Land Navigation II
Map and Compass

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

Good advice found on nautical charts:

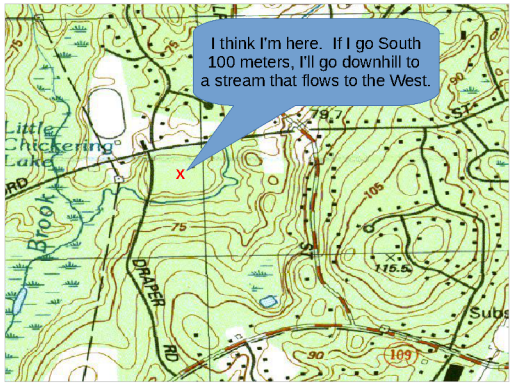
"The prudent mariner will not rely solely on any single aid to navigation."

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

Wayfinding Errors

- 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.

One 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 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 the map.

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

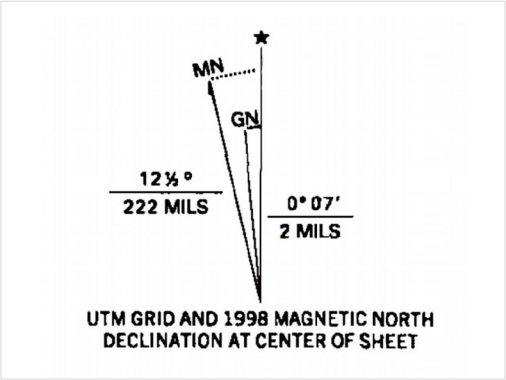
If you move in that direction and you don't find what the map says you should find when you should find it, then either – you weren't where you thought you were, or you aren't traveling in the direction you thought you were traveling in, or both.

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

Where does the compass needle point?

North.

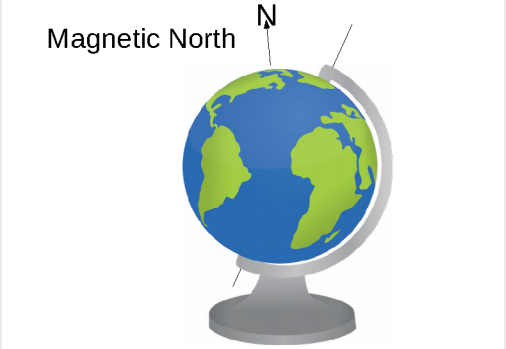
Which North?



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

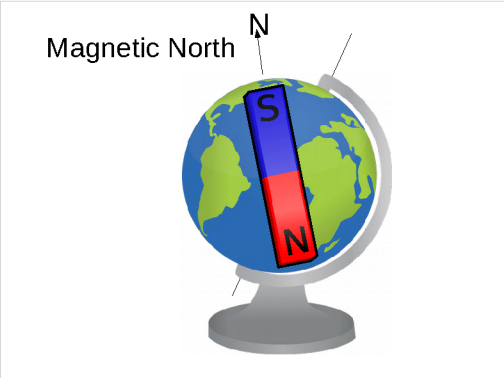
The Earth rotates around its axis.

That's true north.



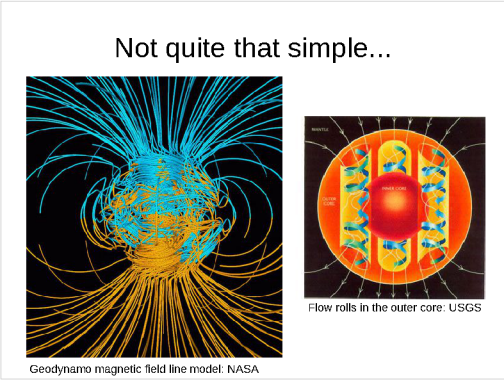
The north magnetic pole isn't in the same place as the north pole (right now) – it is somewhere off the north edge of Canada (and it is headed towards Russia).

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.



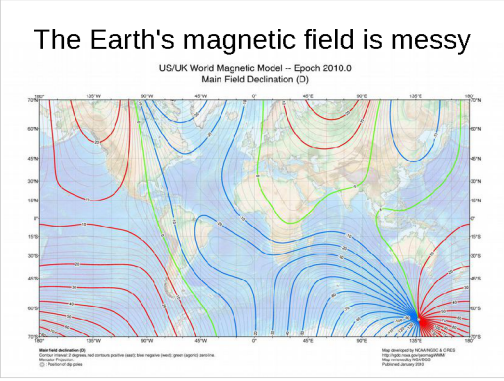
We can simplistically think of the Earth as a giant bar magnet, with the poles of the magnet not quite lining up with the axis of rotation of the earth.

(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).



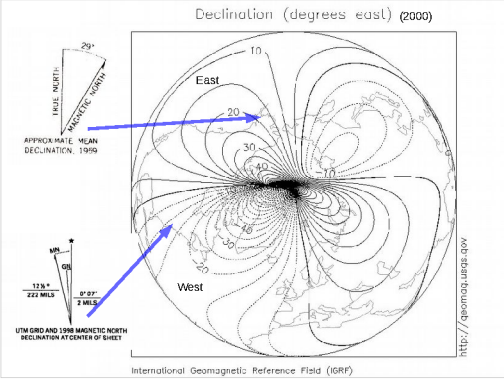
But, it isn't that simple: The Earth's outer core is iron rich fluid, it conducts electricity, it flows, moving electrical current produces a magnetic field. Heat from the inner core causes the fluid inner core to rise, the coriolis force causes the flow to be organized into N-S organized flow rolls: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

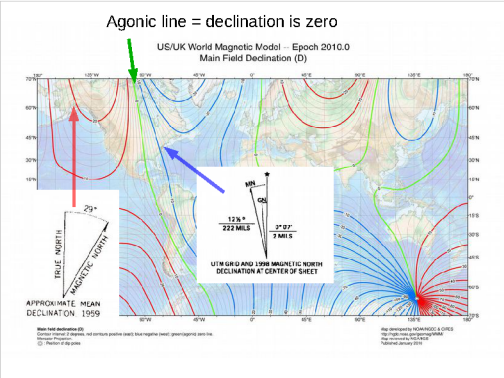
Your compass needle doesn't point straight at the North magnetic pole – it points towards North in your local bit of the Earth's (messy) magnetic field.



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.

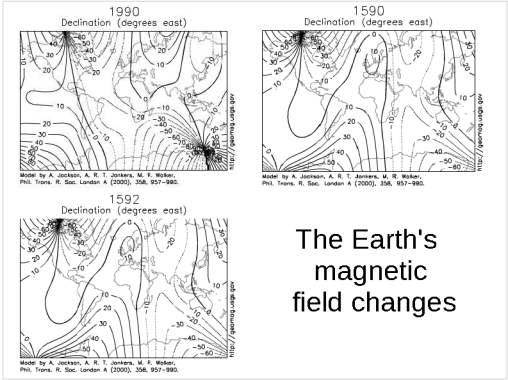
When magnetic North is West of true North, we say we have a West Declination.



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

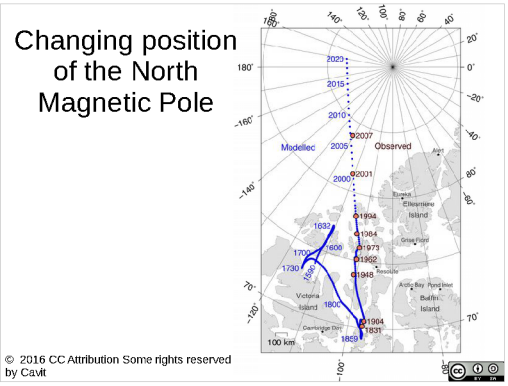
Roughly, along the Mississippi, magnetic north and true north are the same. This line where the declination is zero is called the Agonic line (without angle, (goniometer, tool for measuring angles)).

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.

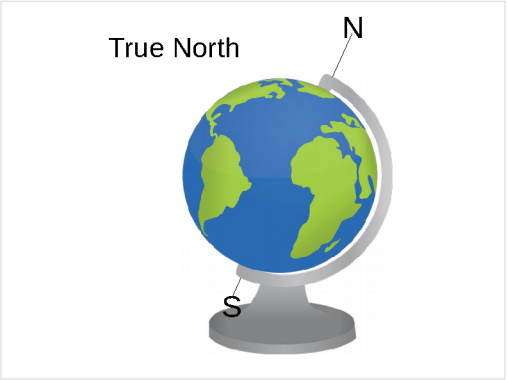
In the 1980s, the Earth's magnetic pole was in Northern Canada.

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.

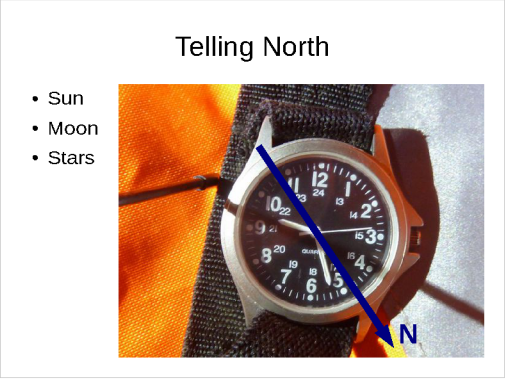


The Earth rotates around its axis.

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.



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.

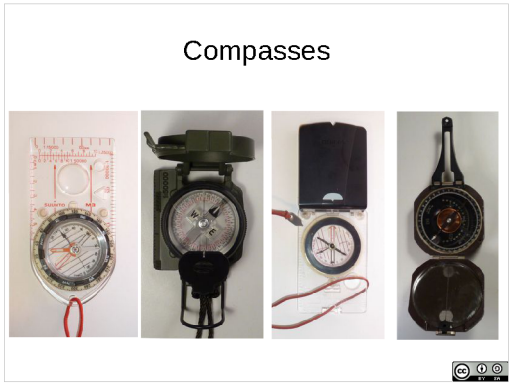
Traveling short distances (e.g. on grid lines), you can continually check that you aren't going off course by keeping the sun/shadows/the moon/a bright star in the same place.

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.

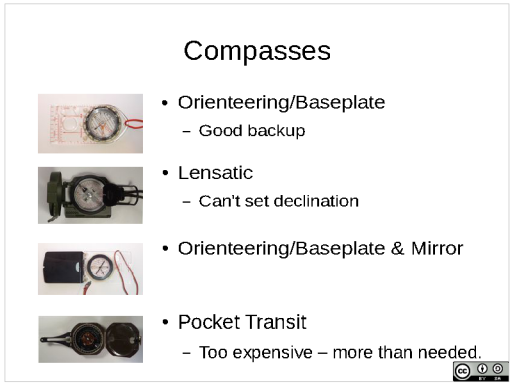
When coming back on the next leg on the back bearing, the searcher should have the sun over their left shoulder and should again be traveling almost parallel to the shadows.

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).



Lets look at compasses – many different sorts, with advantages and disadvantages of each.



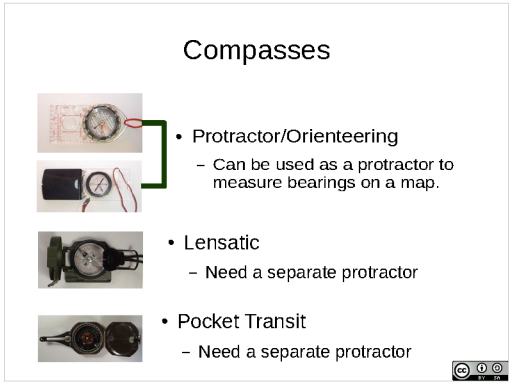
Four typical styles:

Baseplate/Orienteering – good for basic navigation, make a nice backup, hard to be accurate enough with them for accurate grid navigation.

Lensatic, accurate navigation, can't set the declination.

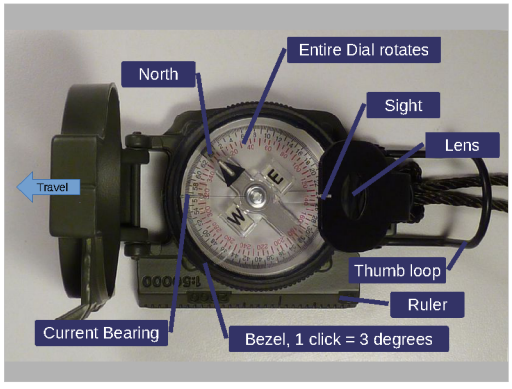
Baseplate/Orienteering with mirror –accurate navigation, can set declination.

Geologist's pocket transit – overkill.



Orienteering compasses can also be used as a protractor to measure angles and bearings on a map.

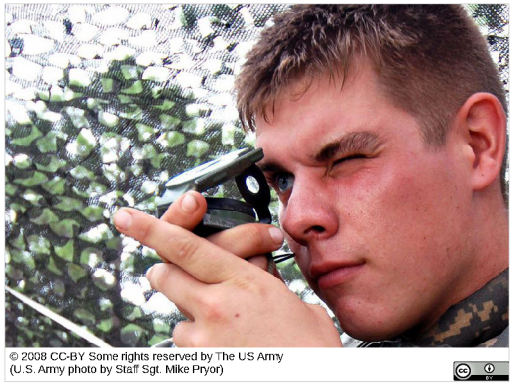
Let's look at the Lensatic compass.



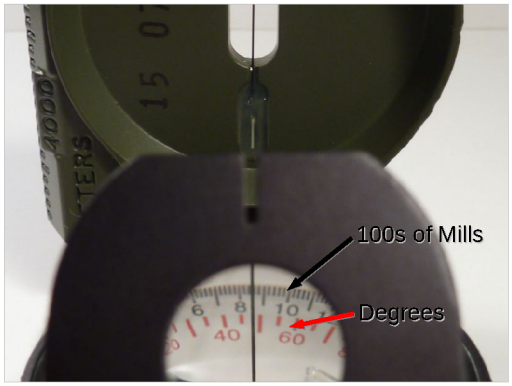
Parts of a lensatic compass

Cover and lens with sight fold up.

Entire dial with the numbers swings free and rotates, with N and 0 always pointing north..



For most accurate navigation, fold the cover and magnifier part way open, and hold up to your eye.



