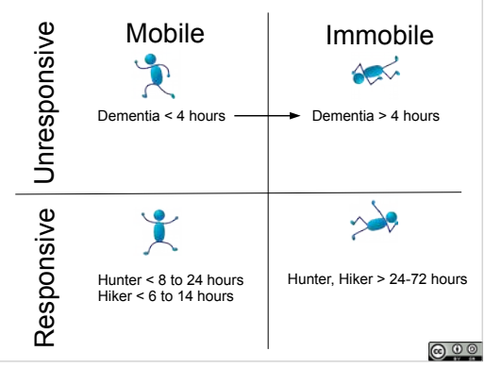
We talked about this before.

Tactics in a search – direct and indirect.

What are some examples of each?



Tactics influenced by likely responsiveness and mobility of the subject. Indirect tactics won't help much for an immobile unresponsive subject.



Where a subject falls in this matrix changes over time.

In general: change from mobile to immobile.

Different subject categories have different statistical profiles in how rapidly they tend to become imobile.

Responsive? Sound Sweep

- Stop
- Pause
- Call Subject's name
- Wait and **listen** (important part)
- Continue

Sound Sweep:

Key part of calling out for a possibly responsive subject is waiting and listening to see if they answer.

Not: “Johnny, Johnny, Johnny, Johnny....”

Direct or indirect tactic? (direct, you are doing it while actively searching for the subject).

How does this differ from attraction? (you are doing it while actively searching for the subject, not making noise and waiting for the subject to come to you).

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”

Some direct and indirect tactics.

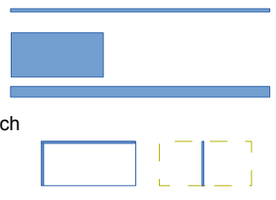
Not mutually exclusive. Search managers will use both direct and indirect tactics at the same time.

Investigation is key in all searches.

Lets look in more detail at some Direct search tactics.

Search Geometries

- Route Search
- Area Search
  - Segment
  - Corridor
- Boundary Search
  - Containment
  - Binary Search



Search resources can be tasked to search:

Routes: Trail/route searches on likely travel routes. Search along a linear travel feature.

Areas: Search an area (which could be a long narrow area along a travel corridor (like up a valley floor)).

Or searches along **boundaries** of segments – typically with signcutters.

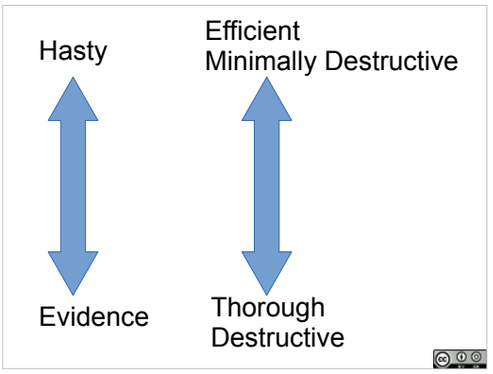
As we talked about (in the ICS planning P) direct tactics in a search often proceed from a focus on route (hasty) searches to area searches.

Types of Ground Search

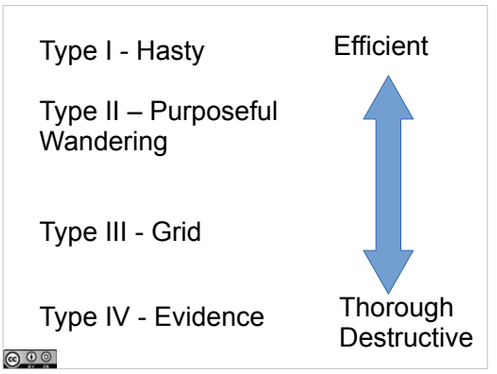
- **Type I**
  - Hasty tasks: speed – trails, high probability and high risk areas.
- **Type II**
  - Small teams, loose grid - efficiency
  - Clue finders with critical separation
- Type III
  - Grid search – Thorough, slow, **destructive**
- Type IV
  - Evidence Search

We can divide ground search into 4 types.

These vary in efficiency, thoroughness, and destructiveness.



Type I search is most efficient, and least destructive. Type IV search is least efficient, most thorough and most destructive.

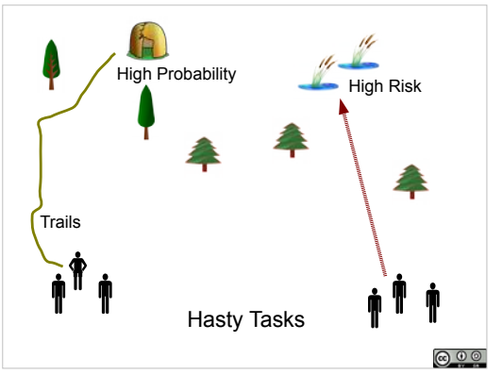


So there's a range from

Hasty – efficient

to

Evidence search – thorough and destructive.



Type I search – hasty (meaning efficient, not careless) search of areas of high probability or high risk.

High probability is also often trails and travel corridors.

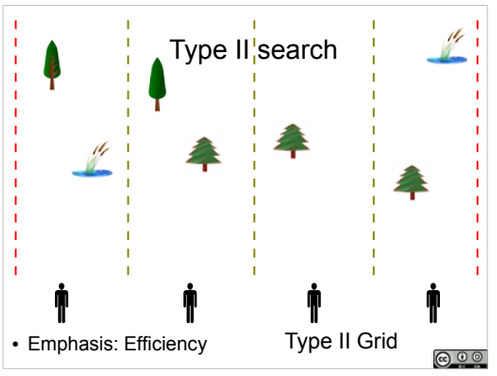
High probability may be particular attractors or structures.

Special attention should be paid to enclosures like refrigerators, freezers, and the interior of parked vehicles where limited breathing air may place the child at even greater risk.

NCMEC Model Missing Children's Policy

Hasty tasks to places of high risk – where if the subject is there now, they are at risk,and finding them may make a difference. Vehicles, abandoned vehicles, refrigerators/freezers, water and swamp margins (entrapment, hypothermia), etc.

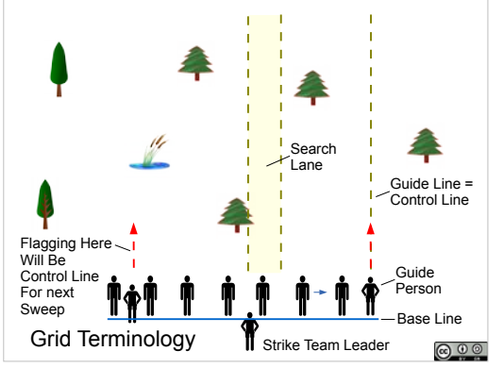
Here's a hasty task searching along a shoreline.



Then, moving up in thouroughness: Type II search.

Open grid search with clue aware searchers.

Everyone has a search lane.



Type II search is a type of grid search. Search lane is a concept from grid search. So, let's describe a grid search.

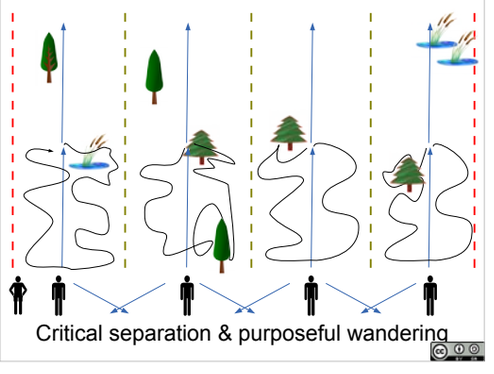
Each searcher has a search line.

Each searcher starts on the base line.

Each searcher maintains distance from a guide person on the guide/control line.

Far end from the control line flags for the control line on the next sweep.

Maintain Span of Control: Someone needs to be in charge, and they need to be able to control the grid line.



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

The searchers are responsible for staying in their search lane and staying together as a coherent grid line, but trained searchers can purposefully wander to go look behind a tree, under a patch of thick brush, etc.

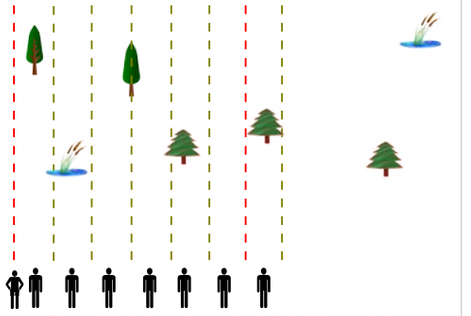
We'll practice this later.

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
- **Grid search as a last resort**
- Manage by objectives
- Search management is information management

General principle – close grid search as a last resort.

General pattern: Start with Type I searches of travel routes away from the IPP. If the subject category is one that tends not to travel far, also start with Type II searches in the high probability area around the IPP. Then later a progression to more Type II and Type III searches.



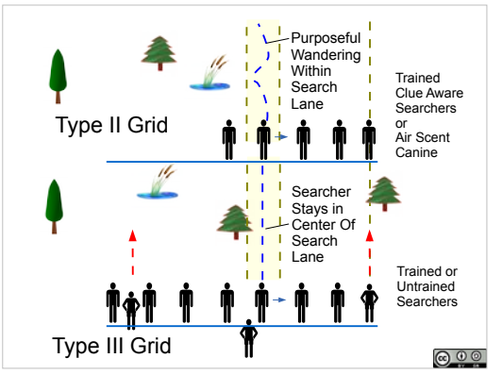
So we move into Type III search.

Type III is a tight grid search, typically with subject finders.

Close spaced grids are inefficient, require large numbers of people, and destroy clues. They use closely spaced subject finders to produce a high probability of detecting a subject in an area.

Maintain span of control and firm control on Type III grids.

Type III searches can use relatively small numbers of untrained searchers mixed with and under the leadership of trained searchers.

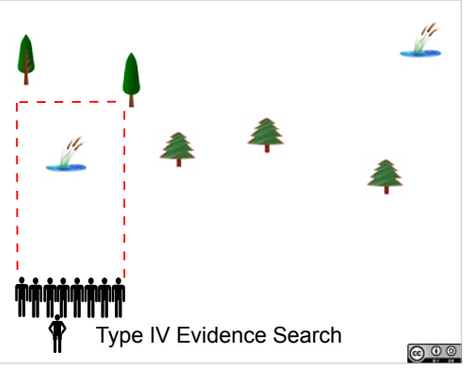


Contrast: Type II grid with purposeful wandering, Type III grid with tight control on unskilled searchers.

Type II searches need trained clue aware searchers.

Type III searches can use a mixture of trained and untrained searchers.

Type III searches need tight control.

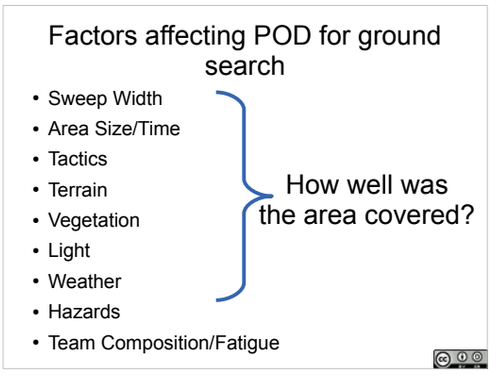


Type IV search – evidence search.

Highly destructive – if a clue wasn't found it won't be.

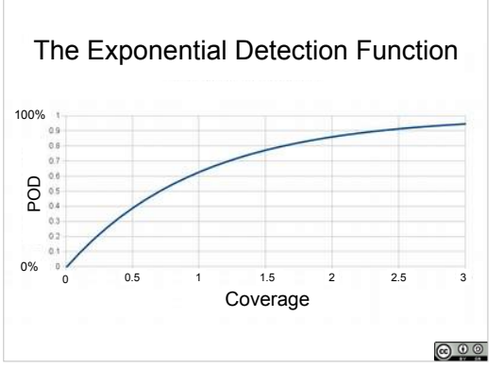
Takes lots of people and lots of time.

Type IV searches tend to be a line of police academy cadets searching a known crime scene for clues.



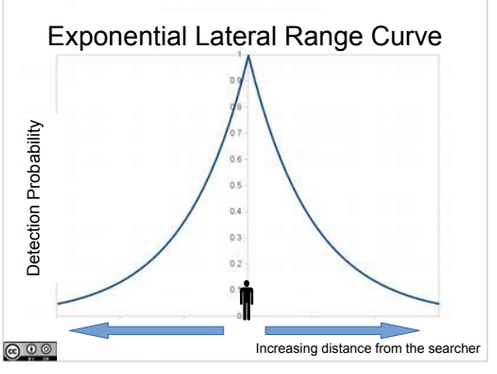
Type II and Type III searches of an area produce some probability of detection for that area.

For ground searchers, the tactics, how far apart searchers are spaced, how fast they are moving (how the size of the area relates to the amount of time spent searching), what the ground cover is like, what the terrain is like, what the light is like, and what the weather is like all affect how well the area was searched, and what the Probability Of Detection was.



Search theory includes an expression of a formal relationship between how well the area was covered and the probability of detection – in this somewhat mysterious graph – the Exponential Detection Function, which relates coverage - a measure of how thoroughly the area has been searched with POD (probability of detection).

Let's see if we can make some sense of this graph.

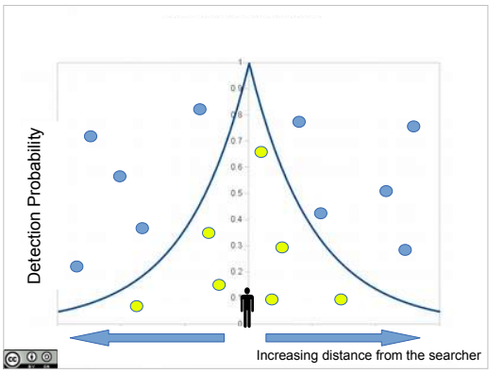


We'll start with this model of detection of subjects by searchers.
This graph holds if the sensors (the searchers) have an ability to detect subjects which decreases exponentially with distance, expressed as an Exponential Lateral Range Curve [not to be confused with the exponential detection function].

Close to the searcher, there is a high probability of the searcher seeing the subject. This probability drops off rapidly the further you get from the searcher.

The searcher is very likely (but not certain) to observe a subject they almost step on.

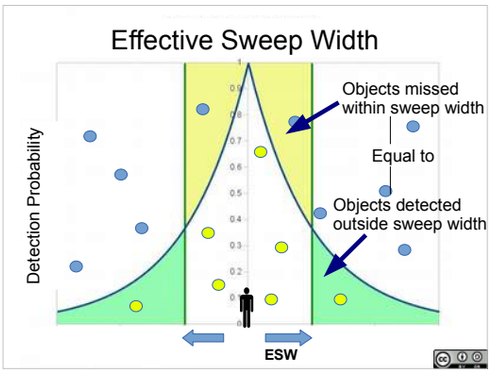
The searcher is much less likely to observe a subject 100 meters away.



Let's consider a searcher walking through an area full of many subject-sized objects.

A searcher will find more of those objects closer to their path, and fewer further away.

We'd like to describe this smoothly decreasing curve with a single width, so...

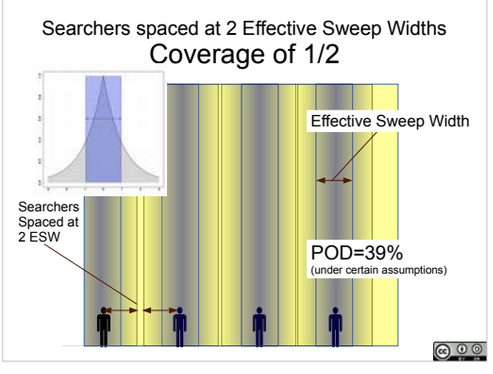


Formal search theory defines something called Effective Sweep Width.

Effective Sweep Width is defined as the distance from the searcher at which as many objects are missed inside that distance as are detected outside that distance.

This also happens to be a rectangle with the same area as the area under the curve.

A close by subject might still be missed, and a far away subject might be detected, but we can model a sweep through a segment by a searcher as a sweep with an effective sweep width.