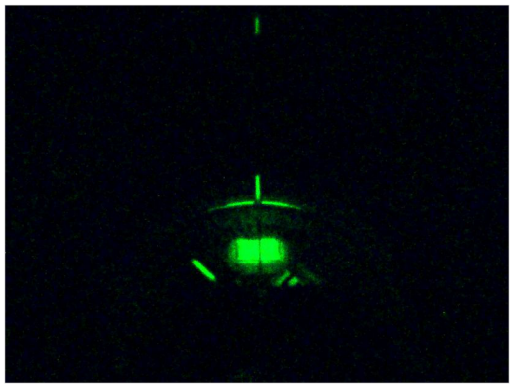
Lens lets you read the bearing on the numbered disk while you sight on a distant object.

Disk has angles marked in degrees and mills (rather, hundreds of mills). There are 6400 mills to 360 degrees, one mill is 1 meter at 1 km.

(one degree is 17.8 mills, so one degree error is about 18 meters in 1 km. 5 degrees error is about 90 meters in 1 km).

The bezel with it's line can rotated, so you need to be carefull that it is lined up with the sights before reading the bearing.

Here North is off of to the left, and we are looking on a bearing of about 48 degrees.



Tritium night sights on a lensatic compass.

Let you sight at night.

Outer bezel ring clicks, one click for 3 degrees. This lets you read bearings by feel when you don't have enough light to read the numbers. Sight on target, line on bezel straight on bearing, then turn and count clicks until the line is lined up with the illuminated north arrow – multiply clicks by 3 = degrees.

Both a compass and a protractor for reading bearings on a map.

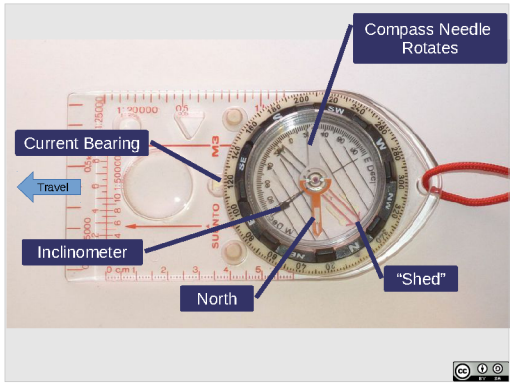
May have adjustable declination.

Good for general land navigation.

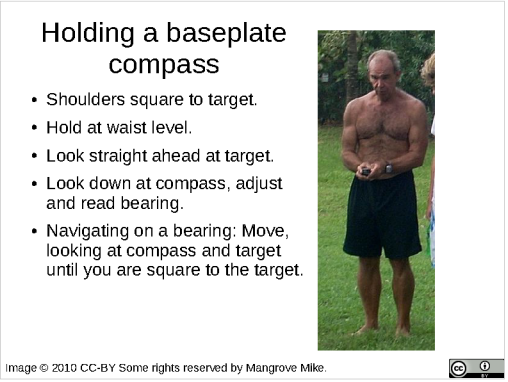
Doesn't have sights, so difficult to use accurately enough for gridding in SAR.

Needle swings free.

Numbers are on a separate dial you can rotate.



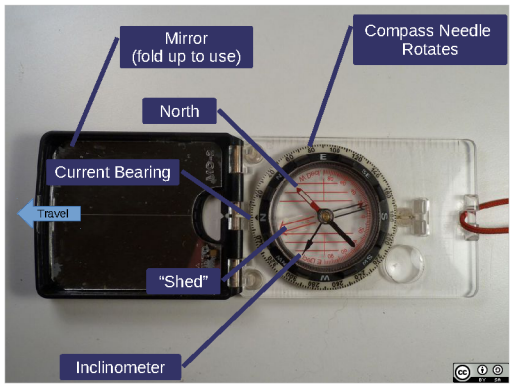
Parts of a baseplate compass.



Navigating accurately with a baseplate compass requires standing square to the direction you want to travel, holding the compass at waist level, and looking back and forth between your target and the compass.

This is a dive instructor in the USVI demonstrating how to navigate with a dive compass – same posture is used for any compass that doesn't have sights that you have to look down at to see the compass needle.

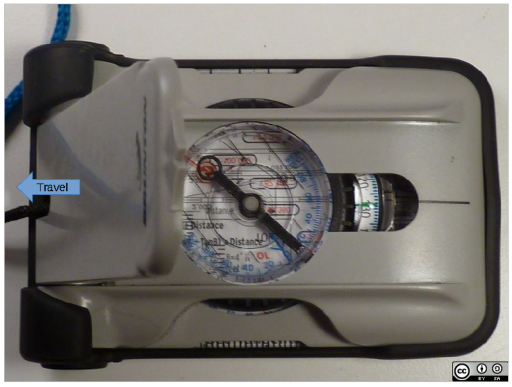
You can also use a lensatic compass or a baseplate compass with needle this way, just less accurately than using their sights.



Parts of a baseplate compass with mirror (laid flat for use as a protractor on a map).

Most designs – mirror goes in the direction of travel.

Fold part way closed and look in the mirror, you are looking in the direction of travel.



Another design of mirrored base plate compass with the mirror folded up for navigation.

"Shed" is a black circle to contain a red N on the compass needle in this design.

Compasses get fancier and more expensive.

Geologist's picket transit getting to be overkill for SAR. Accurate, easy to use, durable, heavy, expensive.

To hold a baseplate compass with a mirror:

Fold the mirror part way closed.

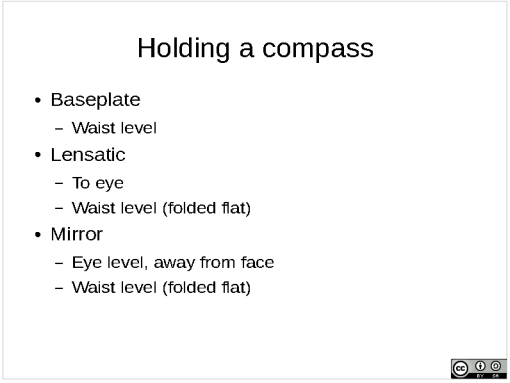
Hold the baseplate between thumbs and forefingers, at eye level.

Sight on your target, look in the mirror to see the compass needle (and the shed).

Turn right and left to make sure that the compass needle swings freely.

Align the line down the mirror with the pivot point of the compass needle.

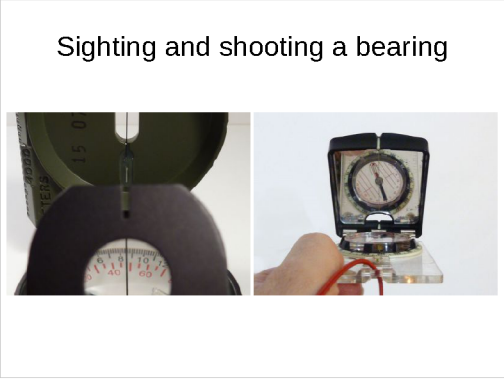
Rotate the dial to put the north arrow in the shed, and read your bearing.



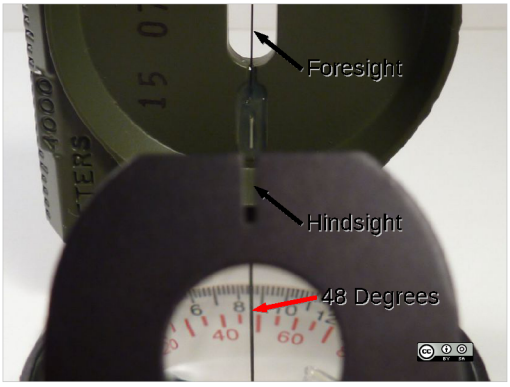
Reviewing: Any of the compasses can be used held at waist level looking straight down. Reasonable for travel, but not accurate navigation for SAR.

Lensatic compass, hold up to your eye.

Mirrored base plate compass, hold flat at eye level away from your face.



How to shoot a bearing (or travel on a bearing)

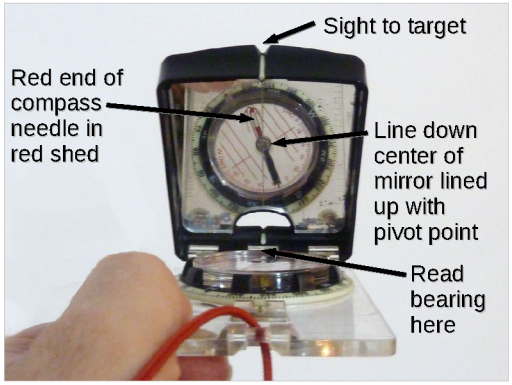


With a lensatic compass, line up the foresight, the hindsight and the thing you want to navigate towards.

Then look through the magnifier and read off the bearing.

Given a bearing, turn your head and the compass and look through the magnifier until the compass is pointing on your bearing.

Then look up and see what the hindsight and foresight are pointing at.



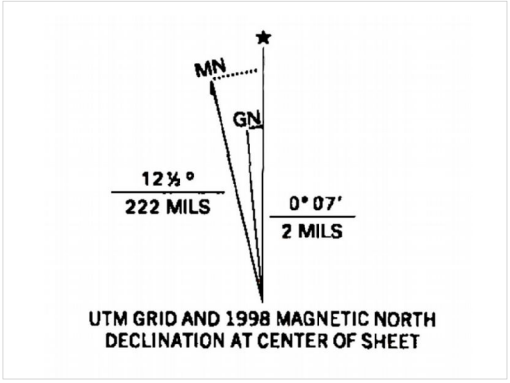
With a mirrored base plate compass, hold level (move side to side to make sure the needle swings free), line up the line down the middle of the mirror with the pivot point of the compass needle.

Sight on the thing you want to navigate towards (sighting here on either the top or bottom sight).

Rotate the dial to put the red end of the compass needle in the red shed.

Make sure that everything is level.

Now look at the direction of travel end of the dial and read off the bearing.

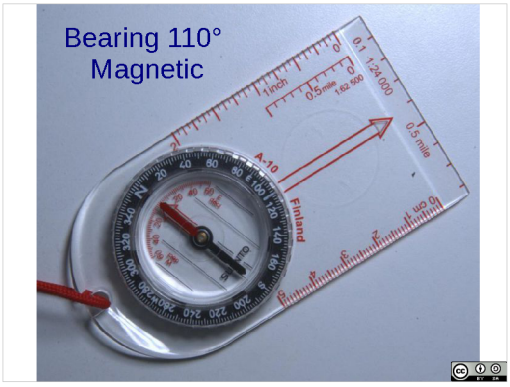


How do you account for declination?

Declination & Adjustable Compasses

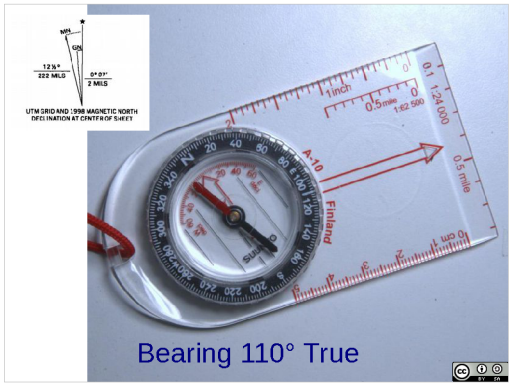
- Ignore it (OK if near agonic line)
- Do math (Correct for declination)
  - Everyone in the field works with magnetic north
  - People at base do the math, communicate magnetic.
- **Set declination on compass**
  - **Everyone works with true north**
- Mark magnetic north lines on map
  - Everyone works with magnetic north

With an adjustable compass, these are our choices:



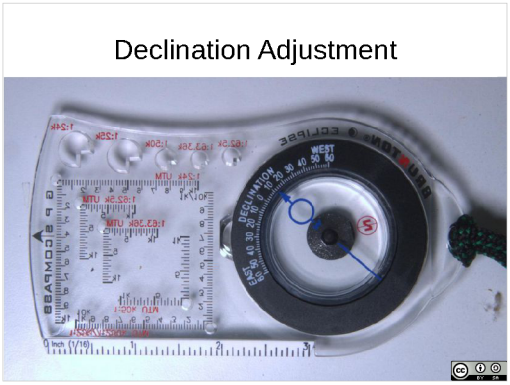
Some base plate compasses aren't actually adjustable for declination, but have a declination scale on either side of the red orienting box (shed). Here the north end of the compass needle is in the red shed.

The bearing (at the direction of travel end of the dial) is 110 degrees, thus 110 magnetic.



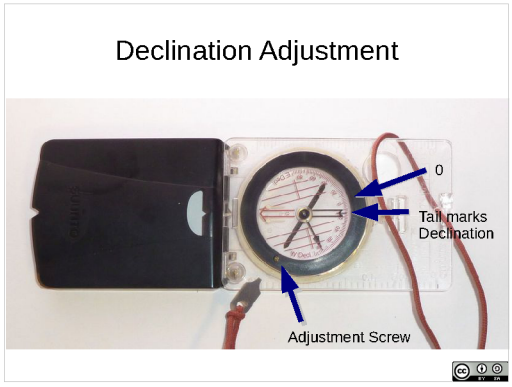
Here we don't have the red compass needle lined up with the shed, we have it line up at the 15 degree west of north angle next to the shed.

Bearing at the travel end of the dial is 110 degrees, but we've accounted for the declination, so this is 110 true.



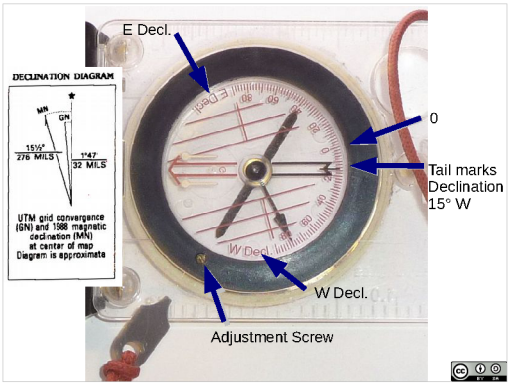
Declination may be adjustable, rotating a pointer on the orienting box against a declination scale. Here, the declination scale is printed on the bottom of the bezel, and the N arrow on the orienting box/circle points to the declination.

Adjustment is a friction fit in some compasses (press the capsule with the compass needle in it between thumb and forefinger and twist the bezel)



Mechanical adjustment screw in other compasses.

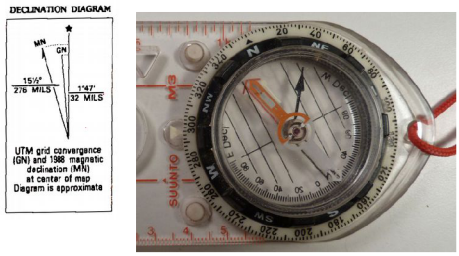
Here the tail of the orienting box (the black end of the shed) points to a declination scale marked in degrees E and W declination.