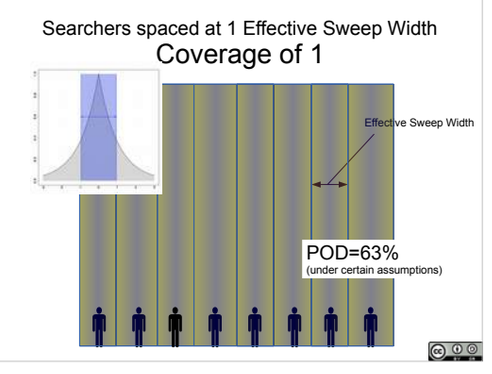


Now let's space a grid line of searchers 2 Effective Sweep Widths apart, so that there is an area of one ESW separating each searcher's ESW.
Half the area is covered within one ESW of a searcher. Half of the area falls more than one ESW away from a searcher.

This is a coverage of one half.

A coverage of 1/2 has a POD of less than 50% as inside each searcher's effective sweep width some subjects will be missed (and outside each searcher's effective sweep width some subjects will be detected).

The POD for a coverage of 1/2 is 39%, depending on certain assumptions about how the area is swept.



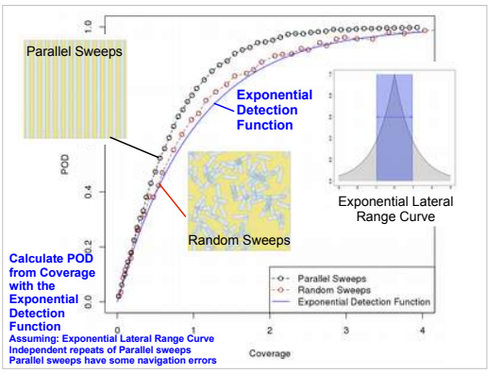
Now let's tighten up the grid line so that searchers are placed at one effective sweep width apart.

All of the area now falls within one effective sweep width of a searcher.

This is a coverage of 1.

Subjects near the searches may still be missed – so even though the entire area falls within one effective sweep width of some searcher, some subjects will be missed and the POD is less than 1.

The POD for a coverage of 1 is 63%, depending on certain assumptions about how the sweeps are placed.

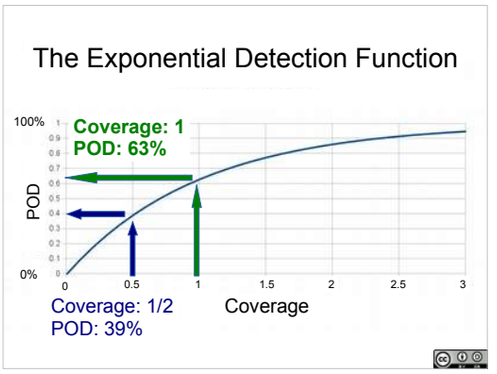


We said "depending on certain assumptions about how the sweeps are placed."

Given an exponential lateral range curve, if the parallel sweeps are perfectly neat and clean and parallel, then the detection function (Coverage-POD relationship) lies above the Exponential Detection Function we showed earlier.

But, if we make lots of short randomly placed sweeps, then the Coverage-POD relationship (the red circles and line here (from a simulation)) approximates the Exponential Detection Function.

We don't search in short randomly placed sweeps, but adding small navigation errors to parallel sweeps, and sweeping the same area more than once with independent sensors (who don't line up exactly on the previous sweeps), shifts the Coverage-POD relationship to close to the Exponential Detection Function.

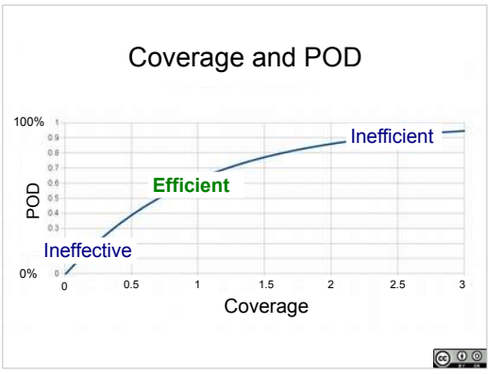


We thus think of the Exponential Detection Function as a conservative way of estimating the Coverage-POD relationship accounting for navigation errors and independent repeat searches (lots more on that in a search management course).

The exponential detection function lets us answer the question: given some coverage, what's the POD.

The important thing to note here is: that there are big gains in POD in going from a coverage of 1/4 (POD=22%) to 1/2 (POD=39%), gains in going from a coverage of 1/2 to 1 (POD=63%), less going to a coverage of 2 (POD=86%), and very small gains with each increase in effort over a coverage of 2.

Doubling the effort in going from a coverage of 1/4 to 1/2 nearly doubles the POD, doubling the effort again to a coverage of 1 increases the POD by about 50%, doubling the effort again increases the POD by only about 30%.

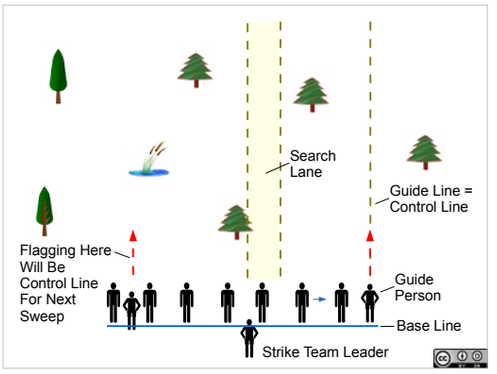


Low coverages are ineffective – they get low probabilities of detection.

High coverages are inefficent.

The resources used to go from a coverage of one to a coverage of two in one segment would be better used to search a second segment at a coverage of 1 (if we search two segments we probably get a higher Probability Of Success than if we only search one).

A coverage of about 1, with a POD of about 63% is efficient, and what search planners aim to target.

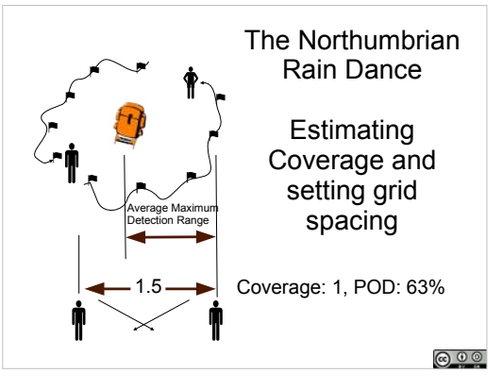


Let's come back to the Type II or Type III grid.

How wide do we make the search lanes (how far apart do we place searchers) to try to obtain a coverage of 1?

There isn't a formula for ground search (too many variables: terrain, weather, vegetation, light).

There is practical, rule of thumb way of finding out how far apart to place searchers.



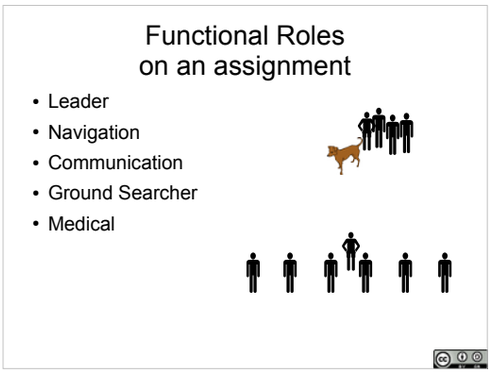
Called the Northumbrian Rain Dance.

Place an object the size of a subject (like a backpack) on the ground, in terrain and vegetation typical of the search area.

Have several people walk away from and towards the object, marking the points at which the object just ceases to be detectable

Add up these maximum detection ranges, and take an average (the Average Maximum Detection Range).

Spacing searchers at one and one half this Average Maximum Detection Range can be used “with some trepidation” as a practical way of estimating spacing for a coverage of One in a ground grid search.



There are lots of responsibilities in a resource that is searching. Divide those responsibilities up.

A resource being deployed on some search assignment (Ground or Canine, Type I, II, III or IV) will need:

A leader (a field team leader, or the canine handler).

A navigator

Ground searchers (to look for clues and the subject).

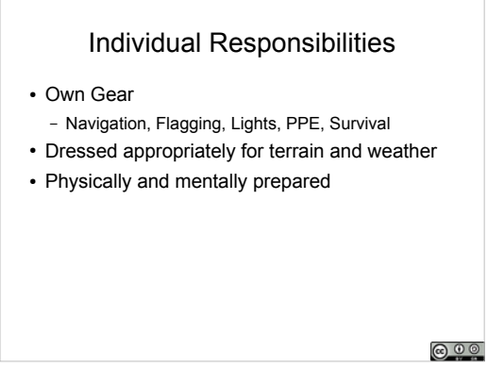
Someone to handle communications.

Someone to handle medical situtations.
(and Law Enforcement functions on locating crime scenes)

Good composition of an air scent canine resource, the canine and handler, and three additional people to provide navigation, communications, and medical support, everyone able to observe for clues.

Handler's focus is on the dog and it's behaviors, everyone else can also observe the dog and support the handler.

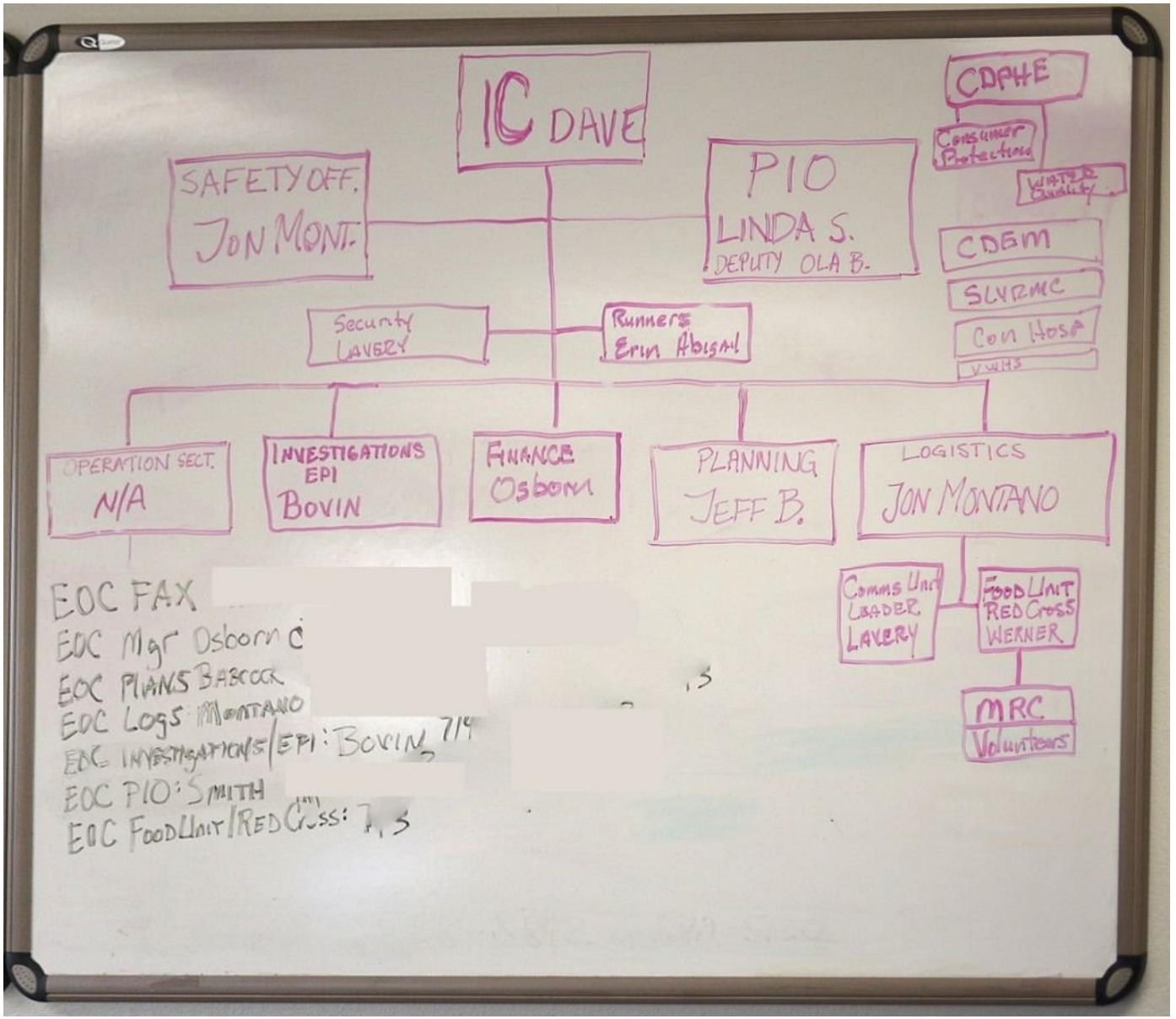
Four people is a good minimum. If necessary (e.g. someone gets hurt and the route in to them needs to get flagged), the task can split in two groups without anyone needing to be left alone.



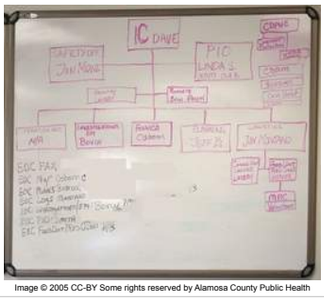
There are also responsibilities for each individual searcher.

You need to be prepared to search.

Incident Command System



Incident Command System



Unit 7: ICS
Date Last Updated March 3, 2020

What is present in any incident?
[Chaos (uncertainty, misinformation, etc..)]
The Incident Command System is a means for reducing chaos.

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
- Grid search as a last resort
- **Manage by objectives**
- **Search management is information management**

Two of the search crucials highlight the importance of ICS

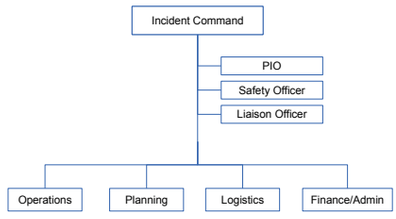
"Manage by objectives" (a core ICS principle) – focus on the things that you can control. set SMART objectives (Specific, Measurable, Actionable, Realistic, Time specific). By 18:00, route search all of the travel corridors from the IPP to the containment boundary.

And, "Search management is information management", ICS identifies specific information tracking functions (such as the situation unit within the planning section),

The nature of an incident is chaos.

ICS lets us organize, manage, reduce the chaos.

Searches (and other incidents) are usually multi-agency. ICS gives us a common management framework and a common vocabulary.



So, let's look at ICS, and how it can function to assist in reducing chaos in a search (or a SAR training event, or any incident).

ICS Scales

Incidents Scale

ICS is designed to scale

More organization as more resources come in. Less organization as resources are demoblizied

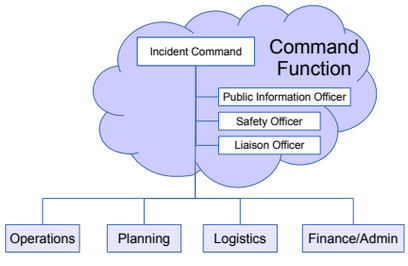
Searches can grow

- 50% over in about 3 hours
- ~20% take more than one operational period
- 8% take more than 24 hours
- 2% take three days or more

- Andy Warburton: 8 days, > 5000 people
- Lisk Sisters: 3 Days, 1200 people.
- South Williamsport: 58 hours, 350 people
- Bluff Mountain: 5 days, > 350 people

Most searches are over fairly quickly and involve few agencies.

Searches can grow to last for days and involve hundreds (or thousands) of responders from many different agencies.



5 main functions

ICS defines five functions that are performed at most incidents.

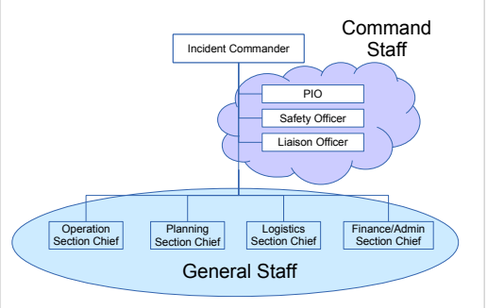
Command – overall management

Operations – the actual boots on the ground, the resources carrying out the incident action plan.

Planning – collecting, managing, and evaluating information about the incident

Logistics – service and support (staging areas, rest areas, food, water, fuel, supplies, medical services for incident personnel).

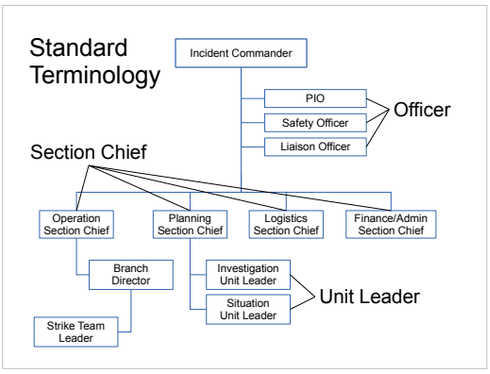
Finance/Administration – on site financial activities to support the incident (tracking hours, maintaining purchasing records, injury and damage claims, etc). Key in large searches and in disasters where there may be reimbursement from FEMA.



ICS designates specific titles for roles that may be filled in an incident.

ICS scales, all functions can be wrapped up in the IC (as in a traffic stop), or the IC can designate as needed (e.g IC, Operations Section Chief, resources in the Operations Section, and a Safety Officer in a small fire (with the IC able to handle all public information, liaison, planning, logistics, and finance/admin functions).

If filled out, there is a general staff composed of section chiefs, the IC and a command staff composed of the public information officer, safety officer, and liaison officer.



In an incident, multiple people from different agencies (police, fire, medical, SAR) and different jurisdictions work together.

One mechanism for reducing chaos is teaching everyone a standard terminology – so that everyone at an incident speaks the same language and understands how the incident is organized.

Standard terminology includes titles for positions.

Seems picky, but is important. (Why?) [for managing chaos – getting everyone on the same page]

Standard Titles

- Incident Commander
- Command Staff: Officer
  - Safety Officer, Liaison Officer, Public Information Officer
- Section Chief:
  - Operations Section Chief
- Branch Director
- Division Supervisor
- Group Supervisor
  - Search Group Supervisor, Rescue Group Supervisor
- Unit Leader

Some of the key titles.

Only “Officers” are in the command staff: Safety, Liasion, Public Information.

Sections have Section Chiefs. Divisions and groups have Supervisers.

Look closely at this picture: The Fire chief in the white helmet is the operations section chief, subordinate to the firefighter in the black helmet who is the incident commander.

A purpose of the standard roles and titles in ICS is to allow positions to be filled by the most qualified individuals, regardless of their ranks within their organization.

Another purpose is to reduce chaos by having all responders speak a common language.

Standard Places

- Incident Command Post
- Staging Area (S)
- Base (B)
- Camp (C)
- Helibase (H)

H-2
Helispot

Locations are given standard names and are places for standard functions.
Management of the incident at the ICP – separated from distractions (e.g. keep the family out).

Staging area – resources that are available (for deployment within 3 minutes).

Base – Logistics section – primary service and support activities.

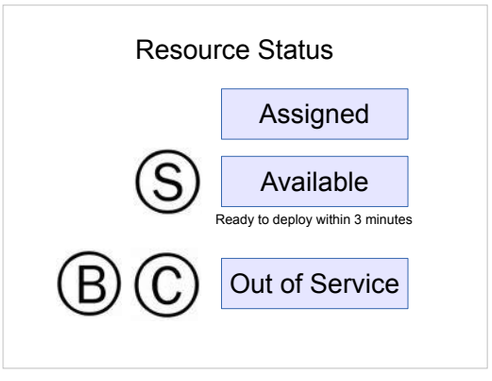
Camp – temporary food/water/sleep support areas, resources may be available or out of service

Helispot – landing zone
Helibase – fuel, maintenance, etc.

Incident Command Post can be set up in a building, or be a mobile command post vehicle. Here is the MA Department of Fire Services Incident Support Unit serving as the command post for a search.

Out of service resources, resting, rehabilitating, servicing.

Available resources ready (within three minutes) for assignment



Resources can have one of three possible statuses at an incident.

Assigned – performing some assigned task.

Available – ready for assignment within 3 minutes.

Out of service.

Resources don't just show up.

One element of managing the chaos: All resource requests must be approved by the incident commander.

Resources don't just show up, a need is identified, the IC approves the request for a resource, then the resource gets requested.

Is pre-planning important?

Chain of Command

Everyone has exactly one supervisor.

Supervisor is up the chain of command in the incident command system, not necessarily up the normal agency chain of command.

A task force leader may report up to a Division Supervisor, who reports to the Operations Section Chief, who reports to the Incident Commander.

Chain of Command: Within ICS

Rank relationship within agency in blue – member reporting to officer.

Operating as part of a task force in ICS, the yellow relationship applies – everyone in the task force reports to the unit leader (the canine handler).

Grouping Resources

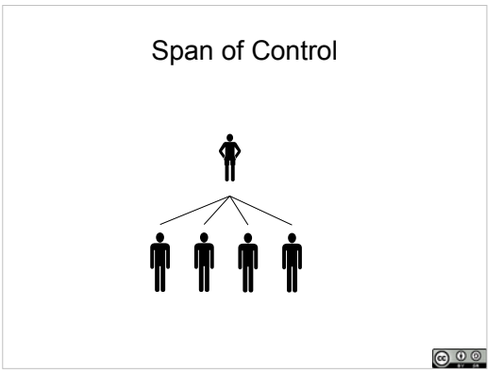
- Single Resource
  - One of one sort of resource
  - Single Resource Boss
- Strike Team
  - Multiple resources of similar type
  - Common Communications
  - Strike Team Leader
- Task Force
  - Multiple resources of different types
  - Common Communications
  - Task Force Leader

Resources are of one of three types:

Single Resource – One of one sort of resource (an ambulance) lead by a Single Resource Boss.

Strike Team – Multiple of the same sort of resource (an ambulance strike team) with common communications and operating under a Strike Team Leader.

Task Force – More than one sort of resource (USAR Task Force) with common communications and operating under a Task Force Leader.



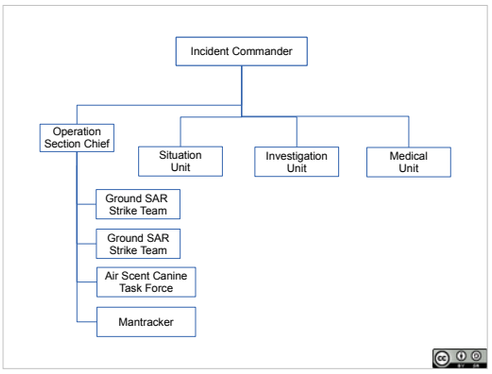
How many people can you manage in an incident?

Older NIMS: 3-7, optimum 5.

Current NIMS: As many/few as can be effectively managed.

How do you manage a grid team of 15 firefighters in thick brush?

So how does ICS maintain span of control:

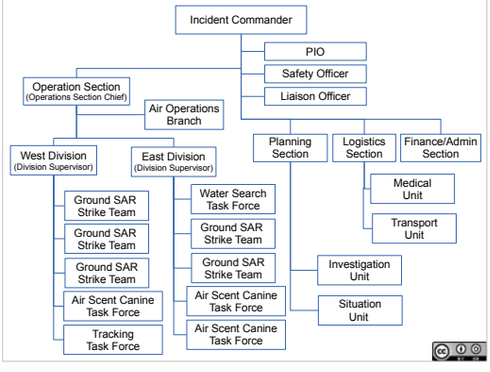


Here's what an organizational chart might look like early in an incident.

The IC is handling all the command staff functions.

The IC has designated an operations section chief to manage four assigned resources in the field.

The IC has an investigation unit working on the investigation.
The IC has assigned someone to write down what is getting done (as the Situation Unit Leader).
The IC has called for an ambulance to come and stand by if any searcher gets hurt – as the Medical unit (which supporting the responders, falls under logistics).
What's the IC's span of control? The Operation Section Chief's?



As things scale up, it is necessary to maintain span of control. IC Delegates responsibilities as needed.

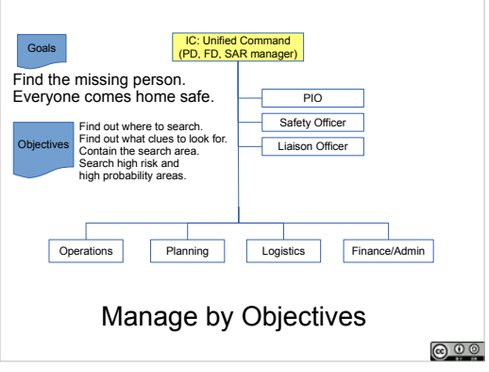
The Operations Section Chief has split the operation into two geographic divisions (each lead by a Division Supervisor) and a branch (lead by a Branch Director, air operations always go in their own branch).

The IC has delegated the PIO/Safety/Liaison functions by filling the command staff positions.

The IC has also filled all the general staff positions.

What is the IC's span of control?

What's the operations section chief's span of control?



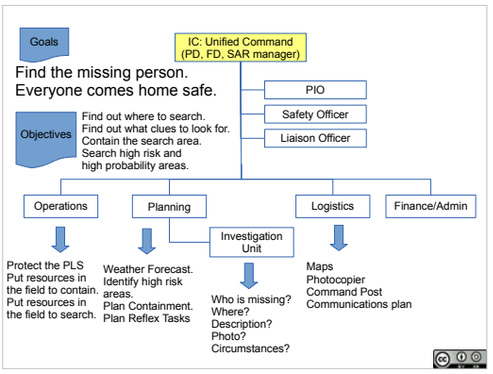
In the chaos of a search, there will be things you can control, and things you can't control. Focus on the things you can control, and set SMART objectives.

Specific, Measurable, Achievable, Relevant, Time-bound.
Specific, Measurable, Actionable, Realistic, Time-bounded.

At high level, IC sets informal goals, then command and general staffs in the planning meeting establish a list of incident objectives. In initial response, less formal statement of incident objectives by the IC – but key driver of what happens.

Objectives focus on strategy, not getting into details of tactics (leave that to operations).

Establish containment on the 95% probability perimeter by 16:30. (with no statement of containment tactics or resources).



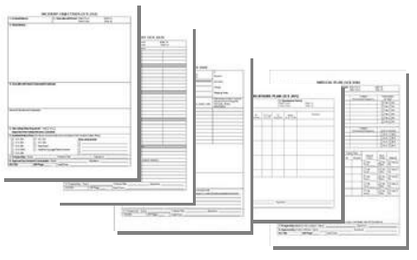
Incident objectives then drive the activities of the search – focusing them on actions on things that can be changed.

Ensure the safety of all responders and the general public through out the entire duration of the incident.

Goal: Everyone goes home safe.

SMART Objective...

Incident Action Plan

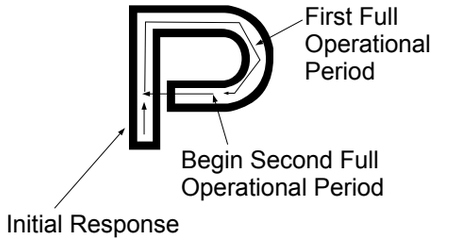


Searches run on paper. However:

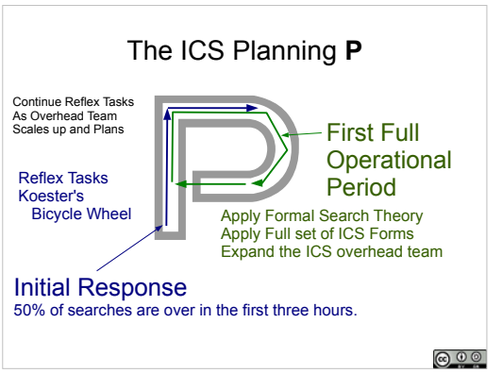
Don't get bogged down in paperwork and planning.

Evaluate the situation, come up with a plan (reflex actions, short checklist of things to get done in every search), write down a list of objectives, get boots (and paws) on the ground, document who is doing what where.

The ICS Planning **P**



Remember the ICS planning P.



Very important not to get bogged down in paperwork during the initial response. But also very important to document the search effort.

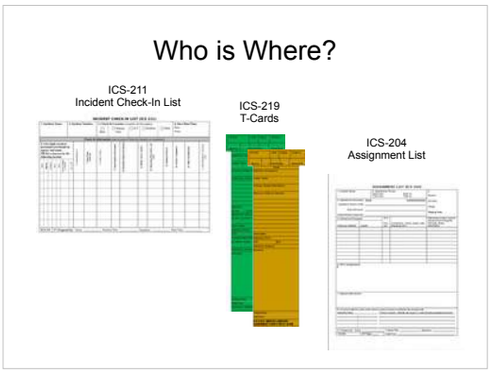
Keep it simple.

Set objectives (using Koester's bicycle wheel or a checklist as a guide) for reflex tasks.

Record who is going on what task.

Get boots on the ground.

Work on a full IAP later as you go into cycles of planning/operations in full operational periods.



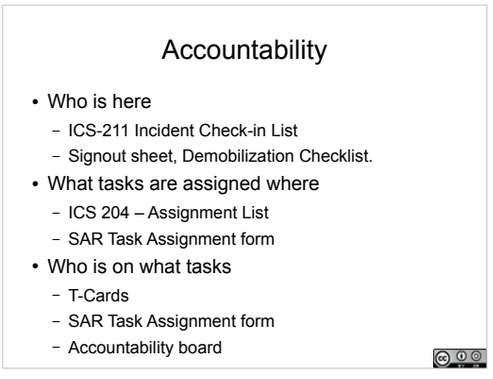
Accountability

You have people off searching: Who are they? Where are they searching? How do we communicate with them?

You have people not searching yet – who are they, where are they, are they ready to search.

Resources are returning from assignments: Did everyone come back? Is any searcher unaccounted for?

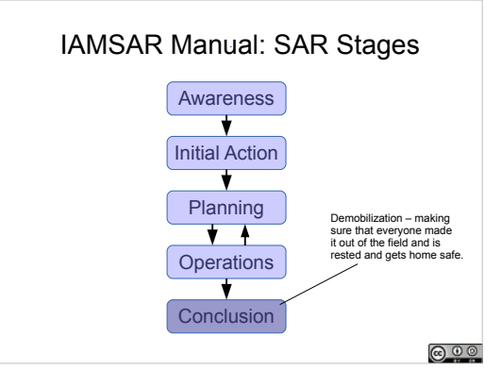
ICS has forms designed to manage this information.
Always sign everyone in.
The search isn't over until everyone is home.
Starting out, write it down on a blank piece of paper, and assign someone to keep an activity log.



Can also use:

Accountability board – write out who is where, what their status is.

Accountability Tags (tag in/tag out – common in the fire service).



In the SAR stages model there is a conclusion stage: sending resources home, after action review, finishing up the documentation.

An element in ICS is demobilization (which is continuous in ICS, resources are released when they are no longer needed). Accountability is part of this – making sure that everyone got out of the field and gets home safe (which can include rest before they drive home).

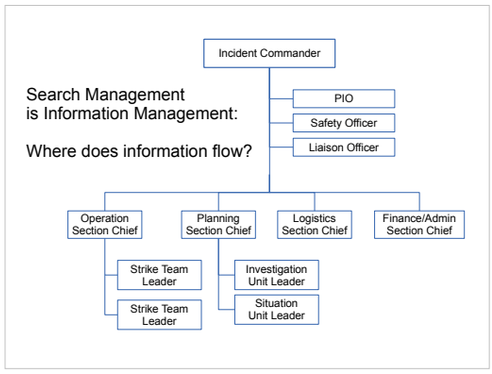
Usually a signout sheet for a search.

ICS has a Demoblilization Checkout process and form (returned all issued equipment, etc.).

You have a lot of tools in your bag.

ICS isn't one of them.

ICS is the bag.



Use this slide to start a discussion:

Where does the information flow?
Objectives to planning section to operations section, and back to planning section.

What are the Key elements of information to be communicated?
Searching Information, Clues, Where was searched, How well it was searched, Hazards found, field decision points. Where wasn't searched.

Briefings

- Operational Period Briefing

- Briefing for assignment

We have briefings to communicate the plan to the responders. Two main sorts in SAR. Operational period briefing, and briefings for assignments.

What can we expect in an operational period briefing?
Highly stylized. Many people. Here's who is running the show. Here's the situation. Here's how we are going to deal with it. Here are the safety issues. Go out and do it. **Not the place for questions.**

What about a briefing for an assignment?
A few people, or one on one – operations section chief (or other operational supervisor) with leader of an assignment (or leaders of assignments). Specifics of assignment and logistics. **Place to ask questions.**

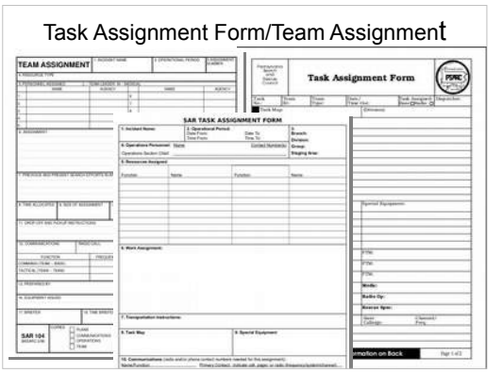
Briefing for specific assignment

- Who should be present?
- What information should be communicated?