Closer view, screwdriver on the lanyard is used to adjust the declination.

Compass here set to a 15 degree west declination.

Sanity check



Is magnetic north west of true north?

With a 15 degree declination dialed into this compass, does it say that the same thing as the declination diagram?

Does the declination diagram say that magnetic north is west of true north?

Does the compass agree?

What bearing is this compass set for?

What if you can't set the declination? (as when using a lensatic compass)

Two choices – do math, or put a magnetic north grid on the map.

Declination & **Lensatic** Compasses

- Ignore it (OK if near agonic line)
- Do math (Correct for declination)
  - Everyone in the field works with magnetic north
  - People at base do the math
- ~~Set declination on compass~~
  - ~~Everyone works with true north~~
- Mark magnetic north lines on map
  - Everyone works with magnetic north

Here are the choices – everything but setting the declination on the compass.

Do Math

- **Map to compass – West, Add**
  - Bearing measured on map: 45 degrees (true)
  - Declination 15 degrees west
  - Map to compass: 45 + 15 = 60 degrees (magnetic)

- **Map to compass – West, Add**
- Compass to map – West, Subtract
- Map to compass – East, Subtract
- Compass to map – East, Add

To convert between magnetic and true:

Remember: Map to compass: West, add.

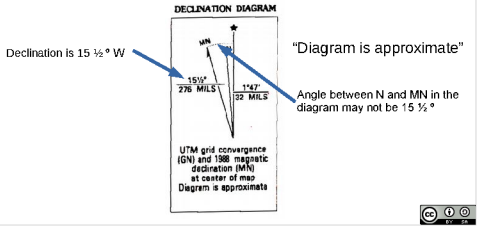
Magnetic-True Conversion Handout.

Who does the math?

- Everyone who is moving bearings to/from a map.
  - Do math to convert between magnetic and true bearings and plots on map.
- Everyone in field works with magnetic bearings
- Radio transmissions are magnetic bearings.

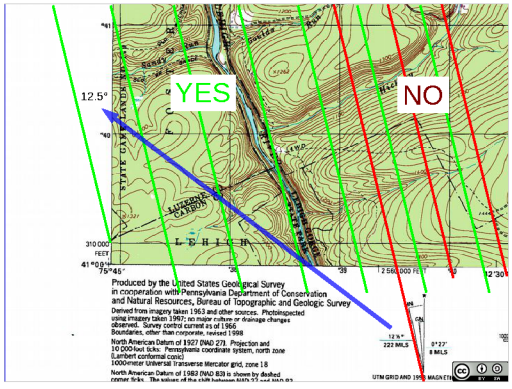
Most effective way to work when compasses can't be adjusted for declination is to put all communications in magnetic north, conversion only happens when someone needs to work with a map.

Adding A Magnetic North Grid to a Map (Preparing a map for use with magnetic bearings)



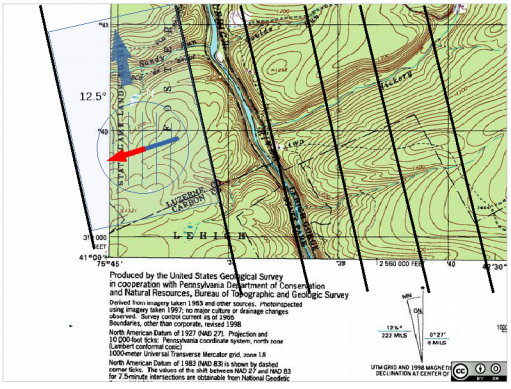
You can also mark up a map with magnetic north-south lines, and read magnetic north directly off the map.

Look at the declination diagram on the edge of the map, find out the declination angle.



Now using a protractor from the edge of the map, measure that angle, and draw lines on the map running magnetic North-South.

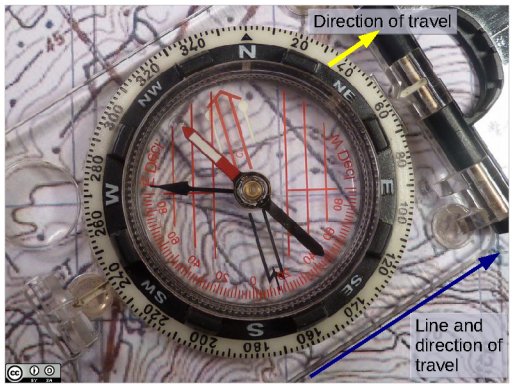
Don't start by extending the magnetic north line on the declination diagram, it may not be accurate. Always measure the number of degrees of declination.



You can use your compass as a protractor to start the lines – set the dial to the number of degrees of declination, line up the lines on the base of the dial with the edge of the map, sanity check that the edge of the compass is lined up with the magnetic north line on the declination diagram, and draw a line down the edge of the compass.

Now you can use a ruler to draw multiple parallel magnetic North-South lines on the map.

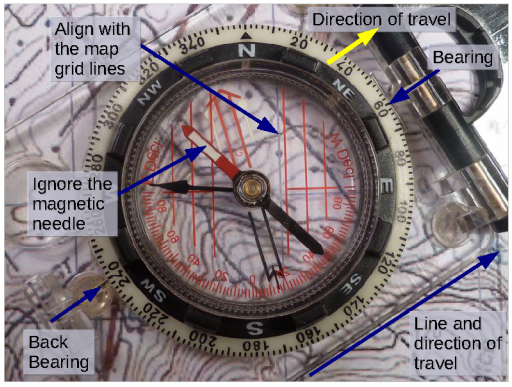
You can use your baseplate compass as a protractor to measure bearings from one point to another on a map.



Draw a line on the map connecting two points you want to travel between.

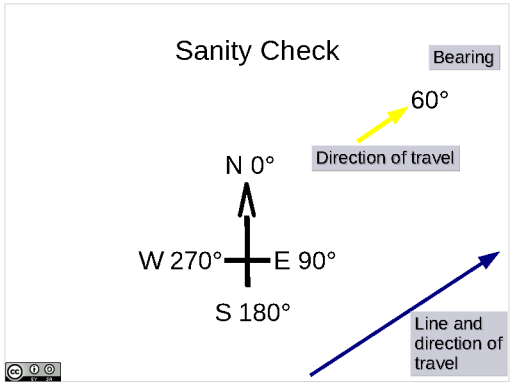
Lay the compass on the map, edge of the compass along your line, the mirror (or direction of travel arrow) of the compass pointed in the direction you want to travel.

Ignore the magnetic needle on the compass – you are going to use the compass as a protractor.



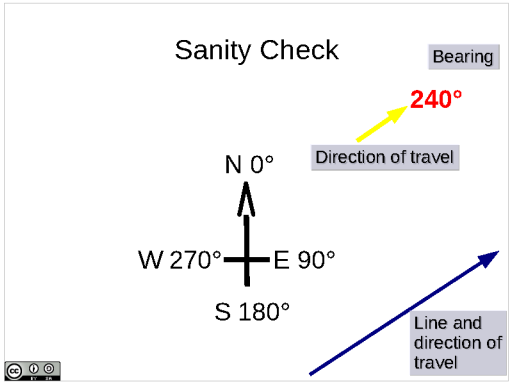
Rotate the compass bezel until the lines in the back of the dial line up with the north-south grid lines on the map.

Read your bearing off the compass – at the compass/direction of travel end.



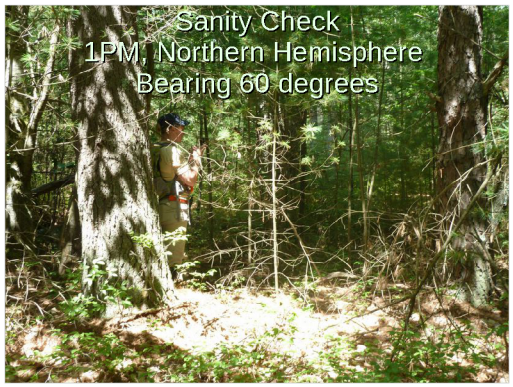
Now sanity check your results.

North is 0 degrees – E is 90 degrees. Your direction of travel on the map is to the NE. 60 degrees is between 0 and 90 degrees, so your bearing seems sane.



What happened here?

If you read the back bearing by mistake, your sanity check will flag that 240 degrees is not between 0 and 90.

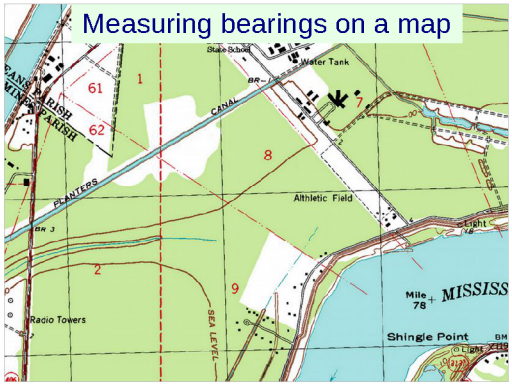


It is 13:00 in the northern hemisphere. The searcher is traveling on a bearing of 60 degrees true.

Sanity check: is she traveling in the right direction?

What can we see that tells us this?

(the sun is approximately south, she's standing at an angle of somewhere around 60 degrees off the shadow the tree is casting on her).



Practical Evolution (5) Determine Bearings on map.

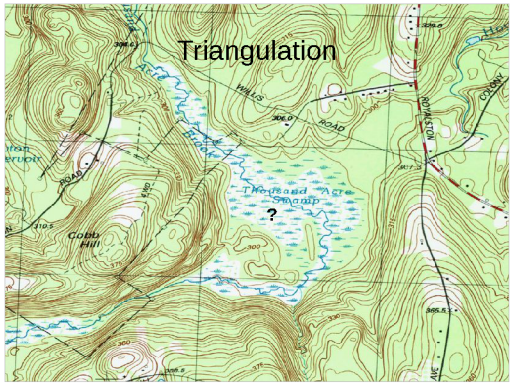
On USNG Training map:

Set declination (1 degree east).

Measure bearing(relative to true north): light on Shingle Point to the water tank near Planters canal.

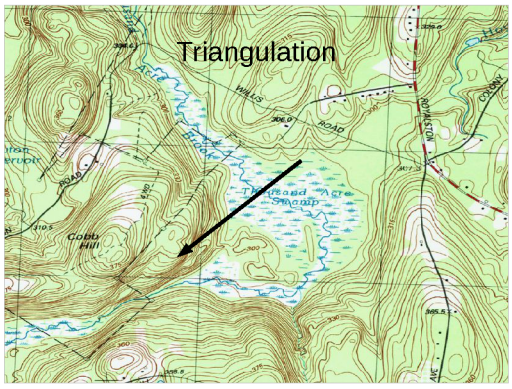
Measue the back bearing (from the water tank to the light).

Repeat with the bearing from BR 3 where the road crosses Planters Canal to light 18 on the north bank of the Mississippi river.



I'm in the one thousand acre swamp.

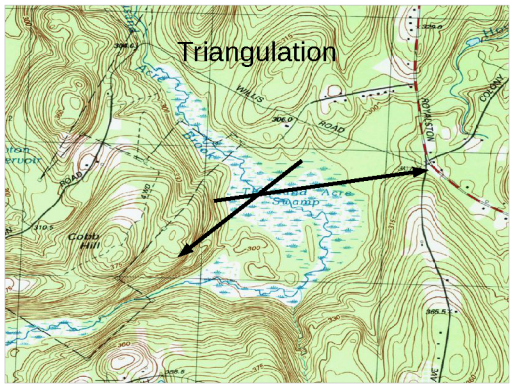
Where in the swamp am I?



Pick a landmark, shoot a bearing to the landmark.

Here, 245 degrees to what you think is the top of the steep drop off on the SE corner of Cobb Hill.

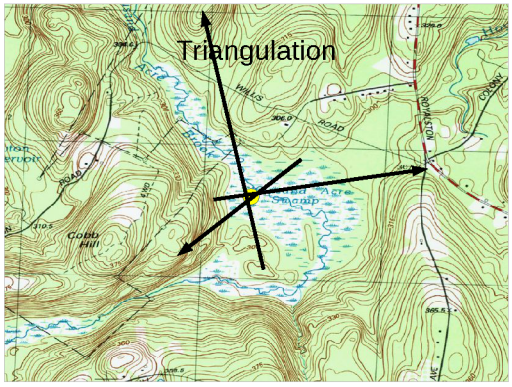
Draw a line on the map passing through where you think you are and the landmark. You are somewhere on the line.



Repeat with a second landmark.

Here 80 degrees to the northernmost edge of the hill to the south east of the swamp.

Draw another line. You are approximately where the two lines cross.



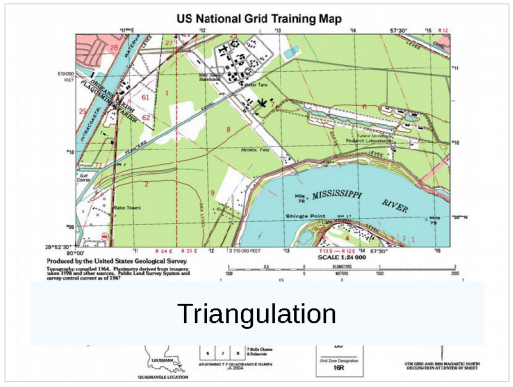
Add a third line.

Here 350 degrees to the steep sided hill North of the swamp.

You are where the three lines cross.

You can describe a location with three bearings two three landmarks.

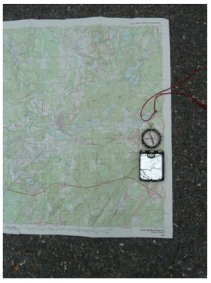
Most accurate if the three landmarks are very specific (e.g. a Church steeple), and if the three landmarks are widely separated (about 120 degrees apart).



Exercise (6) Triangulation

Orient map to north

- By Landmarks
- With Compass



With landmarks, like triangulation – locate your position on the map, then rotate the map so that about 3 landmarks that you can see are off in the same directions on the map as they are around you.

By compass: Put the map on a flat surface, align compass with side of map, dial N onto the direction of travel, adjust for the correct declination, rotate the compass until the magnetic needle is in the shed.

Don't do this on a car hood or some other metal surface (including concrete with rebar).

Go outside and do practical evolutions 1-4
(1) Orient Map to North with a compass.
(2) Orient Map to North by landmarks.
(3) Shoot Bearing.
(4) Triangulate location.