- Search operates under "Need To Know"
  - You will not learn everything

Leaders of SAR field assignments should be briefed on their assignments. Generally just operations section chief or a supervisor from operations doing the briefing either one on one or with a small group of field team leaders.

Information flowing from command and planning functions into the resources going out into the field.



There's a (non ICS form) tool often used to support the information flow between field resources and planning in SAR.

Under various names and in various formats. Often called a Task Assignment Form.

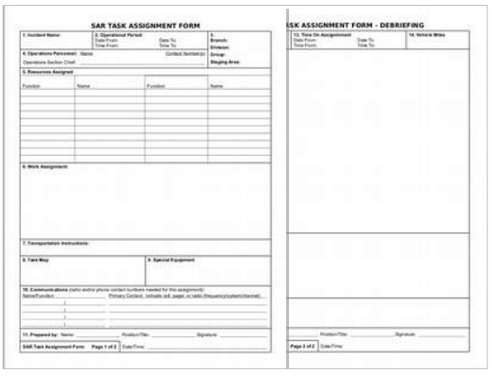
Essence is details of a specific assignment:

Who is assigned?

What are they assigned to do?

How do they get there?

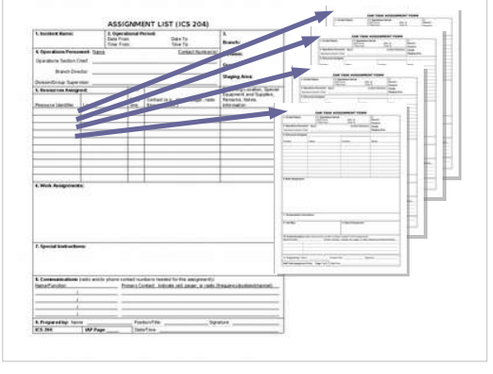
How do they communicate?



Then, when they return, what did they do?

Record of the assignment. Record of the debriefing.

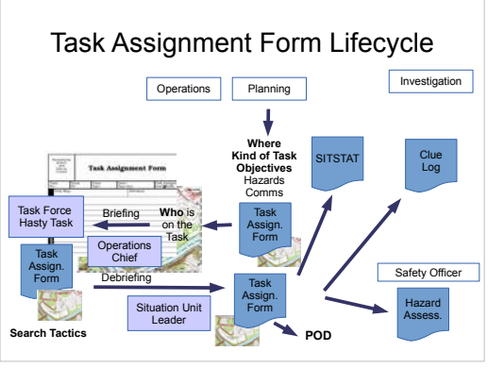
A good practice: One copy goes out with the task, copy of the cover page stays with Operations. On return, a completed copy with the debriefing goes back to Planning.



Think of each ICS-204 Assignment list going with a stack of SAR Task Assignment forms, one for each assignment listed on the ICS-204.

A SAR Task Assignment Form might match with a T-card, but the T-card serves only to track resource status, the SAR Task Assignment Form serves to document the plan, resources, and results from an assignment.

In SAR, resources are often mixed and matched into Task Forces for assignments, then when complete, remixed into a different set of Task Forces for new assignments. SAR Task Assignment forms are effective for tracking the particular set of individuals on an assignment.



Search management is Information management.

Who frames objectives?

Who determines strategy?

Who assigns particular resources to particular tactical assignments?

TAF life cycle epitomizes the information flow in SAR: TAF starts in planning, where to search, hazards, communications. Then to operations: Specific tactical assignment, who is on the assignment, brief them. Task in the field, field tactics, return, debrief, TAF goes to planning (situation unit leader), information from it into SITSTAT, clue log, hazard assessment, feeds into planning for next operational period (in particular, the reported POD).

This is the key bit. Why?

Discuss. What are the consequences of information gathered in the field not getting back to the planning section?

- Areas Not Covered
- Clues
- Hazards
- POD
- Sweep Width
- Area Size/Time
- Tactics
- Terrain
- Vegetation
- Light
- Weather
- Team Composition/Fatigue

How well was the area covered?

Debriefing should cover: Areas not searched, Clues, POD, hazards observed, and all of the factors that can influence POD.

Practical Evolution:

(1) Complete a Task Assignment Form
In pairs of small groups, given a general description of an assignment have each group fill out a task assignment form for the other, then exchange and brief on a simulated assignment.

NEWSAR SAR Field Team Member: Unit 7: ICS March 3, 2020

Legal and Ethical Framework

Includes materials from Search and Rescue Topics: Legal Aspects,

NEWSAR SAR Field Team Member: Unit 8 February 20, 2020

Legal and Ethical Framework

Includes materials from Search and Rescue Topics: Legal Aspects, Copyright 2013 some rights reserved, CC-By-SA by Keith Conover

Unit 8: Legal and Ethical Framework for SAR
Date Last Updated February 20, 2020

- Legal: What do applicable laws and common law principles say?
- Ethical: What will most reasonable people say is the right thing to do?
- Moral: What do you think is the right thing to do?

A cascade for decision making.

Legal to Ethical to Moral.

Legal – what laws and common law principles apply to the situation?

Ethical – if the law doesn't provide guidance, what would most reasonable people think is the right thing to do?

Moral – if ethics don't provide guidance, what do you think is the right thing to do?

NEWSAR Code of Ethics (selected points)

- Work under the Incident Command System
- Will not respond to any search unless called out by a responsible agency.
- Will not openly or publicly disagree with any aspect of a search.
- A search is a potential criminal investigation, disclosure of information could jeopardize prosecution.
- Will adhere to strict operational security during a search and not divulge information to any individual not participating in the search.

Handout the NEWSAR code of ethics.

Highlighting some elements of the NEWSAR code of ethics.

Ethical guidance for situations that frequently come up around search.

Authority Having Jurisdiction

Volunteer searchers work for an authority having jurisdiction.

In most of the US, that is the county sheriff.

Highly variable in NE US.

In most of the world, some law enforcement entity is the authority having jurisdiction over land search and rescue incidents. Why?

Searches run under **Need to Know**

- You won't be told everything.
- Do not tell anyone anything about the search.
- Direct the press to the Public Information Officer. Say nothing to them.

Need to know – you won't know everything.

Don't share information about the search.

Absolutely nothing to the press.

The public does not Need to Know

- No sharing information on social media
- No sharing images on social media
- Any release of information about a search must be cleared with the public information officer first.
- Take no pictures, don't provide an appearance that information might be shared.

Or public.

Do not publicly criticize any Emergency Services Department.

Constructive criticism in mission critique.

No Freelancing

- Callout only on the request of an authority having jurisdiction.
- Callout is of teams as resources, not individuals.
- Cards/contact information given to authorities having jurisdiction must provide your team's callout point, not your personal contact information.

We work as emergency service organizations.

All resource requests must be approved by the incident commander.

You don’t show up at a search unless requested through the proper channels (this means pre-planning the proper channels).

At a search, you don’t go off and search things on your own. You only carry out assigned tasks.

Scope of Practice

Are you trained to do this?

No? Then don't.

You are trained up to some level (particularly with regards to medical care). Don't exceed the scope of that training.

Standard of Care

- Consensus of informed opinion of how to care for a given medical condition or pursue a search and rescue operation in the context at the time and place of the condition or SAR operation. Expressed in appellate decisions on malpractice cases.
- For wilderness medicine and wilderness search and rescue there is little if any case law, certainly not enough to establish a standard of care. Current editions of relevant textbooks are seen, to a degree, as expressing this ideal standard of care.

Wilderness medicine and wilderness search and rescue, very little legal precedent to go by. Current texts are probably best guide to standard of care for SAR.

Negligence

- Plaintiff must prove a chain of 5 elements
  - you had a **duty** to act
  - that you **committed** a unreasonable act or omission in the course of this duty
  - an **injury** occurred to the plaintiff
  - your act or omission **caused** the injury
  - you must have been able to **foresee** the injury

Need to prove chain of elements for negligence.

Engendered Reliance

Duty To Act

Abandonment

What do these mean?

Engendered Reliance involves an organization claiming that it can provide some capability, and a community relying on that organization to provide that capability.

In general, paid responders have a duty to act that comes with their job, when called to an incident they have a legal duty to respond, volunteers have a duty to act that takes effect if they respond, but only a moral or ethical duty to respond if called to an incident. Might engendered reliance come into play if every volunteer in an organization declines to respond?

Abandonment occurs when someone initiates medical care (touches) a patient, and then ceases to deliver that care without passing the patient on to medical care of equal or higher level.

Consent (to medical care)

- Implied Consent
  - Patient is unconscious or has impaired capacity to make good decisions.
  - Any reasonable person would assume that the patient would want your care.
- Express Consent
  - Patient says "yes"
- Informed Consent
  - Needed not only for agreeing to medical care, but also for refusing care or evacuation or transport.
  - Inform them, what, in your best judgement, the outcomes are if they accept care or if they refuse it.

Obtain consent before providing medical care.

Evaluating Capacity to Consent

- First, when in doubt, do what is best for the patient.
- Second, the needed level of capacity varies with the seriousness of the decision.

If we make a find, the subject may need medical care but may or may not have capacity to consent.

What are some conditions that could be encountered in a search that would affect a subject's capacity to consent to medical care?

Entry onto private property

"[A]s long nobody objects, you are perfectly welcome to walk across someone else's property in the US. There is no crime in doing so. However, if you do something stupid, like not closing a farmer's gate behind the last member of your field team, then you may be liable for the loss of cattle."

Conover, 2013 p.18

There is variation from state to state.

Some people object.

Trespass

- Someone tells you to get off their property
- The Property is posted **No Trespassing**
- Entry makes you liable for damages

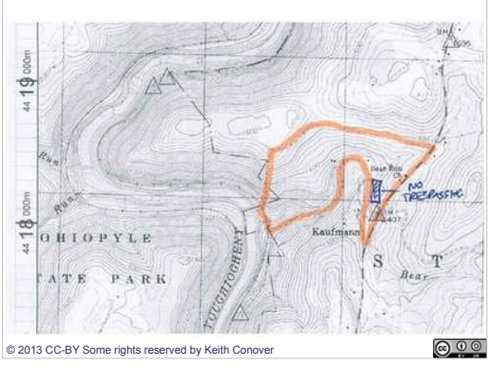
Trespass occurs when you enter somewhere you've been told not to (in person or through posting).

Except

- Sworn peace officers with jurisdiction may legitimately enter lands posted No Trespassing during a search, and may take the rest of the team along with them.
- Doctrine of Necessity – to save a life – **very limited circumstances** – e.g. you **see** a person who needs immediate medical care.

Some exceptions.

Doctrine of necessity is very limited. It doesn't allow you to enter a posted property to search if a subject might be there and might be injured – you need to see the person, they need to need immediate medical care.



So, what do you do when you encounter property that you don't have permission to enter?

Report it in debriefing.

If you ask for permission to search property and it isn't granted, report that.

Good Samaritan Laws

- Medical
- SAR
- Vary from state to state.
- Generally cover care rendered:
  - Without compensation
  - In good faith
  - Without gross negligence.

There are good Samaritan laws for both medical care and SAR. They vary.

Generally three elements:
No compensation
In good faith
No gross negligence

Details are Important

- MA SAR Good Samaritan Statute
  - Covers volunteers called out by the MA State Police.

Details state to state are important.

Confidentiality

- Never share any specifics of tasks outside debriefing
  - May compromise a criminal investigation
- Never share any information about the subject's condition
  - Illegal under HIPAA
- Press: Refer them to the Public Information Officer.

As said earlier – confidentiality is critical in a search.

A search may involve a crime. Shared information might compromise a criminal investigation or prosecution.

HIPAA protects medical information.

Refer the press to the PIO.

What Not To Say over the radio

- Assume all communications are being monitored (by the general public and the news media and the perpetrator).
- Use other communication channels (cell phone) to report a find of a deceased person.
- No codes, unless you have been briefed on a code to use to communicate sensitive information (such as a find of a deceased subject when cell coverage aren't available).
- You do not want someone to overhear something they shouldn't (the perpetrator may be monitoring search communications).
- Absolutely no swearing the radio

Radio transmissions may be legally monitored, and in a search, they will be.

The general public will be listening.

The media will be listening.

A perpetrator may be listening.

Searches involve multiple kinds of agencies – follow NIMS/ICS principles and use plain language for all communications: Except if you have been briefed on a specific code to use in the case of a find of a deceased subject.

No pictures.

Absolutely no pictures of someone injured.

No pictures – don't even provide the appearance that you might leak information.

Safety

Think safety. Think your own safety, think the safety of your fellow searchers, think the safety of the general public.

Think.

Emergency Response

- Volunteers, Most Responders: With Traffic
- Emergency Services: Follow Departmental Protocols.

?

Search is an emergency, but it is generally a slow motion emergency.

Response generally with traffic.

What do your departmental protocols say? Lights and sirens, or with traffic for response? Particular circumstances for lights and sirens?

Accountability

3 Cases in ISRID are of missing SAR Personnel

Important to know where everyone involved in the search is – and when they are out of contact.

Who has been called out. Who is where in the search.

Accountability check – radio net, typically every 30 minutes, are all assigned resources in contact.

Is everyone back from the field?

Getting home safely.

"In a bank, bad accounting may cost money. In a search, bad accounting may be life threatening"

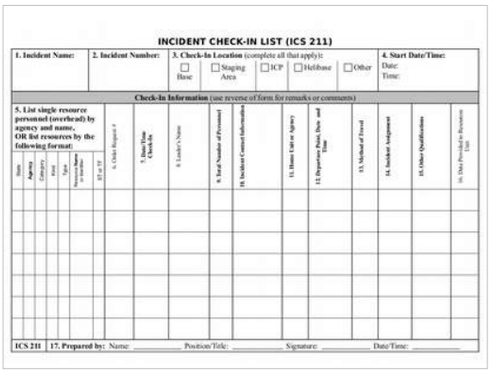
Bad accounting may mean what?

Discuss.

Inadequately documenting the search effort.

Loosing track of where your searchers are.

How does this relate to freelancing?


INCIDENT CHECK-IN LIST (ICS 211)

1. Incident Name: | 2. Incident Number: | 3. Check-In Location (complete all that apply): ☐ Base ☐ Staging Area ☐ ICP ☐ Helibase ☐ Other | 4. Start Date/Time: Date: Time:

Check-In Information (use reverse of form for remarks or comments)

5. List single resource personnel (overhead) by agency and name, OR list resources by the following format:

Date	Agency	Category	Kind	Type	Resource Name or Identifier	ST or TF	6. Order Request #	7. Date/Time Check-In	8. Leader's Name	9. Total Number of Personnel	10. Incident Contact Information	11. Home Unit or Agency	12. Departure Point, Date and Time	13. Method of Travel	14. Incident Assignment	15. Other Qualifications	16. Date Provided to Resources Unit

ICS 211 | 17. Prepared by: Name: _____ Position/Title: _____ Signature: _____ Date/Time: _____

Tools for managing accountability – sign in on arrival.

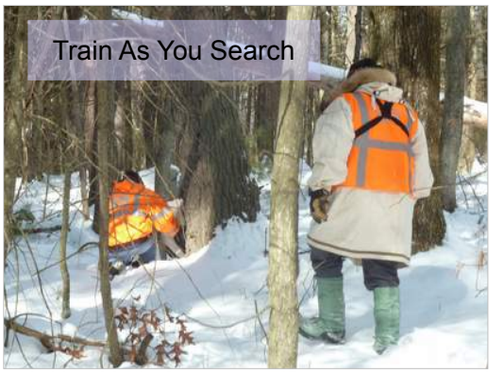
T-Cards, task assignment forms, etc.

Radio status checks. (In the language of the fire service, PAR checks (Personnel Accountability Report)).

Nobody Leaves Last

Good general principle for all incidents, including all training.

Why?



The habits you get into in training will be the ones that you fall into when under stress in a search.

Look up.

Look for clues (and hide them in training).

Write things down. Maintain the same documentation for training that you maintain in a search.

Train in adverse weather conditions. Know that your gear will keep you warm and dry and comfortable and effective.

Documentation

- Search Documentation
- Your Own Documentation
  - Training Logs
  - Mission Logs

Why is documentation important?