Hazards and Risk Mitigation

Unit 11: Hazards and Risk Mitigation

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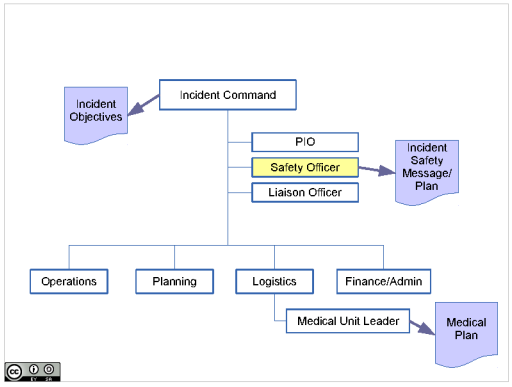


A general goal for any incident is that everyone goes home safe.

Express as smart objective (manage by objectives): Ensure the safety of all responders and the general public throughout the entire duration of the incident.

ICS embeds several functions and documents to support safety.

Safety officer is responsible for standing back, observing and assessing the safety of the operation, and for formulating a safety message and plan for hazard mitigation.

Logistics embeds a medical unit, to serve the medical needs of the responders to the incident, the medical unit formulates a medical plan of resources and facilities available for the care of responders – entirely separate from medical response to the incident embedded in operations.

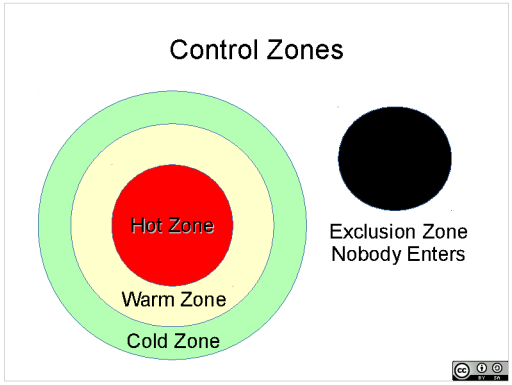
Branch Director Todd Abel and and Safety Officer Pete Stewart. Photo by Kari Greer. Credit US Forest Service Gila National Forest

Everyone needs to be concerned with safety.

Safety officer is specifically called out as a separate command function to counteract tunnel vision on the response to the incident.

Incident response is not without risk.

Safety message/plan is a statement about risk mitigation.

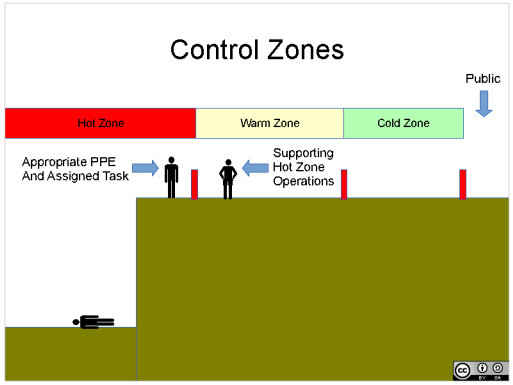


One tool for risk mitigation is Hot/Warm/Cold zones.

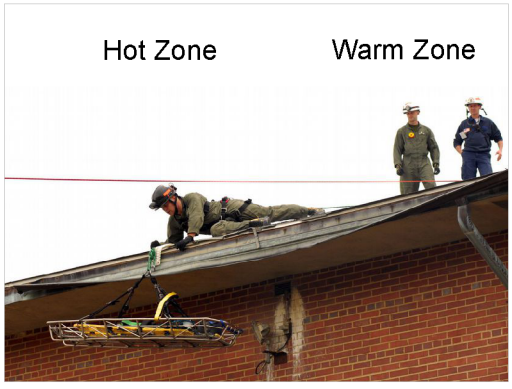
Cold Zone: ICP, Staging
Warm Zone: Support for entry into Hot Zone
Hot Zone: Only with PPE for specific assignment.

General public kept out of the cold zone.

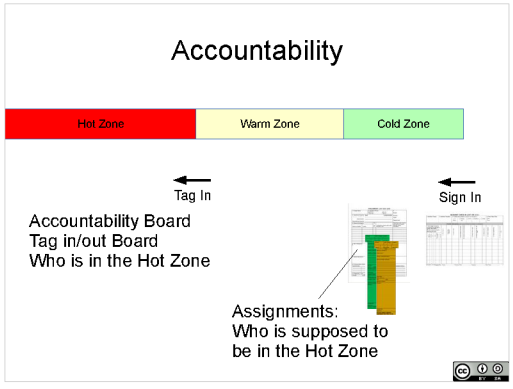
Special control zone – exclusion zone, nobody is to enter.



This course doesn't prepare you to operate in the hot zone, or to support operations from the warm zone.



Treat 10 feet from an edge as a hot zone.



Accountability mechanisms for the cold and warm zones include sign in and t-cards. T-cards can record who has an assignment in the hot zone.

Hot zone should have a separate accountability mechanism such as an accountability board recording who enters the hot zone when, and when they come out – a mechanism for identifying who is in the hot zone.

Some hazards are everyday hazards.

What is this?

Everyday Hazards & Mitigation

- Ticks: Recognition, insect repellent, light colored clothing, gaiters, tick checks.
- Poison ivy: Recognition, long pants, long sleeves, avoid sweaty thin clothing, barrier creams, poison ivy scrubs.
- Low branches: Wear safety glasses at night.
- Dehydration: Drink lots of water, carry lots of water.
- Sun exposure: Sunscreen, sunglasses, clothing.
- Uneven footing: Boots with ankle support.

Commonplace hazards, but can be very dangerous.

Some everyday hazards in New England listed, along with some potential means of mitigating these hazards.

What's this?

Poison ivy.

Contains urushiol, which causes contact dermatitis in sensitive individuals (most people).

And this?

Poison ivy vine – with distinctive fuzzy rootlets.

Prevention measures: Dry, loosely woven fabrics, pre-exposure barrier creams, post-exposure (within 2 hours) solvent (Tecnu, Goop, Dishsoap), immediate washing with soap and water. Launder exposed clothing (urushiol contaminates and remains on clothing).

“Most ... rashes tend to occur through sweaty thin clothing”
“Proper identification and avoidance of *Toxicodendron* species is the best prevention”
[Quotes from: Gladman, 2006, *Toxicodendron* dermatitis. Wilderness and Emergency Medicine. 17:120-128.]

What's this?

Poison sumac

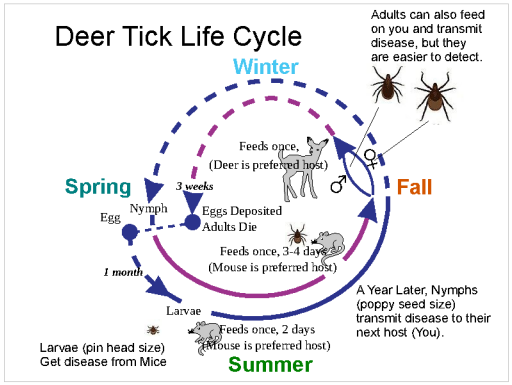
Wetlands – shady swamps and bogs.

Compound leaves, leaflets connected by a red "stem" (rachis).

Poison Ivy and Poison Sumac common in New England.

Deer Tick *Ixodes scapularis*, Adult Female

Carry and transmit disease organisms for: Multiple unpleasant tick borne illnesses: Lyme disease, Anaplasma, Erlichthyosis, etc.



Deer ticks have 2 year life cycle. But, Ticks can be about at **any time of year**. Disease transmission peaks in Spring/Summer, but happens year round.

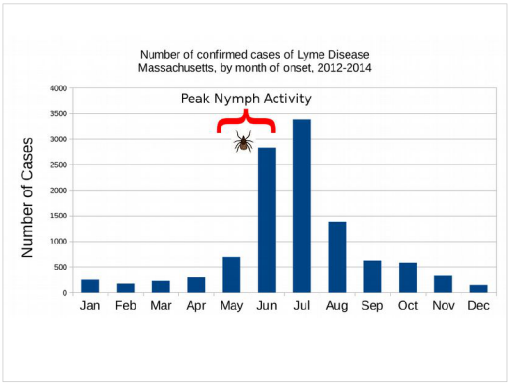
Larvae (pin head size) feed off small mammals, get infected with Lyme from the small mammals.

Next stage, Nymphs, feed off of mice, birds, deer, dogs, foxes, humans, etc. Nymphs very high risk for transmission of lyme – small and hard to notice.

Nymph: Think small black spot about the size of a poppy seed.

How do you mitigate this risk?

Tick Checks. Light colored clothing, permethrin treated clothing, insect repellent.



Here is surveillance data (for confirmed cases of Lyme disease, an underestimate of total cases) from Massachusetts.

You can catch Lyme disease any time of year.

Ticks carrying Lyme disease (and other tick borne illnesses) can be active anytime of year.

Protect yourself year round.

Peak incidence in MA is June-July, following after the usual peak times for Nymph (poppy seed size, already fed on mice, carrying disease, hard to see) activity around May-June.

Human Hazards

- Armed subject (hunter, despondent)
  - Volunteer SAR resources generally will not respond for searches for fugitives.
- Clandestine Drug Operation
- Wells
- Mineshafts, Quarries
- Abandoned Buildings

People and things made by people can pose risks to searchers.

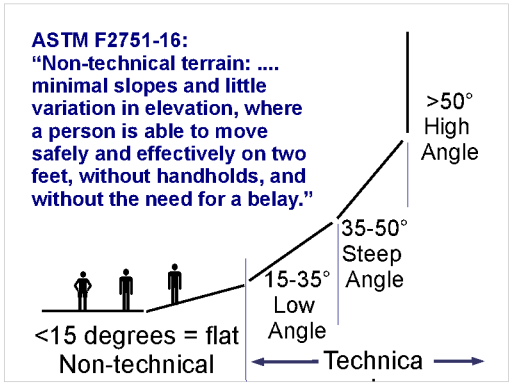
Subjects may be armed (and might have an altered mental status).

Learn to recognize hazards and stay back/out.

What do we have here? Clandestine drug lab.

What hazards?

Are we too close?



Definitions for high/low angle conditions vary:

NFPA: High Angle = Weight supported by rope system.
Low Angle = Weight supported by ground.
ASTM F2751-16: High Angle >50°, Low Angle 30°-50°
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.
ASTM F2751-16 3.1.4 definition of non-technical terrain quoted.

Anything more that 15 degrees calls for support from technical rescue resources.

What hazards exist in searching this terrain?

Gravity.

Gravity moving large rocks.

Slip and break an ankle/leg/head.

Can you move safely on two feet without handholds or a belay?

Technical Rescue Environments

- Technical Rescue resources may be needed in any phase of the search:
  - Locate
  - Access
  - Stabilize
  - Transport

We usually think of needing technical rescue for access, stabilization, and transport phases.

May need it for the locate phase as well.

Learn to recognize environments that should be searched by appropriate technical rescue resources.

Technical Rescue Environments

- Vertical Environment
- Confined Space
- Trench
- Structural Collapse
- Water (Still Water and Swift Water)
- Ice

All need specialized training and equipment.

You may get or seek out high angle rescue training.

Confined Space

- Large enough and configured so that a person can enter and perform assigned work
- Limited or restricted means for entry and exit
- Not designed for continuous occupation.

Confined spaces are dangerous, and regulated.

Generally limited to fire service technical rescue resources. Significant training and equipment needed to enter.

Permit Confined Space

- Large enough and configured so that a person can enter and perform assigned work
- Limited or restricted means for entry and exit
- Not designed for continuous occupation.
- One of:
  - Contains or may contain a hazardous atmosphere
  - Contains material that may engulf a person
  - Internal configuration that could trap or asphyxiate a person
  - Contains any recognized serious safety hazard

Confined spaces may be outright deadly.

OSHA regulated confined spaces that require a permit for an employee to enter.

Example confined spaces likely to be encountered in inland SAR

- Silos
- Sewers/Manholes
- Septic Tanks
- Underground utility vaults
- Ducts
- Pits and Ditches
- Machinery Housings

CC-BY Don O'Brien

You are likely to encounter hazardous confined spaces during searches including:

Agricultural confined spaces (silos, fruit storage), drains, septic tanks, areas frequented by urban explorers (abandoned buildings with ducts, abandoned utility vaults, pits, machinery housings, etc).

Discuss where, what sorts, what sorts of hazards.

“Silo for High-Moisture Shelled Corn”

60% of all confined space fatalities are of would be rescuers.

Stay out.

Hazardous atmospheres may include

- Low oxygen levels
- Enriched oxygen levels
- Flammable gases or vapors
- Toxic gasses (Carbon Monoxide, Hydrogen Sulfide, etc...)

One reason for the risk to would be rescuers:

Confined spaces may look fine, but contain toxic atmospheres.

Does this need to be searched?

Probably.

But not by you.

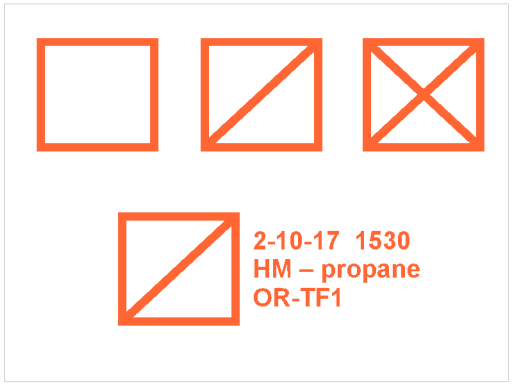
Record it.

Report it.

Check Structures....

What hazards might be present here?

Note old wells, rotten floors over basements, animals, humans, etc.…



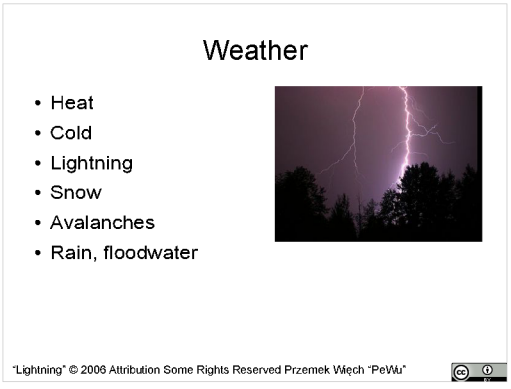
FEMA USAR Structure/Hazards Evaluation marking system.

Square: Low Risk for USAR operations.

Square with one diagonal: Medium Risk for USAR operations. May require hazard mitigation for search.