What needs to get documented?

Where does documentation get used?

Key bits: Documenting search effort. Communicating search effort from one operational period to the next.

Documenting your own training.

Clue Detection

Unit 9: Clue Detection
Date Last Updated February 20, 2020

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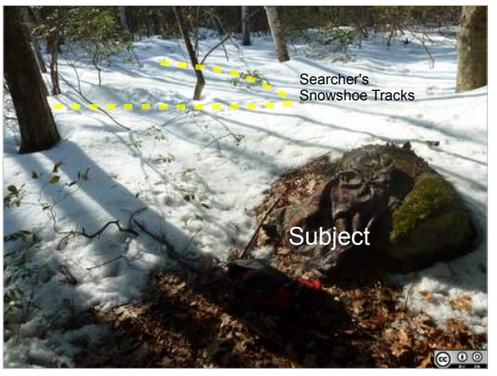


In a training (with an unnamed team), a canine handler passed 2 meters from a subject without seeing the subject. Canine made the find a couple of minutes later. Subject was wearing black pants, a camouflage jacket (in the image), and sitting on a red fanny pack (in the image).

At the point of close approach to the subject, the hander's attention was on the canine, who was in scent and showing untrained alert behaviors.

The yellow dotted line is the handler's track – coming towards the subject from back center, then turning to exit on the left side of the image.

What can we learn from this?

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
- Grid search as a last resort
- Manage by objectives
- Search management is information management

Search is a classic mystery – clues lead you to the subject.

Search for clues not just the subject.

Search for Clues not just the Subject

- One subject, many clues
  - Around 3000 clues per mile when walking [Mantrackers,Tracking/Trailing Dogs]
  - Scent plumes [Air scent dogs]
  - Dropped articles [Clue aware searchers]
- Clues can give:
  - Direction of travel
  - New last known points
  - Shift of priorities of areas to search

All sorts of clues – subjects leave lots of them – around 3000 per mile.

Clues can shift the focus of the search.

Clues may tell us that a crime has occurred.

Clues can be

- Seen
- Heard
- Elicited in investigation
- Felt
- Smelled

Clues come in many types.

Examples?

What needs to happen between your hearing a whistle in the field and that sound being a clue helpful to the management of the search? (it needs to get written down, it needs to get communicated (it needs to get recorded on a clue log, it needs to get followed up on...)

Subject may:

- Walk, leaving sign
- Drop things
  - Litter
    - Candy wrappers, drink containers, food wrappers
  - Hypothermia and paradoxical undressing
- Leave messages
  - Trail registers, route plans, suicide notes
- Bivouac

Subjects have behaviors that create clues.

Investigation feeds into clues – knowledge of what brands of candies, cigarettes, foods, etc that the subject might drop let us identify specific bits of litter as potential clues.

Clues feed into investigation – notes left by the subject can give new directions for investigation.

Why would someone drop their hat and jacket and gloves in the woods in the winter?

Is this a clue?

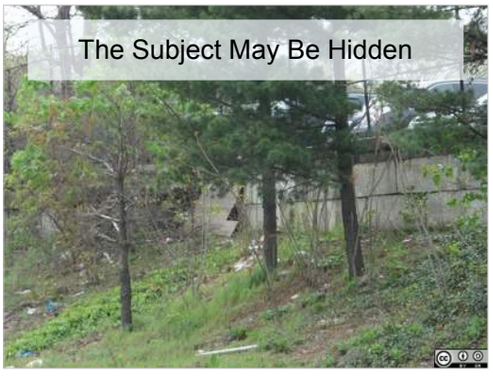
How about this?

Does the subject smoke? Does the subject carry a lighter in their camping gear?

Information elicited in the investigation – lost person questionnaire.

What do you think when you encounter a pile of clothing?

Hikers may leave a record in trail registers – and other hikers on the trails at the same time as the subject may leave contact information that can be followed up in investigation.



Where are hiding places?

The plywood sheet is a shelter used by a homeless person, Porter Square Commuter Rail Station, Cambridge, MA.

The subject may be hidden and not respond when their name is called (why not?)

Altered mental status, unconscious, dead, evading, child taught not to respond to strangers...

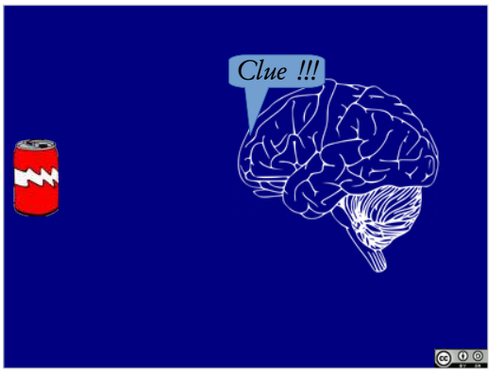
Hug-a-Tree instructions

- Tear a hole for your face in a large plastic garbage bag.
- Pull the bag completely over yourself, leaving your face exposed.
- Sit next to a tree.

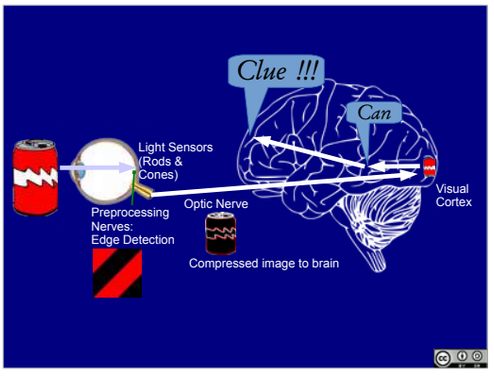
Subjects may be sheltering in a dark plastic bag – that's one of the preventative SAR messages, carry a plastic bag in your pocket or pack for expedient shelter.

Subject in a plastic bag under a tree.

How does clue detection work?



What is the sequence of events involved in your observation of a clue?



Lens in your eye focuses an image on the back of your eye.

Light sensing cells (rods and cones) detect the light and pass the signal to a layer of nerve cells in the back of the eye.

These nerve cells pre-process the image, particularly detecting edges, and pass a compressed image down the optic nerve to the visual cortex at the back of the brain.

The image from the eyes is processed in the visual cortex, and objects are identified and labeled further forward in the brain.

Meaning is then attached to objects in the forebrain – step from seeing to observing.

Teach your Brain to Observe

You can teach your brain to observe clues.

Be attentive all the time.

Kim's game is a classic exercise for improving observation skills.

Cover a set of 20 to 50 random articles with a blanket. Remove the blanket. Let everyone look at the articles for 60 seconds. Cover the articles again.

Have everyone write down a list of all the articles they remember.

Practical Evolution 1: Kim's Game. (carry out here or at end of unit).

Include clues in regular training evolutions

- Clue specific
  - Kim's Game
  - Type I, Type II, and Type III searches
- Add clues to Canine training evolutions
  - Leave clues along trails
  - Leave clues along likely grid lines
  - Leave clues along exit route from subject

Regularly include clues in your training evolutions.

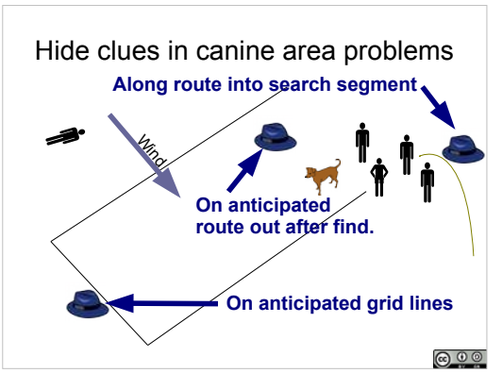
Use specific clue detection evolutions

and

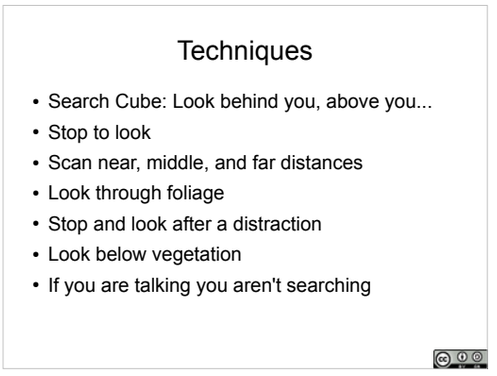
Leave out clues in other evolutions – particularly in canine evolutions.

Canine route problems are ideal for adding clues – if the subject travels out on the route, have them leave some clues along the way.

Be judicious in including clues in canine training evolutions. Don't include clues in specific short evolutions where the goal is to teach the dog a specific behavior, and where the handler being distracted by the clue could cause the dog to fail.

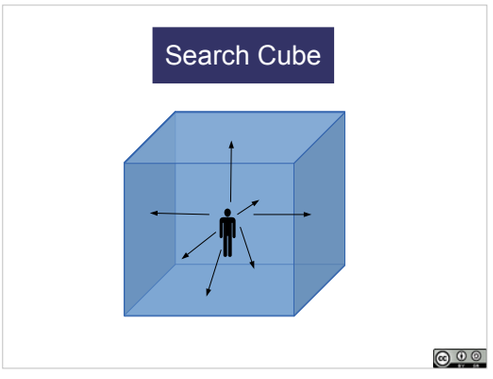


Canine area problems are a little more chancy for clue detection – the humans of the task force may not pass near a clue dropped in a random location in the search segment. Routes in to the search area, anticipated grid lines, and anticipated routes out of the area after the find are good places to consider.



There are also strategies that you can follow to improve your ability to see and observe clues.

This list is empirically supported (Koester et al, 2004, Sweep Width Estimation for Ground Search and Rescue), except for not talking which didn't have a clear effect on visual detection, but which is generally considered good practice and will affect auditory detection.



While you are searching, think of yourself in the center of a cube. Actively look at all 6 faces of that cube – in front, right, left, above you, below you, and behind you.

When you see a bush or trees, don't let your eyes focus on the leaves and trunks, look past them into the spaces beyond.

“It isn't the trees that are missing”

Put your attention into the spaces between the leaves – what do you see?

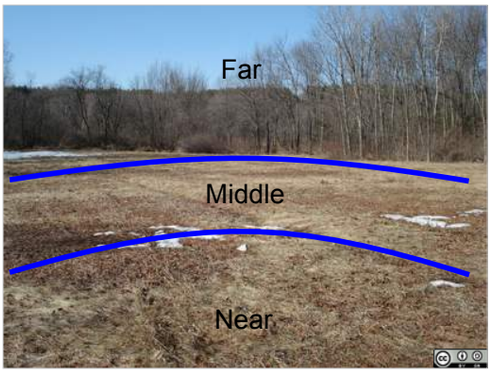
Take a Knee.

Kneel down and look beneath things.

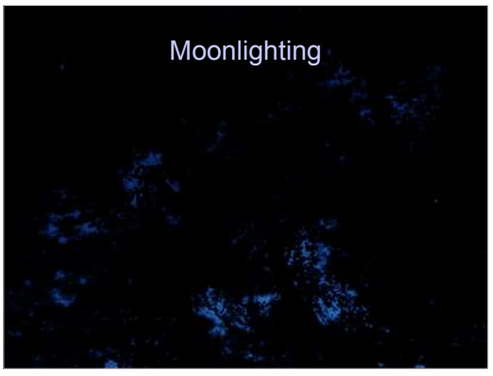
When there are ferns or other vegetation, get down and look under the leaves.

Clue hidden in a search segment in a MA SAR Exercise, and missed by a type II grid search team.

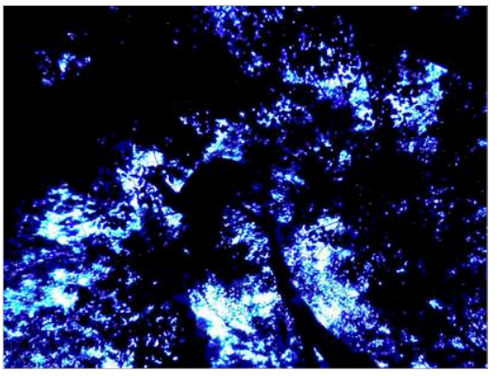
Clue was hidden low in an attractive pile of boulders – purposefully wander and Take a Knee.



Divide the world into near ground, middle ground, and far ground. Actively look at each of these separately. Spend some time focusing on the near ground, then on the middle ground, then on the far ground.



At night, look up and move your head.



Silhouetting things in the trees against the lighter sky.

While traveling trail systems or places where a subject may have traveled, look for places that are likely to retain sign from the subject's passage.

Check these track traps for sign, and avoid destroying sign.

Low muddy spot in the trail – don't follow the path of least resistance, walk around the edge and check the path of least resistance for sign.

What do we see?

Check track traps. Don't walk straight through them.

Behind, Behind, Behind

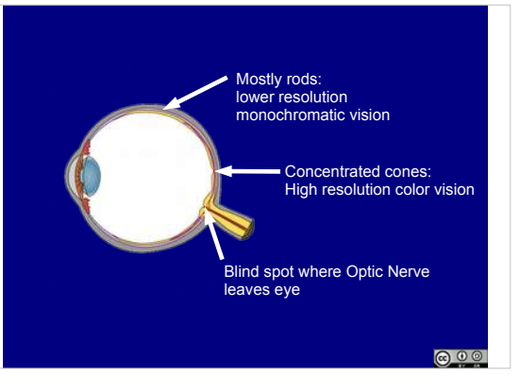
Look at all 6 faces of the search cube.

Look behind you.

Clue hidden in a search segment in a MA SAR Exercise, and missed by two searchers a type II grid search team.

What else is here?

There is a track of disturbance in the leaves from the left to right of the image from the person who was hiding the clues. The searchers also didn't see the lines of disturbance in the leaves. Be track aware.



Knowing something about the eye can help us observe things.

Concentrated cones – high resolution color vision in center of field of vision. Moving away from there, fewer cones, mostly rods, lower resolution black/white vision, processed for motion detection.

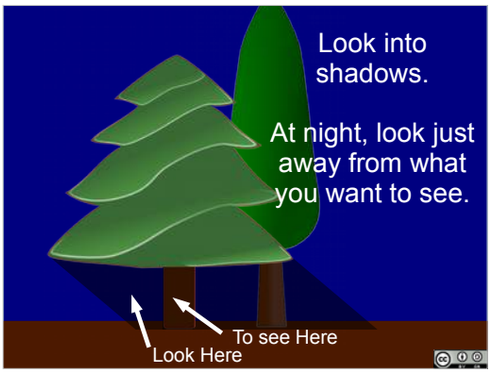
Also, not of particular significance, small blind spot where the optic nerve leaves the back of the eye, processed over so we aren't aware that it is there.

We think we see this.

Look at the puppy's nose.

At one moment in time, one eye is seeing something more like this – sharp and color in the center, fuzzier and monochromatic at the edges – with a tiny blind spot, and with edges enhanced.

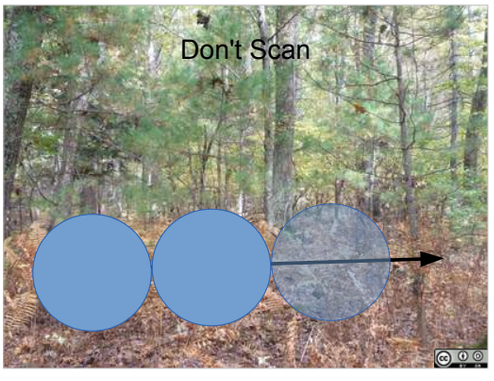
Your eyes are constantly moving (even when you think you have them focused on something), and your eye and brain are assembling what you think is a uniform colored sharp image.



Rods (black/white vision) are more sensitive than cones (color vision).

Fewer rods right at the center of our field of vision.

At night, we can resolve details a little better when we look slightly away from things we are looking at.



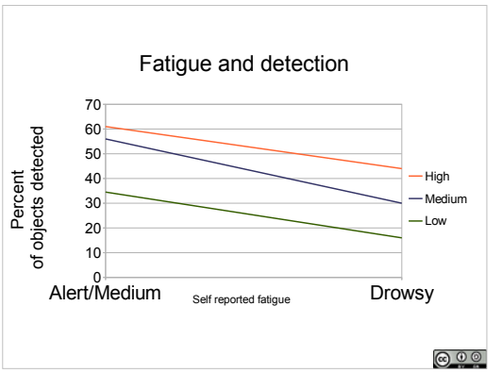
We get a better chance of observing things if we focus on them for a brief period of time.

Instead of scanning your eye across the landscape, pause, move, pause, move, bringing attention systematically to bits of the landscape.

Look at an area about the size of a fist held at arms length. Allow your eyes to focus on that area. Now move to the next area the size of your fist, sweeping across the area you are scanning in steps.

The behavior of a search dog provides clues.

When an air scent dog shows behaviors that you know are associated with it working human scent (not the trained indication behavior, but the untrained alert behaviors), shoot a compass bearing on the wind direction and record the location and wind direction.



Fatigue is well known to decrease performance.

[Here is the effect of 'self reported level of fatigue' on detection, from Koester et al., 2004. Sample size is small (93 alert, 17 moderate, 3 drowsy), minimal difference between alert and moderate, take this as a graphic only, numbers have weak support.]

General principle is well known and well supported: Fatigue decreases peoples' ability to perform all sorts of task.

Object missed in sweep width experiment by a searcher who reported fatigue level as drowsy. Object is 4 meters from track.

Figure 8.10 from Koester et al., 2004. Public Domain

Related to Fatigue is Hydration: Drink plenty of water. Keep Hydrated.

Not being well hydrated also affects performance (and clue detection).

What do you do when you find a potential clue?

(1) Don't touch it.

(1a) Consider Scene Safety.

Upon finding a clue

- **Don't touch.**
- **Scene Safety**
- **Call out: "Hold the line", everyone stays where they are, team leader comes over to determine what action to take.**
- Call it in.
- Record and flag the location.
- (More in Crime Scene Preservation)

More specifically – when you come across a potential clue, stop, don't touch it, call out "hold the line", then the task team leader (nobody else) comes in to determine what to do.

Task Force/Strike Team leader calls it in and gets instructions.

Likely instructions are to record and flag the location.

Good flagging method, three long streamers of flagging tape.

Write assignment name/number on the flagging, along with date and time.

(often encounter single little bits of flagging tape in the woods).

Clue Log

- Maintained in the planning section.
- Log of all clues
  - What was it?
  - Where was it observed?
  - Who observed it, When did they observe it?
  - What follow up action has been taken?
- What clues haven't been followed up on?

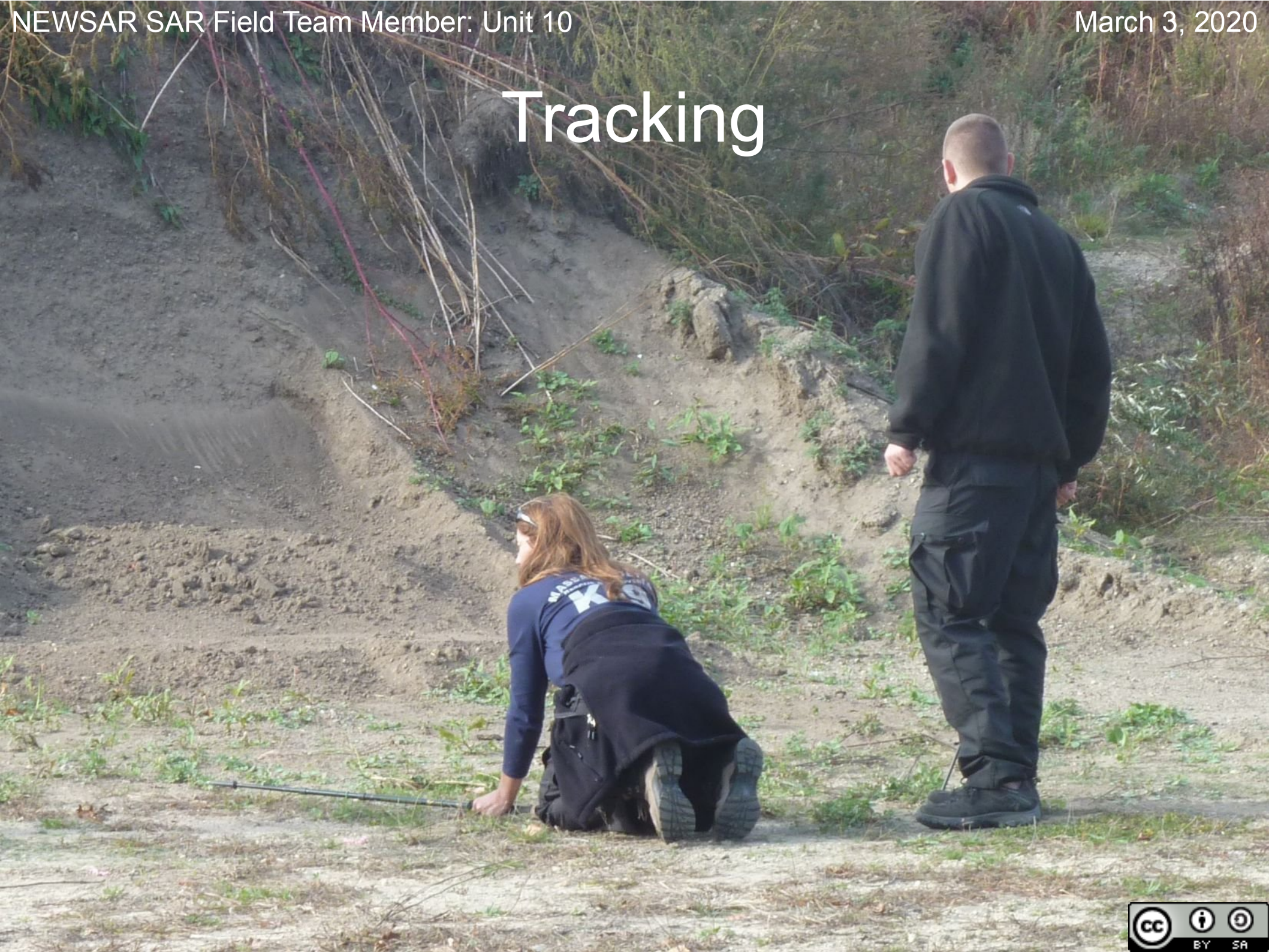
Observing clues is important, also critical is getting that information recorded in the planning section, so that clues don't get overlooked.

Clues called in from the field or reported in debriefing go into a clue log.

One key planning question as the search continues and the subject hasn't been found is what clues haven't been followed up on yet.

Practical Evolution 1: Kim's Game. (carry out now if not done earlier in unit).

Tracking



Unit 10: Tracking/Mantracking/SignCutting
Date Last Updated March 3, 2020

What is "Tracking"

- Locard's principle: "..you can't move through an environment without changing stuff…."
- Following a subject's "sign" (changed stuff)
  - Step by step "man" tracking
  - Signcutting/Tracking/Mantracking/Visual tracking
    - Signcutting = mantracking/tracking/visual tracking
    - Signcutting = trying to acquire a track
    - Signcutting = jump tracking

Dr. Edmond Locard (1877–1966): formulated the basic principle of forensic science as: "Every contact leaves a trace" e.g. "you can't move through an environment without leaving sign behind"

Various names for a person following a sign left by a person, tracking, visual tracking, mantracking, signcutting.

Signcutting is a common name – but has multiple meanings.

[ASTM 2209-14 expects knowledge of "12.11.2 The difference between sign-cutting and tracking." This depends on who you talk to, definitions are inconsistent.]

Changed Stuff

- Sign
- Track
- Print

Sign – what is it? Any evidence of passage.

What is a print?

What is a track?

[ASTM 2209-14 expects knowledge of "12.11.1 The difference between sign and tracks."]

Tracking in SAR

- **Preserve sign**, particularly at LKP/PLS/IPP and along trails
  - **Locate Staging, IC, etc. elsewhere**
- Trackers can establish direction of travel
  - dramatically reduce the high probability search area
- Really good trackers can move faster than the subject
  - They are very rare but a great resource

Step by step tracking is:
- a craft that takes hundreds to thousands of hours to get "good" at
- a perishable skill

Critical for all searchers is awareness that sign exists, and actively acting to preserve sign.

The “right” sign?

- There (nearly always) sign all over the place!
- The “right” sign will be:
  - In the “right” place
  - At the “right” time (age)
  - Doing the “right” thing

There is nearly always sign all over the place.

Is the sign in the right place?

Can aging get you to the right time (of day/date)?

Does the sign support the plausible action(s)?

A print, observed in the early morning.

Notice the very clear impression of the lugs in the sole from the heel of the footwear, and the dark shadow from the soil pushed up by the side of the heel.

Note the broken piece of plastic at the bottom of the picture.

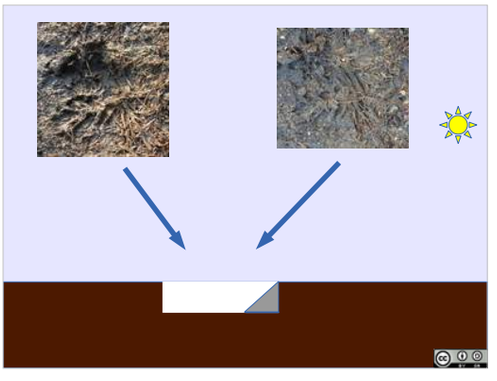
[Don’t spend too much time looking for details in this image, point is comparision with the next image.

Next slide is the same print from a different angle, in this slide, the photographer is facing towards the sun.]

The same print, observed from the other side, the broken plastic is now at the top of the picture.

The sun is at our back, shadows from the print are much less evident.

[This is the same print as the previous slide, taken at the same time, just from the opposite direction, with the sun at the photographer’s back]



Lesson 1:

Angle of illumination is critical for observing sign.

Use Sun Angle

- Tracking is easiest when the sun is low (morning and evening).
- Keep the tracks between you and the sun.

Tracking (with some exceptions) easiest when the track is between you and the light source.

Sign

- Flattening
- Regularity
- Color Change
- Disturbance

Elements of sign that you can observe

You can see disturbance (disturbed pine needle), flattening, regularity (straight lines from the tread, straight line from the side of the sole), and color change (transfer of mud onto the leaf).

[Note: Sign is notoriously difficult to photograph. Do not spend too much time trying to identify all of the sorts of sign in each of the images that follow, each picks out a particular aspect, focus the students' attention on just that aspect, seeing all of the myriad details should be left to practical evolutions. Do not take time to identify heel, toe, and other structures in each image, just focus on the single clear aspect.]

Center of the image shows an area which is much flatter in comparison to the surrounding background.

The tracklayer's weight impressed these pebbles into the ground – they have a dark halo and cracks in the soil around them.

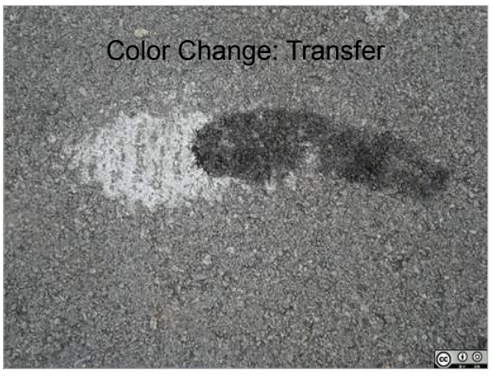
An impressed twig. Again, a dark halo.

Regular wavy pattern from tread on the sole.

Here is regularity from the tread pattern and color changes in the mud.

What sort of footwear is this?

Trick question – you can't tell. All sorts of different tread patterns are put on all sorts of different footwear. Size also is very variable, shoe size has only a weak correlation to length of the print.



Here is color change and transfer from transfer of salt from a salt rich puddle of melting slush on the road side to cleaner pavement. Dark is salt retaining moisture, white is dry road salt.

Can be very durable tracks in urban environments.

Here we have a boundary between mud and asphalt pavement.

A tracklayer walked from the mud onto the asphalt.

Scale bar is at a location we'll look more closely at tin the next couple of images.

Looking closer – there's a print in the mud – some mud got stuck on the sole

And on the asphalt, some of the mud got left behind.

Transfer.

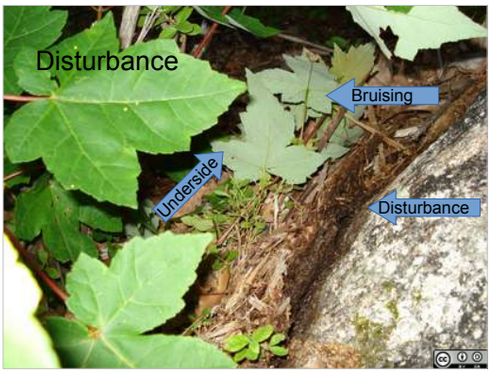
Transfer, later when the pavement is dry.

[Same track as the previous slide, later in the same day, transfer remains, clearest as patch of brown dirt on asphalt, left top center.]

What can see here?

Scrape marks on the stick where frost was scraped off.

Mark where stick was frozen on the ground and has moved.



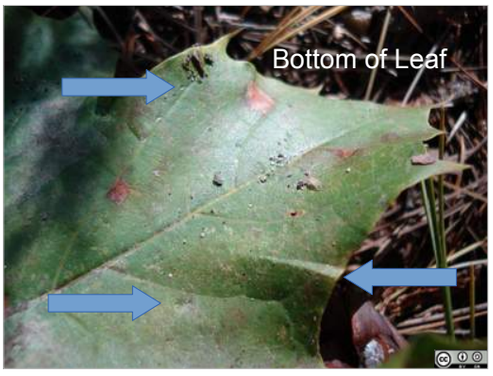
Check things that people would step over. Top often has scrape marks. Place where they put the foot down on the far side often has disturbance from lots of force.

See also brusing on bottom of overturned leaves.

Dry leaves crack when stepped on.

This is one tool for aging sign, the edges of the crack draw back over time.

Older cracks dry and spread apart.



Examining the bottom of a leaf that has been stepped on may reveal more sign than the top.

This image shows transfer of dirt from the ground onto the bottom of the leaf, bruises in the leaf, and a linear feature where the leaf was folded.

What do you know about the sign?

- Conclusively Human
  - Identifiable as the subject's tracks
  - Made: Identifiable and describable
  - Definitely human sign
- Possibly Human: Corroborant sign

Sign might be identifiable as made by the subject, identifiable, definitely human but not identifiable, or possibly human.

What do we see?

[Spend some time examining this image.]

[Students should be able to see at least: regularity, flattening, impressed pebbles, disturbance]

What do we know about this sign?

Definitely human, may not be identifiable.

Look for sign in three dimensions

Sign isn't just on the ground.

Horse Trail crossing Evansburg Creek
Evansburg State Park, PA

Branches over trail.

Good place to check for sign above the ground.

Indeed: Horse hair in branches over trail

Here is the horsehair on leaves above horse crossing

Evansburg Creek
Evansburg State Park, PA

Track in pine needles.

Challenging to see. Popsicle stick marks the heel, rest of print is in focus.

[This image is context for the next two.]

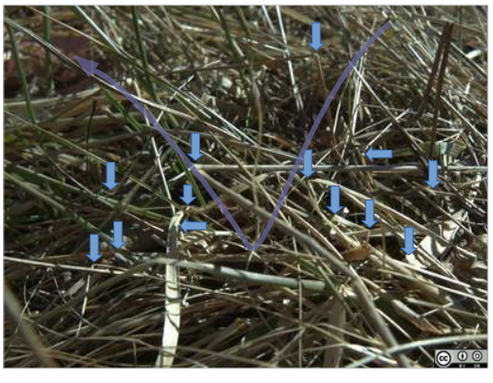
There was a broken twig in the track.

At shoulder height, here's where that twig was broken off in the tracklayer's passage.

Dry tall grass disturbed by passage
Penhurst State School, PA

Flags are marking a line of prints.

Tall dry vegetation is broken.



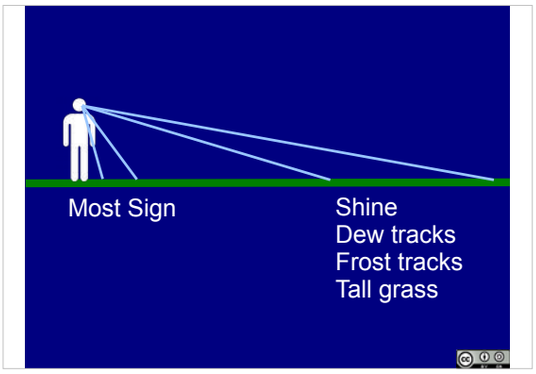
Footprint in tall grass
Penhurst State School, PA

What do we see?

Tracks in dew.

Will these last?

Where can you see them best?