Square with X: High Risk for USAR operations, subject to sudden collapse. Significant mitigation required for rescue operations.

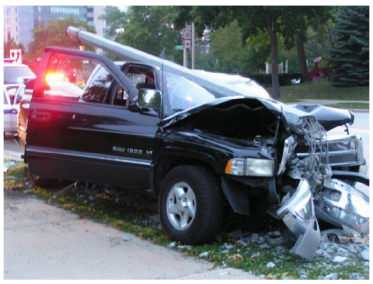
HM: Hazardous Material condition in or near structure.



Weather poses hazards (both in training and in searches)

If you can hear thunder, you should be in shelter.

Fatigue Kills



Don't drive fatigued.

Pull over and rest. Stay home. Rest before returning from a search.

Goes for training as well – if you are too tired to drive out to a training, don't.

Fatigue Kills

- Nobody drives home tired.

Fatigued driving has killed searchers.

Critical Incident Stress

- Single highly traumatic incident.
- Accumulated exposure to less traumatic incidents over time.

Another risk in all emergency response is critical incident stress.

Critical incident stress can come from exposure to a single traumatic incident, or as accumulated exposure to smaller incidents over time.

Sources of Critical Incident Stress

- Death of the subject
- Death of another emergency responder
- Gruesome scenes and imagery
- Prolonged incidents with fatigue, media attention, or where the subject was not found
- Search conditions: Extremes of temperature, spatial disorientation, sense of isolation
- Stress of Command

Some sources of critical incident stress in SAR.

Prolonged incidents with fatigue.

Reducing CIS and Preventing CIS from producing PTSD

- Previsualize
- Limit exposure
- Search in teams of 4 or more people
- Keep everyone oriented to the map
- Critical Incident Stress Debriefing
- Take care of each other

Critical incident stress can progress to post traumatic stress disorder. Important to prevent this.

Previsualize: Include mulage in training. On a callout visualize finding the subject deceased.

Control factors you can control. Limit your exposure to gruesome scenes. Don't go look unless you have to. Limit isolation – work in groups – field deployed resources in teams of at least 4 people. Reduce spatial disorientation, navigator keeps everyone oriented to the map, check your compass even if you aren't navigating.

After exposure to a stressfull incident, seek critical incident stress debriefing.

Watch out for each other day to day, look for any team member who is showing signs of stress or withdrawing.

Hazards for SAR Canines

We work with dogs, there are particular hazards for them as well.

How do we mitigate this risk?

Strong recall, strong leave it, train critters as distractions.

Work to expunge self rewarding crittering behaviors.

Hazards for SAR Canines

- Poisons
- Other Animals (Porcupines, Snakes, etc.)
- Paw/Limb injuries
- Heat
- Automobiles
- Tick Borne Illnesses

Some hazards.

Discuss.

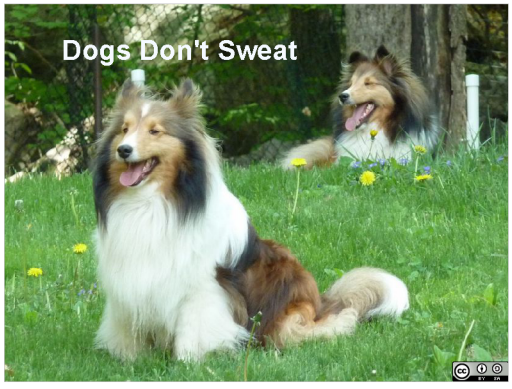
Discuss mitigation.

Mitigation (Poisons, Automobiles, Animals)

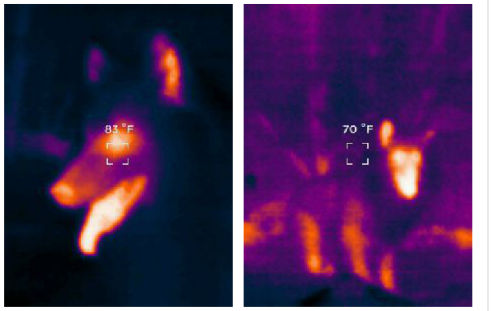
- Train a strong “Leave it”.
- Train a strong recall.
- Train a strong “Safe”.

- Canine Medical Plan – 24 hour emergency Vets
- Canine First Aid training for all team members.

Summarize discussion of mitigation measures.



Primary cooling mechanism is panting. Heat loss through evaporation, like us, but not through entire skin surface.



Here's some thermal images of a dog in the summertime – mouth is hot, primary heat loss through panting.

Dogs can overheat very easily.

How can we mitigate this risk?

Mitigation (Heat)

- In training, keep someone at the cars with dogs that aren't in the field all the time.
- Cooling Mats, Shade Cloths.
- Provide lots of opportunities for water
- Perforated Reflective Vest

Water, Shade, Ventilation. Monitor.

Carry lots of water. Provide your dog with water in their crate and lots of opportunities to drink when searching.

Crime Scene Awareness

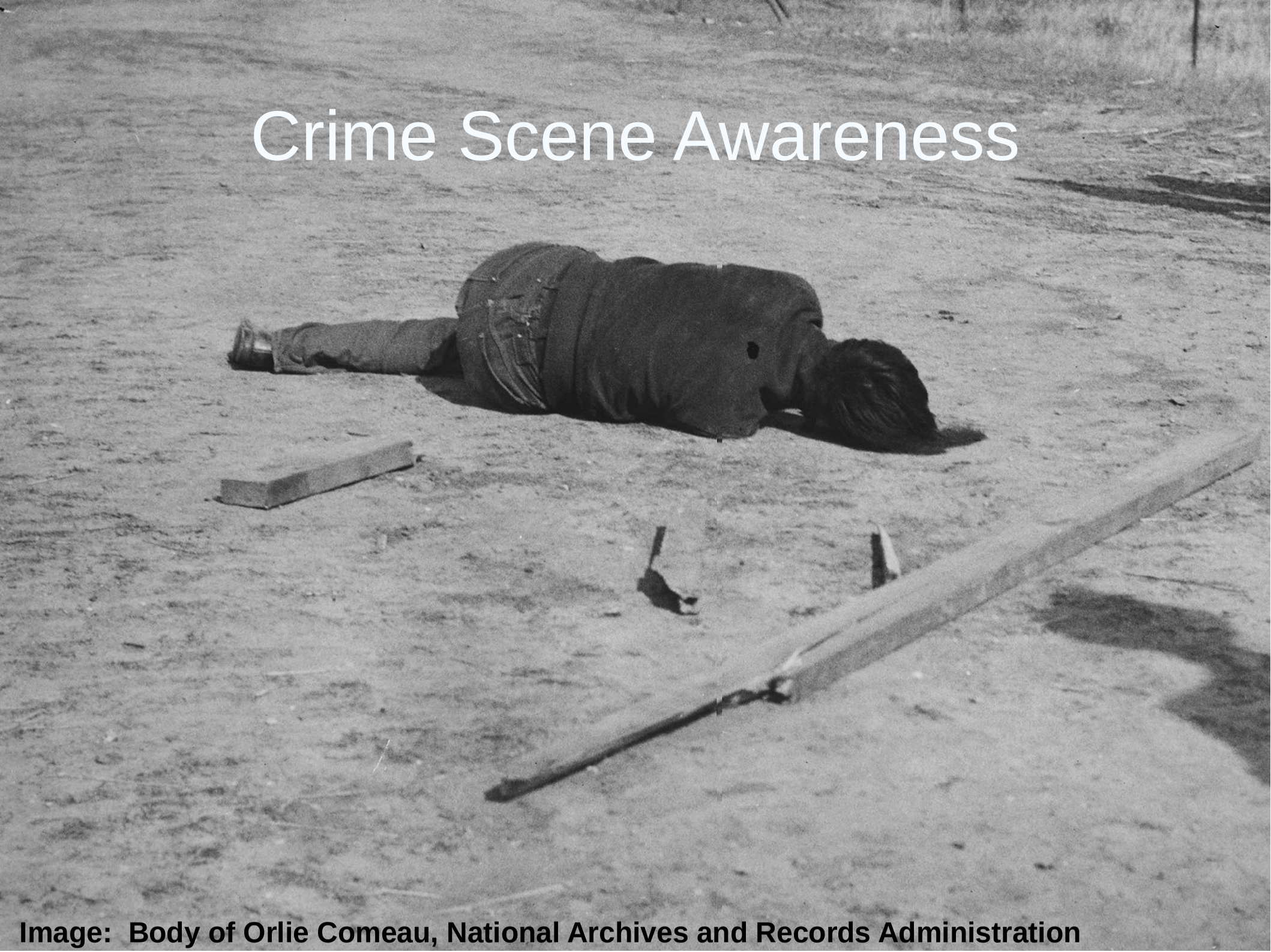
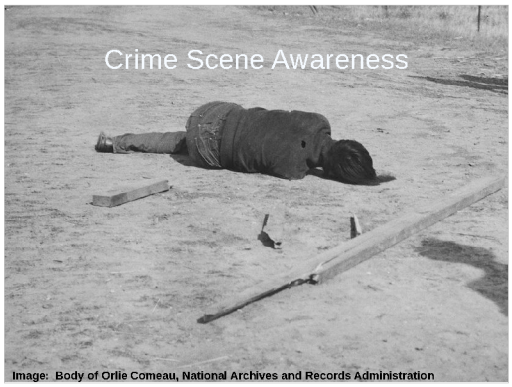


Image: Body of Orlie Comeau, National Archives and Records Administration



Unit 12: Crime Scene Awareness

What is your first concern?

Safety

- Some Hazards
  - Armed subject
  - Subject with altered mental status
  - Perpetrator
  - Chemical Suicide
  - Clandestine Drug Labs
  - .....

What is your first concern?

What are some hazards around clandestine drug labs?

Safety.

Your own safety.

Other responders safety.

Key goals on encountering a crime scene:

Minimize disturbance.

Document what you saw and did.

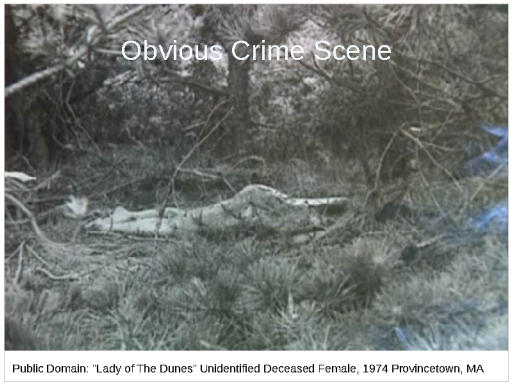
Maintain a chain of custody – sign scene over to law enforcement.

- Obvious crime scene
  - Clearly deceased subject
  - Subject possibly in need of medical care
- Potential Clue
  - Influencer of LKP

Several sorts of situation to consider:

Obvious crime scene.

Potential clue.



Obvious crime scene, deceased subject.

What are your concerns?

What are the threats, where are they?

Obviously deceased. Possibly deceased we'll come to later.

It is going to end up in court

You know this is going to end up in court.

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

In a crime scene, legal considerations come to the forefront – whomever is in charge of the task that finds the crime scene will need to manage the situation – how do we do that? With objectives.

Principles

- Contamination (limit and document)
- Containment
- Restraint
- Call

4 principles to apply to support the goals of minimal disturbance, documentation, and chain of custody, principles that let you frame concrete objectives for the situation.

Contamination, Containment, Restraint, Call.

Limit and document contamination of the crime scene.

Contain the scene – prevent others from contaminating it.

Exercise restraint.

Call in law enforcement to take custody of the scene.

Image: Backpack in Barstow CA, containing the severed head of an unidentified female.

Defense needs to raise reasonable doubt

- Uncertainty
- Untrained investigators
- Too many different observations/observers

Charles R. Gary in 1971 trial of Bobby Seale

Exercise restraint – if there is a perpetrator, the defense only needs to raise reasonable doubt. Anything the defense can point to that raises uncertainty can raise doubts.

Undocumented contamination can create uncertainty.

Many observations from many observers will conflict, this can create uncertainty.

Actions To Take

- Limit and record contamination
  - Minimize disturbance of the scene
    - "Hold the Line"
  - Everyone flags their location and backs out
- Begin a log
- Establish an exclusion zone
- Quiet Notification – preferably via phone

Some actions help:

Minimize disturbance. "Hold the line" - everyone stops.

Record the contamination of the scene. If someone needs to check to see if a possibly deceased subject is in need of medical care one person goes in, checks, and comes back out on the path they went in on.

Everyone flags their location and backs out on the route that they came in on.

Begin a log.

Containment: Establish an exclusion zone.

Call: Quiet notification.

Quiet Notification

- Preferably via phone
  - Radio can be and is legally monitored
  - Radio may be overheard at ICP
  - Cell phones can be illegally monitored
- Call to appropriate jurisdictional Law Enforcement authority
- Pre-planned code may be appropriate to communicate with IC.
- Minimum information necessary
  - Location and time of find. Do not elaborate

Quiet notification – minimum information necessary, don't elaborate. Preferably use a communication channel that can't be legally monitored – cell phone.

Call to IC. IC can notify appropriate jurisdictional law enforcement authority.

A pre-planned code for use on the radio may be provided in briefing – an exception to the ICS use plain language rule.

Radio frequencies will be monitored in the search.

Radio communications may be overheard by family members, press, etc.

Things not to do (Restraint)

- No picture taking
- No discussion of the crime scene with each other
- Absolutely no deploying canines as a "training opportunity"
- No social media activity

Exercise restraint. Not doing so will open up opportunities for the defense to exploit in raising reasonable doubt.

Take no pictures.

No discussion of the crime scene. Members of the task that make the find must not talk among themselves while containing the scene, or later, or with others (critical incident stress debriefing being a contained exception).

No doing anything stupid.

You aren't there to investigate. Don't.

Your job is: Contamination, Containment, Restraint, Call.

Handover

- Only relinquish the scene to a properly identified LE officer (uniform, badge)
- Log the time, log your handover of the scene.
- You retain a log with one entry – time you handed crime scene and everything else over to LE.
- LE gets all materials, with a log with a last entry of your handover of the scene and documentation.
- Relinquish all materials to the LE officer.
- Remove yourself and all other SAR personnel to an identified location for debriefing by investigative LE.
- Discuss nothing about the matter to anyone, including each other.
- Investigative authorities need just the facts, as immediately observed, without your inferences

Maintain chain of custody in the handover.

Restraint: Discuss nothing with anyone, including each other.

Restraint: Just the facts that you observed. No investigation, no inferences.

Suppose you've got a subject who might be deceased? What then?

Possibly Deceased Find

- Emergency medical care takes priority, preservation of evidence is an additional concern.
- If medical care is not necessary (per local medical protocol, e.g. decapitation, extreme dependent lividity, rigor mortis), preservation of evidence becomes primary concern.
- Critical incident stress mitigation
  - If you don't need to see it, don't go look.

Emergency medical care has priority.

Preservation of evidence remains an additional concern.

Someone goes in to check the subject. Enter and exit by the same route. Minimize disturbance.

Evidence

- Physical
- Incorporeal
  - Document it to make it physical.

You are searching the woods and you find a coat – what sort of evidence is that?

You are walking in the woods and you hear a whistle – what sort of evidence is that?

How can you make hearing the whistle into physical evidence?

What do you want to write down?

Interactions with people encountered on the search

- Ask if they saw the missing person
- Downplay the situation
  - e.g. comment about it being nice day
- Observe their behavior – go with your gut instinct, if something feels wrong...
- Get a name and a callback number
- Document the interaction

People can see things – they can provide clues.

They might be the perpetrator.

They might be the missing person.

They might have talked with the missing person.

Turn the incorporeal evidence that you encountered someone and spoke with them into physical evidence – write it down.

Document a means for the investigation unit to follow up, ask for a name and a contact number.

Call out “Hold the Line”

Everyone stops.

Team leader comes over to see what you've found.

Everyone else stays where they were – don't converge on the potential clue.

Actions to take on finding a potential clue in the absence of LE interest or present involvement

- Call it in, get instructions
- Record the location.
- Mark the location with flagging tape
- Take a photo with a disposable camera (which will be handed over to search management).

What are your priorities on finding a potential clue?

Pass the responsibility for deciding what to do up back to the command post.

Record the location, flag the location.

You may get additional instructions, they might include collecting the clue, taking a picture of it, or just leaving it in place.

Images of potential clues can be valuable. Take an image with your own camera or phone and that camera or phone becomes discoverable. LE may want it now, the DA may want it, the defense may want it.

Consider obtaining burner phones to use on searches and then surrender.

Don't flag with a little piece of flagging tape – there's plenty of random bits of flagging tape around the woods.

Make it obvious.

Flagging – not on the clue. Nearby and obvious. Three long streamers of flagging tape.

Principles

- Contamination (limit and document)
- Containment
- Restraint
- Call

Remember the principles:

Contamination, Containment, Restraint, Call.

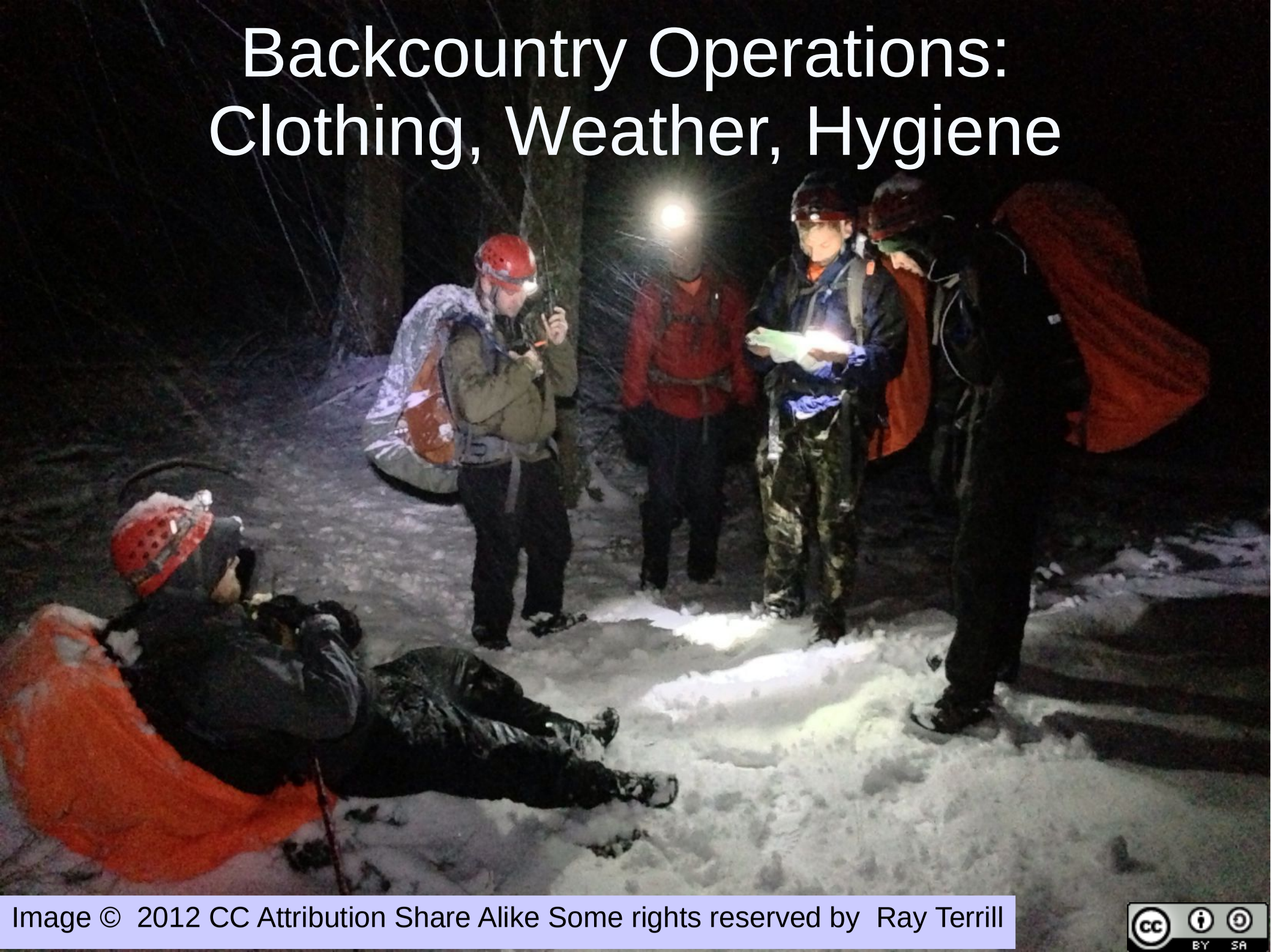
Limit and document contamination of the crime scene.

Contain the scene – prevent others from contaminating it.

Exercise restraint.

Call in law enforcement to take custody of the scene.

Backcountry Operations: Clothing, Weather, Hygiene



Unit 13, Backcountry operations: Clothing, Weather, Hygine.

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SAR can be physically demanding.
Physical fitness is important.

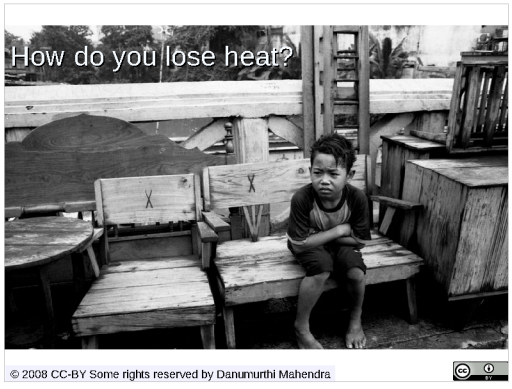
Lost person incidents can happen in all weathers.

You need to be dressed and equipt to both search and remain comfortable and focused on the search in all weathers.

In a response to a lost person incident you may find yourself in a situation where you need to stay overnight outdoors.

You need to understand your own capabilities and limitations (and those of your gear).

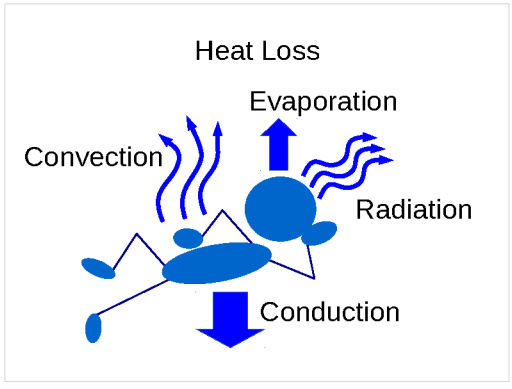
Be prepared, and understand how to stay comfortable outdoors.



Look comfortable?

Title of the image is: Cold, wet, miserable.

By what means do you lose body heat?



By conduction – heat being conducted to colder ground (surfaces) that you are touching.

By convection (and bulk transport) – warm air near your body being moved in bulk away.

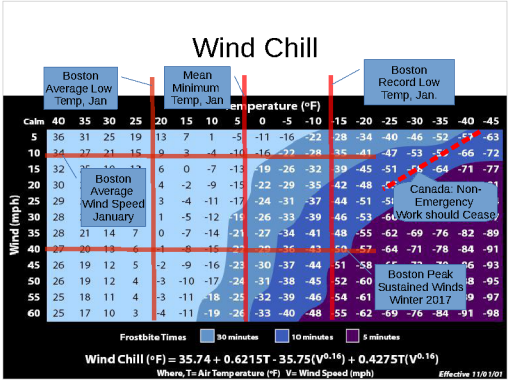
By evaporation – sweat or other moisture on your body evaporating, taking heat to change from liquid to vapor.

And by radiation – heat radiating from your body.

These can be good things or bad – if it is too hot out, heat loss is good. Why do we sweat? If it is too cool out, heat loss is a problem.

- Air is a good insulator
  - Unless it is moving
- Water is good at conducting heat
  - Evaporating water is very good at removing heat.
- The ground is good at conducting heat

- To stay warm:
  - Stay Dry
  - Trap air next to your body
- To stay cool:
  - Let moisture evaporate from your skin
  - Let air get moved away from your skin



Air is a good insulator – unless it is moving.

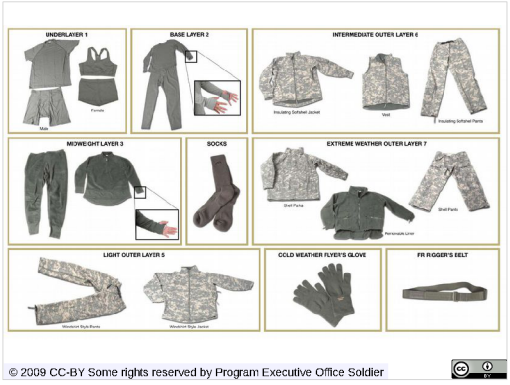
Convection – either air next to your body warming and rising because it is warm, or air next to your body warming and getting moved away by the wind removes heat from your body.

In cold weather – wind chill (chart from NWS). Your body warms the air next to your skin, the colder it is the more heat you loose to the air, the more the wind is blowing, the more the air you just warmed up with your skin is being carried away and replaced with cold air. The more the wind is blowing, the colder it feels – and the more heat you are losing.

If your skin loses heat too rapidly it can freeze – thus frostbite.
It isn't unusual to get winter temperatures and winds in new england that can freeze exposed skin (nose, ears, face, hands, etc, in less than 30 minutes.

Adjust to Change

- The Environment Changes
- Your Activity Levels Change



Thus, wear layers.

As your activity level and the weather changes, you can add or remove layers.

You can open or close layers.

Shell.

Layered clothing – with ventilation.

Here's a shell with breathable fabric – lets humid air out, doesn't let water in (when clean).

Also has zippers in the armpits – ways of increasing and decreasing ventilation (open zippers, loosen cuffs, pull up sleeves, - tune ventilation to your activity).

Fabrics

- Polyester
- Acrylic
- Nylon
- Silk
- Wool
- Cotton

Layers of what?

"Cotton Kills"

Cotton traps water, water is a good conductor of heat.

Cotton is also a poor insulator when wet.

Wool can hold water, but is still a good insulator when wet.

Polyester, Acrylic, Polypropylene: Don't hold water well, are good insulators in the wet (fabrics with hollow fibers very good at insulation when wet)

Rayon (and other cellulose based fibers) behave like cotton.

Down: Lovely at trapping air, collapses when wet.

Good footwear for SAR?

Not.

Graphics Source: Open clip art.

Suitable footware: Ankle support, waterproof, good traction. Flexible (these might be too heavy).

Gaiters to mitigate hazard from ticks (these can also be treated with permethrin).

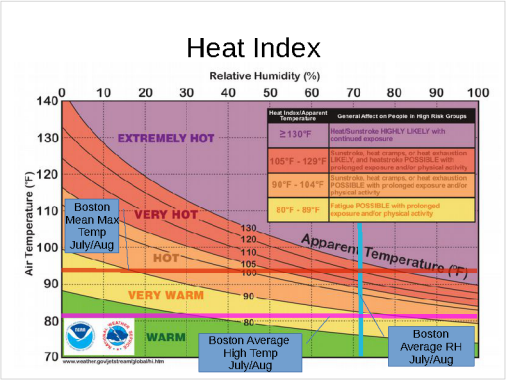
Do you think this person could focus their attention on a search assignment?

Keep your feet comfy.

Good fit is important.

Breaking in your boots is important.

Dry socks are important.



How about hot weather operations?

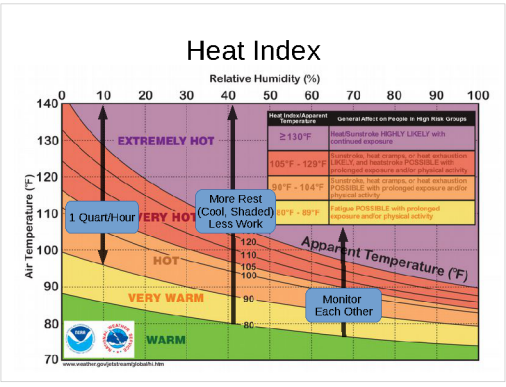
New England summers can get hot.

What are the risks of working in the heat?

What can you do to mitigate those risks?

Drink plenty fluids when working in hot weather.

Aim for about 1 quart per hour.



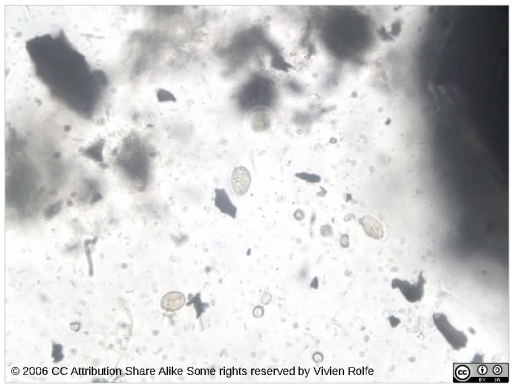
Three things we can do when it is hot:

Hydrate.