Most sign is best seen close to you, with the sun backlighting it at a low angle.

Some sign jumps out at you from a distance, and may be seen best with other angles of illumination.

Track Traps: Natural or created.

You can create them.

Watch for natural track traps, check them for sign, avoid trampling them.

Dirt time

- Tracking step by step
- Tracking Stick
- Drawing and Describing Tracks
- Observing behaviors
- Watching sign age

Learning to track involves teaching your brain to observe sign.

Very time intensive, needs lots of dirt time.

Some steps in the process – learning to observe changes to behavior in the track and learning how sign ages in your local environments take lots and lots of time and practice.

NEWSAR usually has tracking opportunities at the annual training.

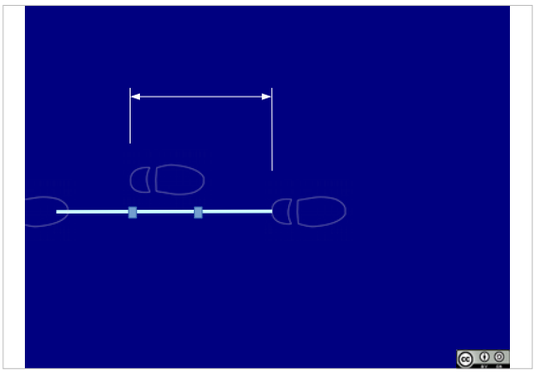
NASAR has a tracking course.

VA Field Team Signcutter course is a week.

Tracking Stick

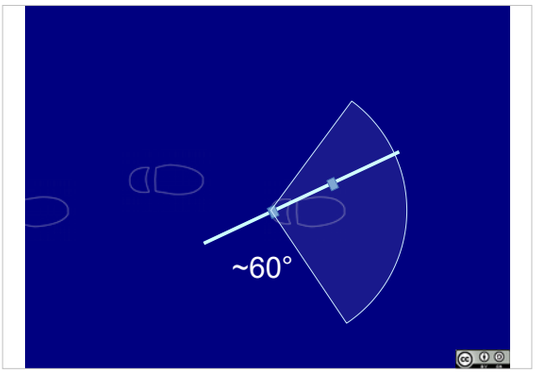
- Mark with print and stride measurements
- Focuses your attention when tracking step by step.

A tool that can help you track is a tracking stick.



After you have measured a track with a tape measure and written down the measurements, you can set up your tracking stick as a quick reference.

Using rubber bands, etc, you can mark out stride length (e.g. heel to heel) and print length on the tracking stick (and other measurements as well).



Marking heel to heel, you can hold the tracking stick at the heel mark of the most recent print, swing it side to side over a 60 degree arc, and focus your attention just in front of the tip of the stick – this is where the next print should be.

Very important for learning is Tracking step by step, don't move on until you've found the next print.

What do we see?

Tracks can also tell you about the subject's behavior.

What is going on here?

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

Humans leave about 2000 clues per mile.

We are searching for? Clues and the subject. Discuss crucials.

Out of Koester's bicycle wheel model, what locations and actions particularly relate to sign? Axle-PLS protect it to preserve clues (including sign). Resources to determine direction of travel to area around the PLS.

Very typical problem at the PLS is contamination – plenty of sign in addition to the subject from family, friends, initial responders, and searchers.

A typical issue for a mantracker is distinguishing the subject's sign form contamination.

Supporting a Tracking Task

- Stay behind.
- Stay situationally aware.
- Look ahead.
- Look for Clues.

When working with a tracking task, don't want to contaminate the sign the mantracker is working.

Don't get into the mantracker's light or get ahead and disturb sign.

The mantracker is focused on the sign. You need to look at the big picture and maintain situational awareness. Look for what's ahead. Look for hazards. Look for clues.

Land Navigation III
Wayfinding, Telling North

NEWSAR SAR Field Team Member: Unit 11 February 21, 2020

Land Navigation III
Wayfinding, Telling North

Unit 11, Land Navigation III. Wayfinding, Telling North
Date last updated: February 21, 2020

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"The prudent mariner will not rely solely on any single aid to navigation"

Good advice found on nautical charts:

"The prudent mariner will not rely solely on any single aid to navigation."

Learn to use multiple tools for navigation at the same time.

Sorts of navigational Knowledge

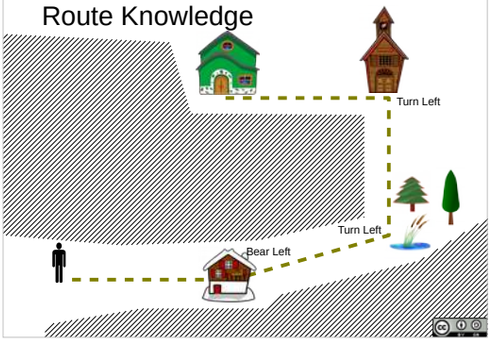
- Landmarks
- Route Knowledge
- Survey Knowledge

Classically, navigational knowledge has been seen as a sequence from identifying landmarks, to connecting landmarks together into knowledge of routes, to broader spatial knowledge of how to navigate cross-country on arbitrary routes.

More recent work suggests that this isn't a simple hierarchy of improving skill, but are interrelated skill sets that are used for different purposes.

Navigational knowledge uses a **mental map** – this mental map is fluid and continually being updated as you observe the environment you are moving through. These updates may make the mental map a more accurate, or less accurate representation of the world.

Route Knowledge

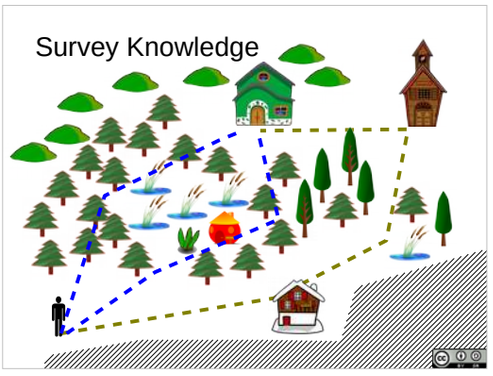


Route knowledge – mental map is of connections between landmarks - travel a route from one landmark to the next to the next.

With route knowledge, there is no clear mental map of the spaces between the routes. Weak perception of distances between landmarks. Weak perception of changes in direction.

Repeated traveling of the route improves the mental map.

What might the expected consequences be of taking a shortcut with just Route Knowledge?



Survey knowledge fills in the map between the landmarks. Survey knowledge lets you plan new routes in your mental map.

Knowledge of where features are with respect to one another allow you to use dead reckoning to navigate – travel in a direction for some distance and turn to another direction for another distance.

The mental map has landmarks, direction (either with respect to home or to north), and probably distances perceived as travel time.

Repeated traveling in the area improves the mental map. It still can be a poor representation of reality.

Wayfinding

- **Maintain orientation**
- **Plan a Route – pick a course towards your destination**
- **Route Monitoring – keep evaluating that you are on course**
- **Recognize your destination, or that you've gone past it.**

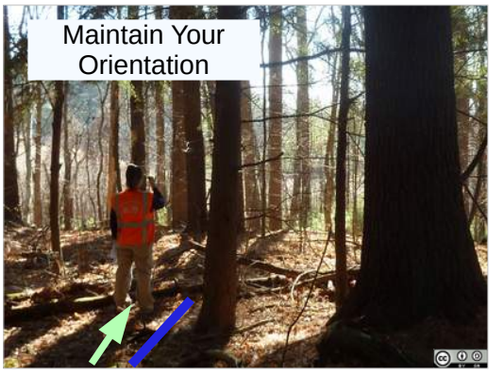
Wayfinding involves four skills:

Maintaining your orientation.

Planning your route.

Monitoring that you are on your planned route.

And recognizing when you are at (or past) your destination.



Traveling short distances (e.g. on grid lines), you can continually check that you aren't going off course by keeping the sun/shadows/the moon/a bright star in the same place.

Here the searcher is navigating on a grid line almost into the sun, and should be crossing shadows at about the same angle over that one grid line.

When coming back on the next leg on the back bearing, the searcher should have the sun over their left shoulder and should again be traveling almost parallel to the shadows.

Not accurate, but a good constant sanity check.

Sun/stars/moon move a handspan in the sky in an hour (360/24 = 15 degrees/hour).

Maintain Orientation?

Practical Evolution

Take the class outside.

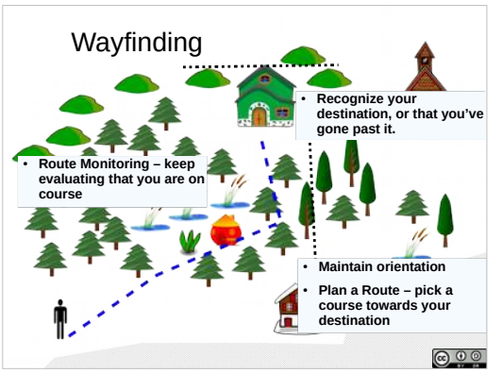
What means do you have to maintain your orientation?

Discuss.

Walk towards a landmark.

Keep environment (sun/shadow/moon/planets/clouds/ wind/waves) in same position as you move.

Use a compass



Survey Knowledge lets you plan your route (go northeast into the pine woods, turn north after the swamp to the green house), monitor it to know that you are on course (pass the orange house in the woods), and recongnize if you've gone past your destination (or a turn – turn north before getting into the deciduous woods, if you get into the hills, you've gone too far north).

Survey knowledge helps you maintain orientation, but also requires that you maintain orientation – start traveling north instead of north east, and the swamp will be on your right instead of your left.

Wayfinding Errors

- Mental maps are fluid.
- Confirmation Bias
  - You tend to only notice things that confirm what you already believe.
  - You tend to ignore things that don't fit in with your belief about where you are.
- Bending The Map
  - You tend to warp the map in your mind to make it fit with what you see around you.

Treat your location as a hypothesis, continually test it.

There are several kinds of mental illusions that our minds follow when we are trying to find our way.

Most importantly: Our mental maps are fluid, our observations of the environment continually change them. Weak mental maps are easily bent.

One illusion is confirmation bias – we tend only to notice things that fit with our pre-concieved idea of what reality should be, and tend to ignore things (like that mountain over there) that don't fit our beliefs.

Another illusion is bending the map – instead of shifting our belief of where we are on the map, we tend to warp the map to fit the things we see around us: a downhill slope gets misinterpreted as uphill, the distance to a faraway hill on the map gets warped into a short distance because there's a hill right next to us...

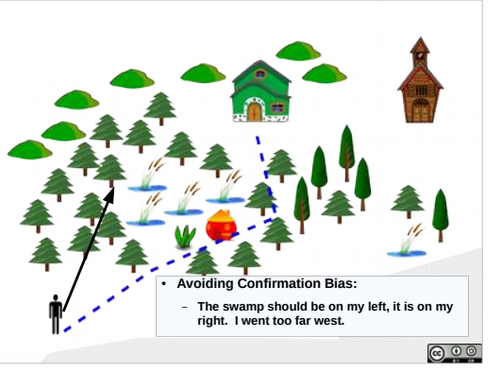
Avoid these traps by continually testing what you see around you against a physical map.

Avoid Bending the map – it is all too easy to shift your mental map around to fit where you think you are.

You pass the swamp on the right, and instead of thinking that you are on the wrong side of the swamp, you bend your mental map to put the swamp on the other side of your planned routed.

Thus, you come to the end of the swamp and turn left, having bent the map to put your destination off to the left, and you wander off....

There might be the nagging feeling that you should have passed the orange hut...



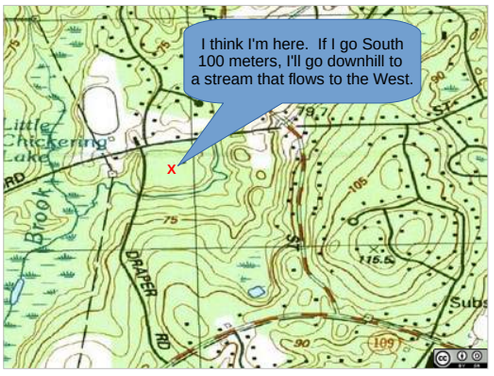
Avoid Confirmation Bias: Look for things that Don't fit, not things that do fit.

Not: There's a swamp, I'm supposed to pass a swamp, but:

The swamp isn't supposed to be on my right, I'm either on the wrong side of it, or it is some other swamp....

Where's the orange hut?

If I go right along the south edge of the swamp for a few minutes, I should come to the orange hut.



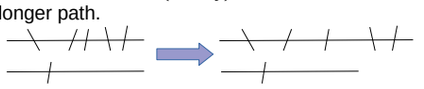
Treat your location as a hypothesis: ask what does the map say should happen if you move in some direction.

If you move in that direction and you don't find what the map says you should find when you should find it, then either – you weren't where you thought you were, or you aren't traveling in the direction you thought you were traveling in, or both.

Use as many tools as you can to continually test your belief of what your location is.

Some Spatial Mental Illusions

- More intersections (falsely) remembered as a longer path.



- Winding routes (falsely) remembered as straighter.

There are several sorts of common misspercepti ons that result from how our brain treats spatial information.

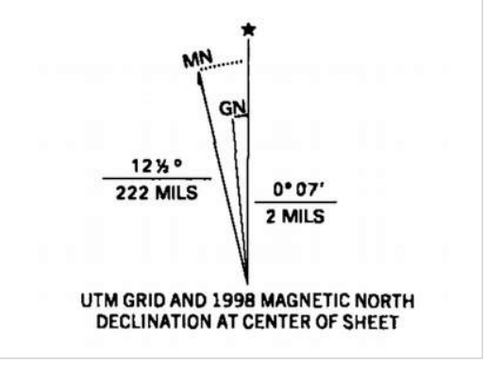
We tend to think of routes that have more points (landmarks, intersections, etc) on them as longer than routes of the same length with fewer points. (The simple seems shorter).

We tend to forget that twisting, turning, windy paths wind and tend to straighten them out in our mind. (What is a potential consequence of this? [e.g. you maintain orientation and don't understand why the path west is taking you north])

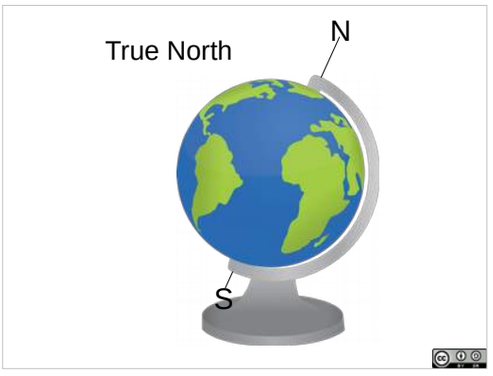
Where does the compass needle point?

North.

Which North?

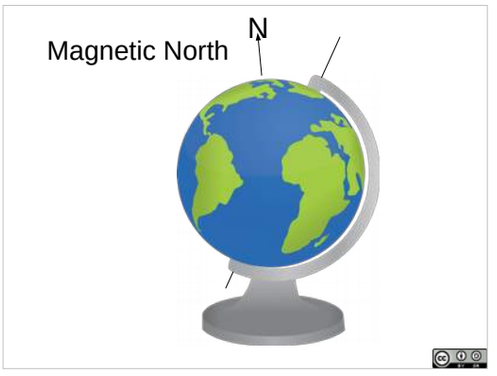


There's true north, magnetic north, and grid north.



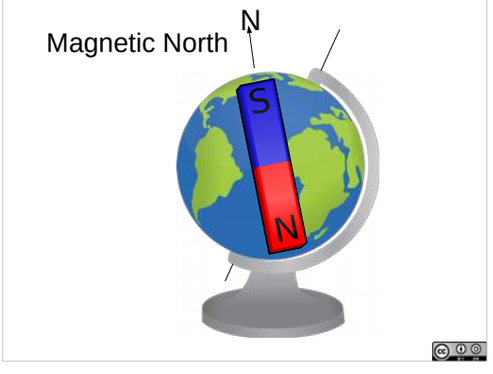
The Earth rotates around its axis.

That's true north.



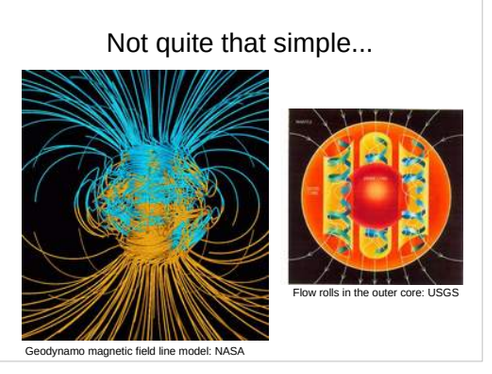
The north magnetic pole isn't in the same place as the north pole (right now) – it is somewhere off the north edge of Canada (and it is headed towards Russia).