Regular rest periods (in cool shade) while working – take regular breaks (in the shade) when working in conditions with a heat index over about 90. The higher the heat index, the more rest relative to work.

Keep an eye on each other: Monitor each other for signs of heat illness.

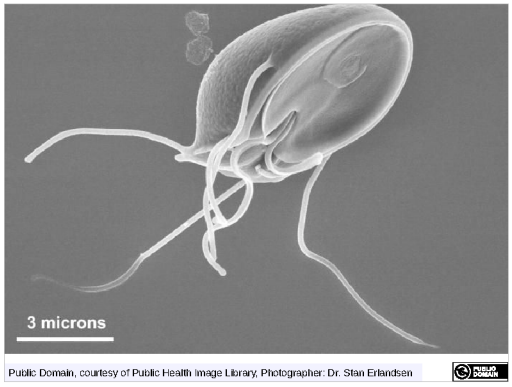
Do you want to drink from here?



Not untreated, not unless you want to get sick.

Why?

Here's Giardia in water.



Here's a close up.

One of the many things you need to worry about being in untreated water.

Beaver Fever. Widespread in new england. You don't want to drink untreated water.

Water disinfection

- **Boiling**: Rolling boil for 1 minute minimum
  - If over 2000 m altitude, boil for 3 minutes minimum.
- Combined Chemical disinfection and Filtration
  - Filtering: <= 1 micron (cyst reduction/removal filter) Protozoans, some bacteria, not viruses.
  - Chemicals: Iodine, Chlorine, Chlorine Dioxide Some protozoans, bacteria, viruses.

The CDC recommends boiling as treatment.

Boil for at least 1 minute. If over 2000m (6500 feet (anywhere in New England this high?)), boil for at least 3 minutes.

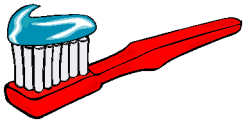
You can also both filter and chemically treat
You need to use both together.

Handout: CDC guidelines

- UV treatment
  - Limited to clear water
  - Pre-filter water
  - Follow manufacturer's directions.

UV treatment methods don't work with muddy water.

Filter it first, then UV treat.



Toothbrushing key for hygiene

Graphics Source: Open clip art

Toilet

- Bury human waste 8" deep and at least 200 feet from natural waters.
- Wash hands
  - Before handling food
  - Before eating
  - After using the toilet

If you are out in an extended search you may end up needing to toilet in the woods.

Pick a spot more than 200 feet from natural waters.

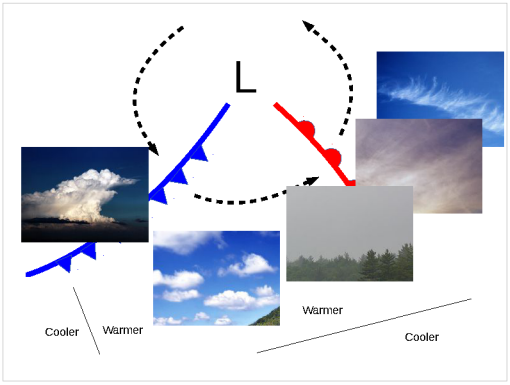
Bury at least 8" deep.

Wash hands.

Also, wash hands before eating and before handling food.

If you need to camp, seek high ground.

Avoid pretty flat meadows next to streams...



How do you find out what the weather is going to do?

Forecasts.

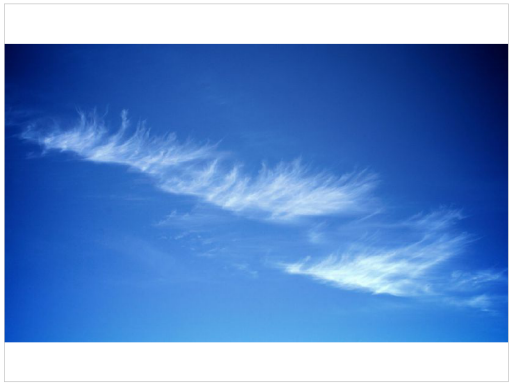
Also simple model that may let you make short term forecasts by observing the weather: Frontal theory.

Low pressure area, air circulating around (counter clockwise in the northern hemisphere).

Warm front – warm air wedging up (rises) over cooler air. Characteristic sequence of clouds over hours to days – high wispy, thickening, lowering, eventually raining.

Then warm front passes – nice weather, puffy clouds.

Then a cold front comes, cold air wedging under warm; Sudden line of thunderstorms, then cools and clears.



High wispy clouds, wind from SW.

What is starting to approach?

Warm front.

May rain later, but probably not for a day or so.

Thickening, high clouds, alto-stratus.

Thickening and lowering more – to stratus.

Won't be that long before rain.

Then to heavy, sustained rain (or snow).

Then the front passes, sunny, clear, warmer.

Puffy cumulus clouds.

What's happening here?

The next cold front is approaching, and with it, thunderstorms.

What are some hazards associated with this?

What do you do when you hear thunder?

Basic Survival

Image: “Kelsey & her new friend- tree well”

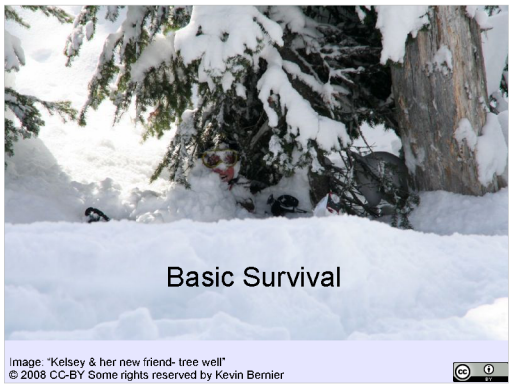


Image. "Kelsey & her new friend- tree well"

Unit 14: Basic Survival

What are your priorities for survival?

The "Rule" of 3s (What kills you)

- 3 seconds to get off the "X"
- 30 seconds to stop your own arterial bleed
- 3 minutes without air
- 3 hours without shelter (harsh environment)
- 24-48 hours without sleep
- 3 days without water (weather & shelter...)
- 3 weeks without food (with all the above)

There is HUGE variability

Loose rule of thumb for priorities: Rule of 3s.

For some very immediate threats (plane crash, sinking ship, vehicle in water, active shooter) very few seconds to act. You've got about 30 seconds to stop your own major arterial bleed before you become unable to do so.

Rule of 3s clearly indicates the priorities for "usual" backcountry survival: Shelter, sleep, water. Food isn't a priority.

Huge variability (among people, among circumstances). Survival without shelter can be 5 minutes in cold water, weeks in dry, warm, temperate conditions.

Think: Immediate survival needs; Longer term survival needs.

Priorities

- Positive Mental Attitude
- Get off the "X" (about 3 seconds)
- Air – about 3 minutes
- Shelter – about 3 hours (harsh environment)
- Rest
- Signals
- Water – about 3 days
- Food – about 3 weeks

Most important priority is positive mental attitude.

Then, air, shelter, rest, signals.

Shelter is key – cold and wet is dangerous. Recall the survivability difference between 1-3 year olds and 4-6 year olds – you want to curl up somewhere warm, cosy and dry.

Water is down the list, you've got a couple of days to address that.

Food is way down the list, you have many days to address that.

Positive Mental Attitude

- Forget the promise that you'd be home for dinner tonight.
- Focus on survival priorities.
- Understand how you deal with isolation.
- Expect initial panic on realizing you are lost.

It's all about what you "go out the door" with
(in your head and on your person.)

Recognize that you are in a survival situation, put other concerns aside.

It's good that you promised that you'd be home for dinner tonight, that means someone will be concerned when you aren't.

Focus on the top priorities first: attitude, shelter, rest, signals.

PSAR Messages

- Hug-A-Tree
  - Hug-A-Tree (stay in one place)
  - Make Yourself Big (visible)
    - Bright (reflective)
    - Unusual (straight lines, threes)
- BSA: STOP
  - Stop
  - Think (stay put, stay together, conserve energy)
  - Observe
  - Plan
    - (First Aid, Shelter, Fire, Signal, Water (don't worry about food))

We talk about survival in the Preventative SAR (PSAR) program messages:

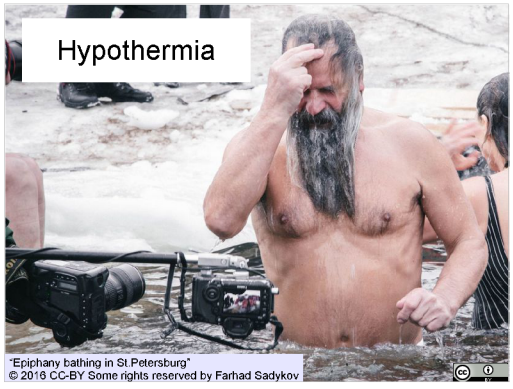
Hug-A-Tree, Hug-A-Tree and Survive.

Hug a tree: Stop when you get lost, stay warm and dry.
Make yourself Big: Make signals

Boy Scouts of America

STOP: Stop, Think, Observe, Plan

Stop: when you are lost.
Think: stay put, stay together, conserve energy.
Observe: situation, hazards, resources.
Plan: first aid, shelter, fire, signals, water.

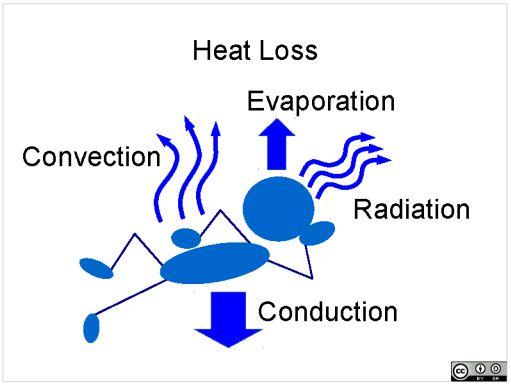


What are the most dangerous conditions for hypothermia?

Why?

Most dangerous conditions: 50 degrees and raining. (People aren't prepared)

Some other higher risk conditions:
Falls during river crossings.
Sweating into cotton. -- Why?



Let's think about paths by which heat is lost:

Conduction – laying on cold ground, conduction into water. Sit on a cold wet rock, what happens?
Convection/bulk transport – Bulk Transport: cold wind, flowing water, transporting the heat away (in still conditions, body heat warming surrounding air, surrounding air rising (convecting away).
Radiation: body heat radiating away. Most noticable if you wrap yourself in a space blanket.
Evaporation: Moisture on the body evaporating, changing water from a liquid to a gas takes lots of energy, moisture on the skin evaporating cools the skin. Sweating – the main way the body sheds excess heat.
Also: Respiration: Breathe in, air is warmed in lungs, breath out, heat is lost to surrounding air. (We can see it in the winter)

STOP: Plan: first aid, Shelter

Understanding heat loss pathways can help you build an shelter.

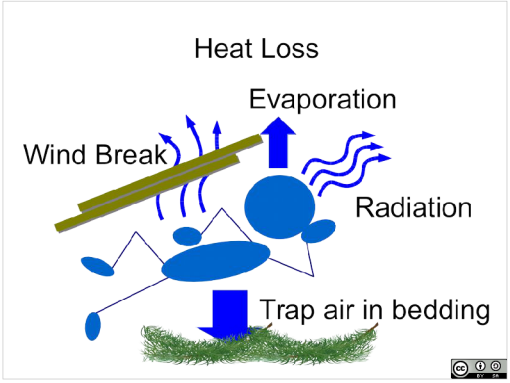
Heat is lost by convection/bulk flow: build a wind break.

Heat is lost by conduction into cold ground: Put insulation below you. Old phrase: “One below is worth two above” - put insulation under you, think mattress, not blanket.

What else do you want in a shelter?

What do you think of this shelter?

Where does your head go? Why? (about 50% of heat loss is through the head, protect the head and core).



Block conduction to the cold ground by trapping air in bedding below you.

Block Convection and bulk flow by constructing a wind break.

Focus on head and core – most heat loss through them.

What else might you want to do?

(reflective blanket, good way to bounce radiated heat back on yourself)

(waterproof barrier to keep the rain off you).

(not build in a low spot where a puddle will form in your bedding)

Fire

STOP: Plan: first aid, Shelter, fire

What is it good for?

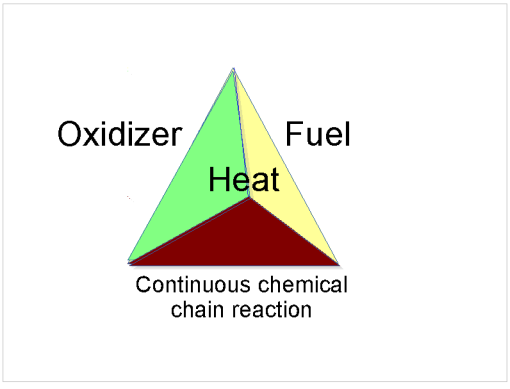
Discuss.

Warmth

Attraction/Signal

Boil Water (boil how long per CDC? (rolling boil at least one minute, at least 3 minutes over 2000 feet))

Morale – Positive Mental Attitude



How do you get a fire going?

You put the four of these together.

Air – with oxygen, an oxidizer.

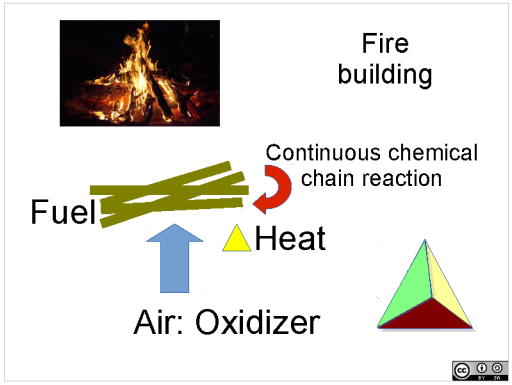
Fuel – something to burn.

Heat – (solids don’t burn, they produce gasses which do), need heat to make the fuel burn.

And a continuous chemical chain reaction.

Take any one away and you put the fire out.

To make fire, need to understand what fire needs.



You need some fuel.

The fuel needs ventilation to get a supply of oxygen in.