The South magnetic pole, likewise, isn't in the center of Antarctica, it is (currently) just off the coast of Antarctica, between Antarctica and Australia.



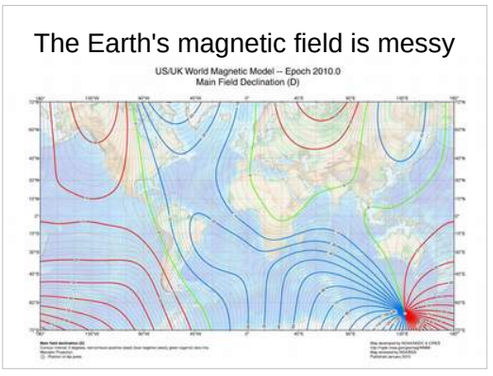
We can simplistically think of the Earth as a giant bar magnet, with the poles of the magnet not quite lining up with the axis of rotation of the earth.

(And yes, opposites attract, if it were a bar magnet, the south end would be at the north pole attracting the north ends of magnets in compasses – we call the north end of a magnet the end that points towards the Earth's north pole).



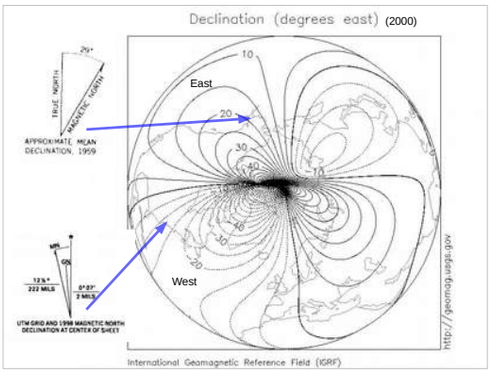
But, it isn't that simple: The Earth's outer core is iron rich fluid, it conducts electricity, it flows, moving electrical current produces a magnetic field. Heat from the inner core causes the fluid inner core to rise, the coriolis force causes the flow to be organized into N-S organized flow rolls: This forms a geodynamo, in essence a gigantic messy electromagnet. The resulting magnetic field is messy.

Also note – near the poles, the magnetic field lines point up and down, near the equator they are paralell to the Earth's surface – this is why you want a global compass, in the northern hemisphere the north end of the compass needle is pulled down, in the southern hemisphere it is pulled up, a compass not designed for it can get the needle stuck when held flat in the wrong hemisphere...



The key point: things are messier than just a bar magnet, the core of the Earth is like a giant fluid electromagnet, it produces a **messy** magnetic field.

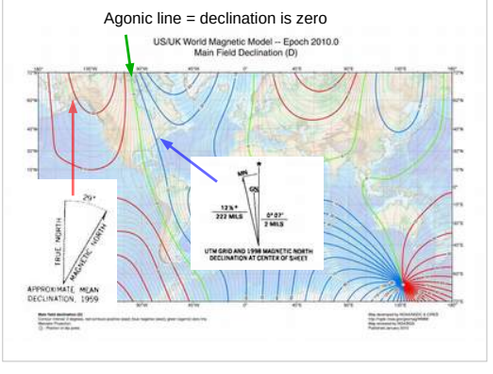
Your compass needle doesn't point straight at the North magnetic pole – it points towards North in your local bit of the Earth's (messy) magnetic field.



The difference between where the compass needle points north in the Earth's magnetic field (magnetic north), and the Earth's axis of rotation (true north) is known as declination.

When local magnetic North is East of true North, we say we have an East declination.

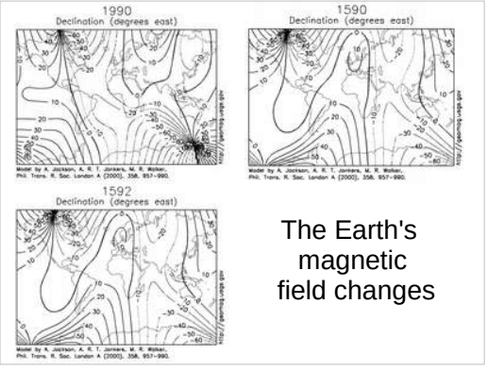
When magnetic North is West of true North, we say we have a West Declination.



Roughly, East of the Mississippi (in the US) magnetic North is West of True North.

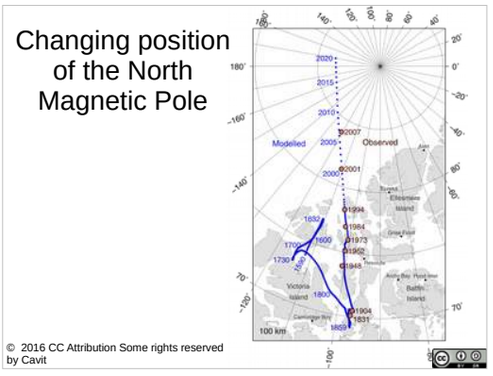
Roughly, along the Mississippi, magnetic north and true north are the same. This line where the declination is zero is called the Agonic line (without angle, (goniometer, tool for measuring angles)).

Other side of the Mississippi, magnetic North is East of True North.



And, the earth's magnetic field changes over time...

(Upper right is an animation of the shifting declination from 1592 to 1990. Left is declination map in 1592 and in 1990.)



And as part of those changes, the north and south magnetic poles move.

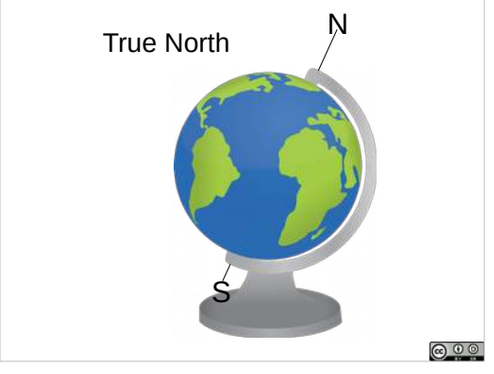
In the 1980s, the Earth's magnetic pole was in Northern Canada.

Now, it is in the Arctic ocean, about 4 degrees away from the North pole, headed towards Russia.

How can you tell North at night?

Northern hemisphere – Polaris, the north star.

Two stars on the end of the cup of the big dipper are the pointers, point to the end of the handle of the little dipper, that star is Polaris and almost at the North pole.



The Earth rotates around its axis.

Polaris, the North Star, happens to line up with the axis of rotation – look straight up at the North pole and you'll be looking at Polaris.

Over the course of the night, Polaris stays in the same place, all the rest of the stars rotate around it – stars/ sun/moon move a handspan in the sky in an hour (360/24 = 15 degrees/hour).

Polaris, sun, moon, others stars all tell you about true north – the rotation of the earth about its axis.

Telling North

- Sun
- Moon
- Stars

Everything else moves in the sky as the Earth rotates.

With some sense of time, we can tell direction from the things in the sky.

Simplest: The sun rises in the East and sets in the West.

More involved: analog watch: point the hour hand of your watch at the sun, half the distance between the hour hand and noon is a north south line.

Here 9:27 AM, sun to the east. Line half way between the hour hand and noon is N-S, knowing it is morning tells us which way is North.

Can you tell which way you are looking?

Where is the sun?

What time of day do you think this is?

Crescent Moon, just after sunset, southern hemisphere, thus looking west.

You would get this view just before dawn in Northern hemisphere, looking East.

Draw a line through the tips of the crescent moon – that's a north-south line (you then need to think about what hemisphere you are in to figure out which way is North)

Full moon is opposite the sun. Crescent moon is near the sun. Full moon rises near sunset. Full moon sets near dawn.

Moon and sun are at their highest elevation when in the South.

Avoiding Getting Lost

- Maintain a straight course, use environmental cues for direction
- Identify backstops (recognize when you've gone past your destination)
- Pay close attention to landmarks
  - Pay close attention to your surroundings (terrain, vegetation, smells, etc)
  - Remember the identity of locations you travel through (give places memorable identities).
  - Look behind you regularly (particularly at trail junctions).
- Track times and directions
- Structure your path

To avoid getting lost....

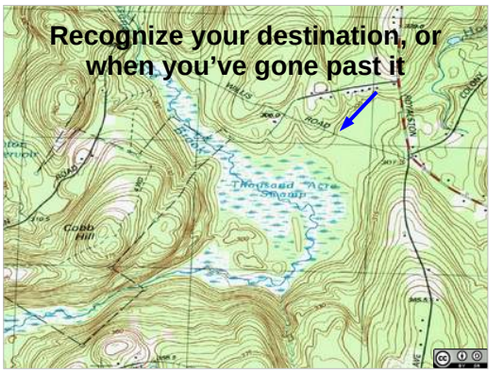
Direction.

Backstops.

Pay attention.

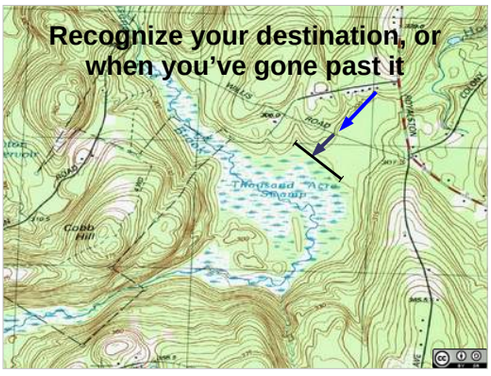
Direction, and travel time.

Structure your path.



Backstops

I'm traveling along the edge of the slope to Willis Road.



If I cross Willis Road (or it is overgrown or doesn't exist any more), if I hit the swamp, I'll know I've gone too far.

The swamp serves as a backstop.

What feature am I navigating along as a handrail?

The slope break serves as a handrail to keep me oriented in the right direction.

What other environmental clues did we just look at for maintaining orientation?

Avoiding Getting Lost

- Identify backstops (recognize when you've gone past your destination)
- Maintain a straight course, use environmental cues for direction
- Pay close attention to landmarks
  - Pay close attention to your surroundings (terrain, vegetation, smells, etc)
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- Track times and directions
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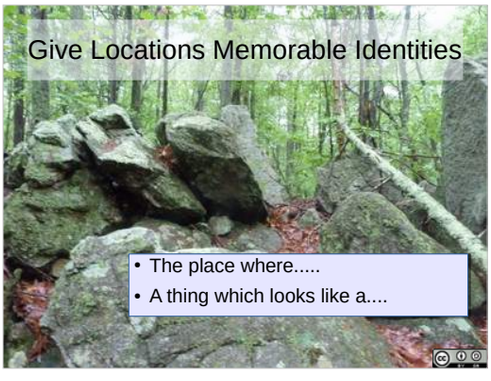
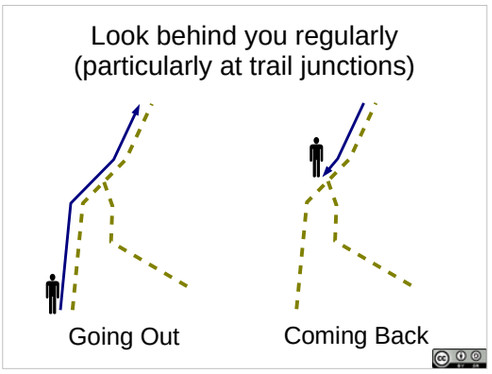
Pay attention.

Give places memorable identities.



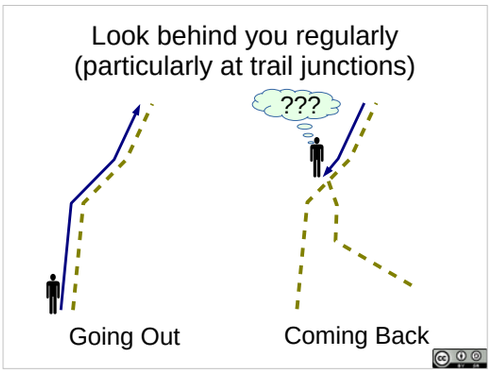
This is the place where....

You will remember landmarks better if you give them identities, particularly if you give them emotional meaning.



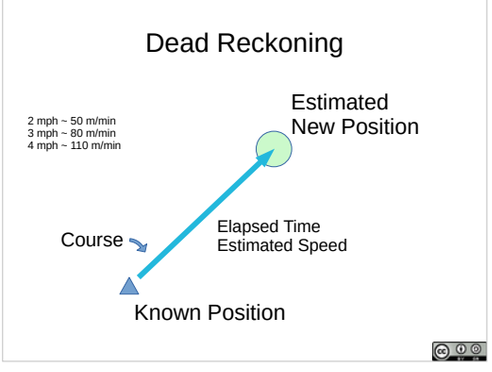
How often have you done this?

Gone one way on a trail, then returned, and come to a trail junction where you don't remember which way to turn...



or even that there was a trail junction there at all...

When you come to a trail junction, turn around an look at it as you will when returning, and make the trail you came from memorable.



Dead Reckoning: Traveling from a known position along some bearing at some speed for some time.

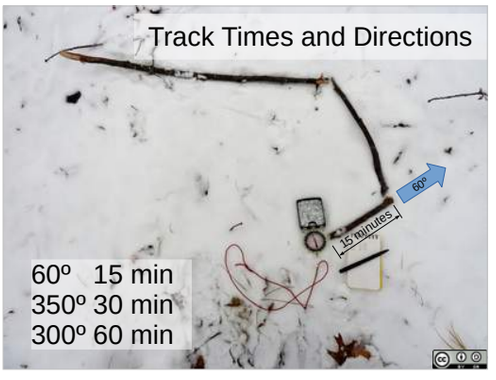
Estimating a new position as an offset (with some error) from the known position based on the travel time and speed on the course.

Good numbers for thinking about distance and time:

2 mph is about 50 meters per minute.

3 mph is about 80 meters per minute.

4 mph is about 110 meters per minute.

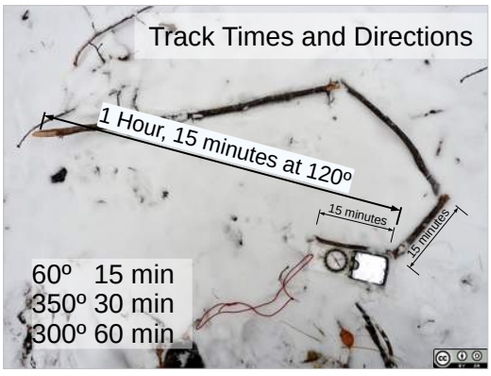


Using Dead Reckoning (or path integration).

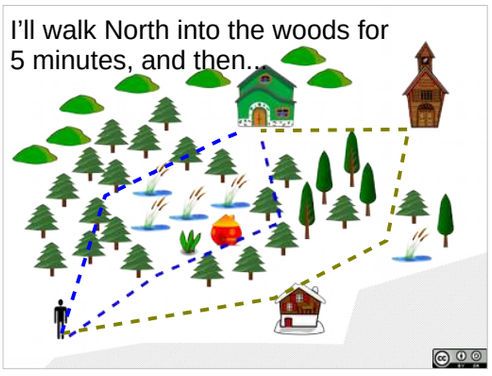
Break sticks into lengths representing travel time on bearings.

Place sticks from the starting point along the bearings that you traveled.

Record approximate direction of travel and travel time, then you can create a dead reckoning map of how you got from where you started to where you are.



Then you can estimate your bearing and travel time back to your starting point.



You can use time as a proxy for distance to plan your route.

How do I get from where I am to the green house?

Plan out your route – structure it, identify things you can monitor along the way, estimate distances (travel times). Give the landmarks names (and emotional meanings).

Identify backstops – how do you know if you have gone too far along some leg of the route.

Structure your Path
Connect places with memorable identities

- **Plan a Route – plan your path – give yourself a structure to follow.**
- **Route Monitoring – keep evaluating that you are on your path.**
- **Recognize your destination, or that you've gone past it.**

Structure your path – connect places (landmarks) with memorable identities (and backstops) into a path with approximate distances/times of travel.

Construct a memorable path from where you think you are to your destination.

Discuss.

Have students identify landmarks and give them memorable identities.

Identify backstops.

Identify places where the route may be miss-remembered.

Identify decision points.

Have students estimate travel times along the path.