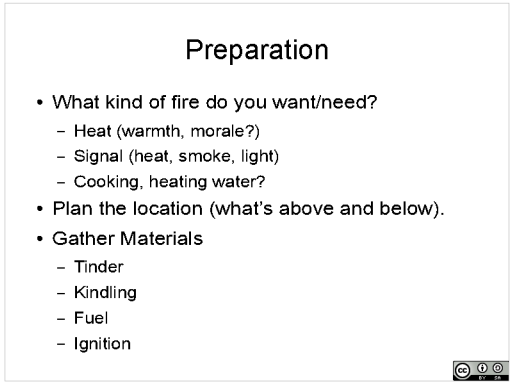
You need to add heat.

You need to maintain the conditions to keep the continuous chemical chain reaction going.

Fuel too large – can't get it hot enough to get the chain reaction going.

Fuel too dense, can't get air in.

etc.



First, prepare for your fire. Why would it make a difference what sort of fire you want?

Gather materials. What might you use for:

Tinder? Drier lint (not if you wear nomex clothing), petroleum jelly saturated gauze, vaseline soaked cotton, magnesium chips, fuzz stick, shredded cloth, birch bark, etc...

Kindling? twigs, etc.

Main fuel? larger and larger sticks, branches, etc.

Ignition source? Lighter (fuel can leak away); magnesium, knife and sparker; matches: (hurricane, strike anywhere, book).

Here's one theory: Build a structured pile of materials all ready to ignite and have the fire grow into the pile.

This one is intended as a signal fire.

Kindling, with a hopefully complete enough sequence of larger and larger twigs and sticks, and then damp leafy pine branches on top to generate smoke.

What are some issues you see here?

Ground might burn.

Might not be enough fuel larger than kindling for the fire to grow.

Here's another approach – start small and add fuel.

Tinder, small bits of kindling stacked on top, open to allow air to draft through.

Ignite tinder – get enough heat for the kindling to ignite, then...

then slowly add larger and larger fuel. As larger fuel items ignite the fire will grow and build up more and more of a draft, bringing air (oxygen) into the fire – and it becomes self sustaining as long as you keep a supply of fuel.

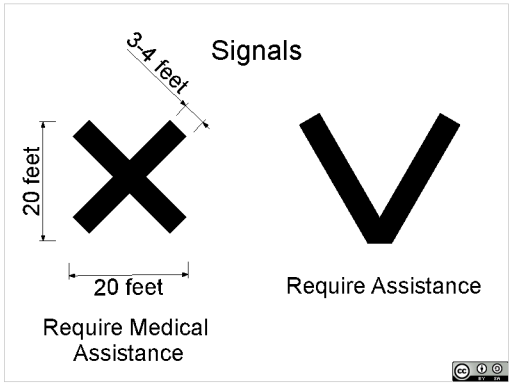
You can add more air into the fire by blowing on it. In windy conditions you may need to set up a windbreak to reduce the initial air flow through the kindling (bulk flow, removing heat, not letting the tinder heat the kindling enough to ignite)

Think about what is below the fire. Will it burn? Does it maintain a draft of air into the fire? Will it shatter when heated (wet layered sandstone)?

Think about what is above the fire. Wet snow on a tree limb...

Then for your main fuel – larger sticks, branches, logs.

Leave them long and push them in as they burn.



STOP: Plan: first aid, Shelter, Fire, Signals

Here are two signals for ground to air signaling by persons in distress from Annex 12 to the Convention on International Civil Aviation.

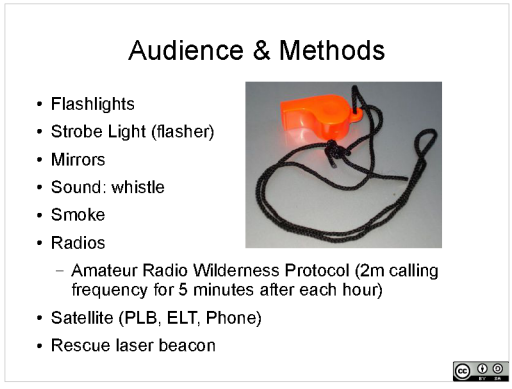
Make as large as possible, preferred minimum size is 20' by 20' with width 1/5 to 1/6 of length.

Make as strongly contrasting with the background. Make deep/tall to cast shadows if possible.

Place in the open, visible from the air, away from shadows.

Destroy after signal has served its purpose.

Audience: Aircraft.

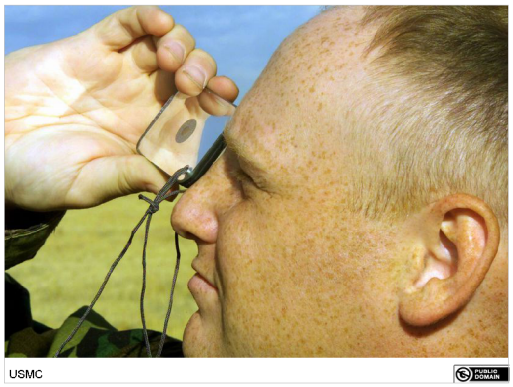


Think – who are you signaling to?

How can you signal to them?

What means to signal do you have on hand?

What means do you have to improvise signals?



Heliograph/signal mirror.

Demonstrate use – and use of arbitrary reflective object (hold hand with fingers in V, aim at target, hold mirror near eye, reflect light onto you hand)

Signal with a mirror when you have something to signal at.

Hug A Tree: Make your self Big.

How do you make yourself big for aircraft?

Lie flat, spread eagled, in the open.

Lights, heliograph, standard ground to air markings, etc.

Audience: Ground Searchers

- Make your shelter findable
  - Trash, Flag lines, Disturbance Lines
- Sound: Whistle, Gunshots
  - Distress: Sets of three, Response: Two
- Smoke
- Flashlights
- Strobe Light (flasher)
- Mirrors
- Radios
- Rescue laser beacon

Think – who are you signaling to?

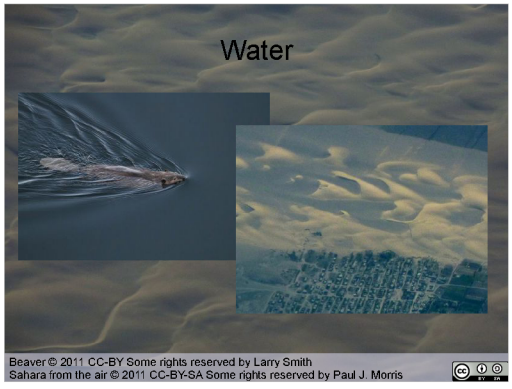
Ground searchers?

How can you signal to them?

How can you attract them?

Shelter made out of natural materials sounds like a nice camouflaged hiding spot.

How can you make your shelter easier for them to see?



STOP: Plan: first aid, Shelter, Fire, Signals, Water

Two problems about water :

No water.

Water not fit to drink.

Potable (drinkable) water

- Boil
- Distill
- Filter
- Chemically treat it
- UV treat it

If you have a source for water (or snow, or salt water), you can make it drinkable. Assume any water in the wild in New England is contaminated.

Handout CDC Guidance on water treatment

CDC recommendation: Boil for 3 minutes or two other methods (filter and chemical treatment).

For chemical treatment to carry, look for long shelf lives.

Avoid eating snow, melt snow into water.

Distill fresh water out of salt water.

Obtaining water when you don't have a source is harder.

Survival methods have many methods, try them.

You may be able to obtain water with a transpiration bag.

Trees suck water out of the ground. Trees breath through their leaves. Trees lose water vapor through their leaves.

Wrap a branch with green leaves in a plastic bag with a pebble in it to give it a weighted low point (for water to collect in), tie the plastic bag closed around the branch. Wait.

Stop
Observe
Think
Plan

You won't be carrying everything you want.

You will need to improvise.

Key to improvising is thinking about Function.

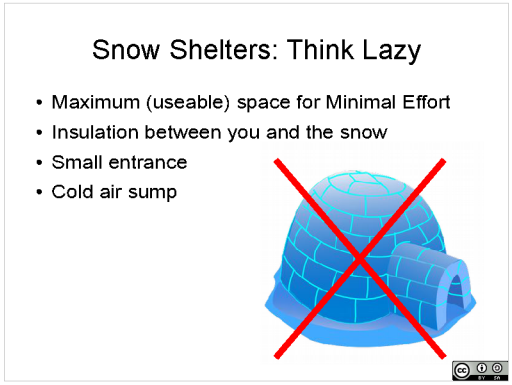
I need to keep my feet dry – what do I have that can serve that function.

A rain jacket doesn't need to have sleeves and pockets and a zipper and buttons.

What is it supposed to do? What materials do I have on hand that can do that?

It does need to keep you dry and let you breathe and trap air near your body (air is a good insulator, but wind carries heated air away from you).

Stop
Observe
Think about how to improve the situation.
Plan



What is a snow shelter supposed to do?

Shelter you from the weather – thus: small entrance,

Snow is cold – snow conducts heat, conduction is very efficient at conducting heat.

Thus: Insulation beneath you (materials? Your pack. Pine boughs).

Cold air sinks – thus: build a low spot for the cold air to sink to.

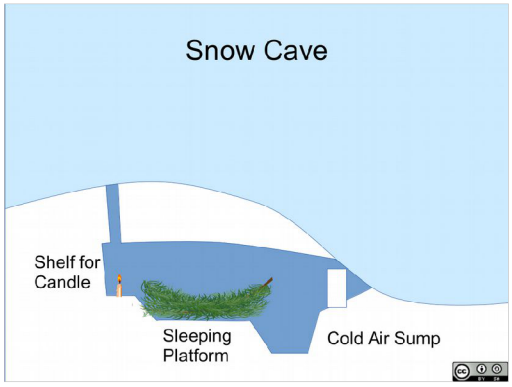
Think Lazy. How can I get the maximum amount of usable shelter space with the least effort?

Here's an example of an Igloo building exersise. In the end this igloo got the open top covered by branches and a tarp, but it still took 30 person hours to build.

10 people to build, holds 6....

Not thinking lazy.

Building with snow takes the right snow conditions and takes effort.



Traditional snow cave: much less labor intensive. Build a pile of snow and hollow it out.

Cold air sinks: Add a low spot for it to sink to.

Snow is a good conductor of heat. Insulate your underside from the snow – insulate your sleeping platform (insulation = something that will trap air (air is a good insulator)).

You can build and elevated shelf and a chimney for a candle.

You can partly block the opening to trap warm air inside.

Think Lazy.

This snow cave took three people, three hours (9 person hours), to pile up snow and hollow it out, holds 8 people.

Contrast with the igloo shown earlier, 30 person hours with 10 people, only holds 6, didn't actually finish the roof...

Three people, three hours (9 person hours), holds 8.

Entrance can be partially blocked to reduce bulk flow.

Candle can provide heat and light, needs a chimney to draft combustion products out.

An even simpler start for shelter is a tree well.

Coniferous trees catch snow on their branches, less accumulates around the base of the trunk.

By itself, shelter from the wind.

You can dig a snow cave into the side of the well.

Equipment: What to carry?

- It all depends (on a lot of things)
- Local conditions
  - Weather,expected and unexpected
  - Terrain
  - Season
- Mission
  - Duration
  - Goal
- Team (experience, skill….)
  - No point in carrying stuff you don't know how to use
  - Sharing the load
- Survival: Things on your person.

For Survival, the only equipment that really counts is what is on your person.

What you can count on is what you have in your head and what you have on your person.

The backpack back in camp, the survival kit in the back of the plane, lots of nice equipment, but it isn't with you.

The "Rule" of 3s (What kills you)

- 3 seconds …..
- 3 minutes …..
- 3 hours without shelter (harsh environment)
- (24-48 hours without sleep, function degrades)
- 3 days without water (weather & shelter...)
- 3 weeks without food (with all the above)

Three seconds... (to get off the X).
Thirty Seconds... (to stop your own arterial bleed).
Three minutes... (without air).

Lots of variability.

In a harsh environment, survival times might be 3 hours without shelter.

Fatigue severely reduces your ability to function and to think clearly. You need sleep for the Think in STOP. Two days without sleep won't kill you directly, but it puts you at much greater risk (e.g. for doing stupid things).

Depending on weather and shelter, you need water within about 3 days.

STOP

- Stop, Think, Observe,
- Plan
  - First Aid
  - Shelter
  - Fire
  - Signals
  - (Sleep)
  - Water
  - Don't worry about food.

So the rule of threes sets priorities for your plan (first aid, shelter, fire, signals, get rest and sleep, obtain and purify water)

Frame a scenario, and discuss each of these in turn. What do you normally carry that could provide these functions? What could you improvise to provide these functions.

(Make point again with image: the equipment you have is what is on your person).

Food

- We don't physically need food for the plausible (local) "lost in the woods" events
- BUT is sure helps on the psychological front
- And it makes a HUGE difference in your ability to keep working!
- Hot drinks
- High caloric content in low volume & weight

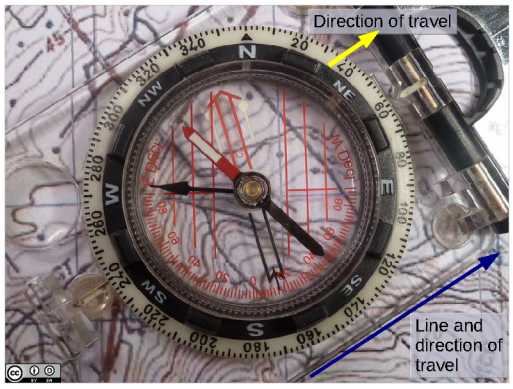
Don't worry about food.

But food is good to have – very good for the positive mental attitude.

Good food to carry: high caloric content, small volume, small weight.

Land Navigation III
Grids with Compass, Basic GPS

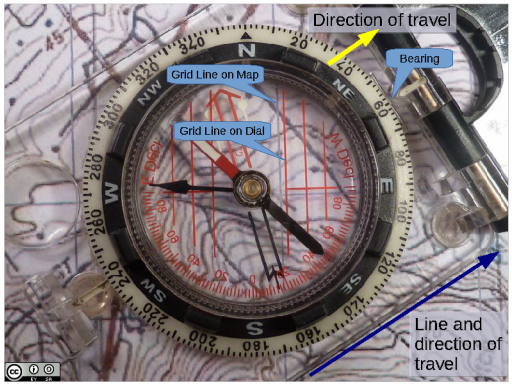
Unit 15, Land Navigation III: Grid with Compass, basic GPS



Reviewing how to obtain a bearing from a map:

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

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



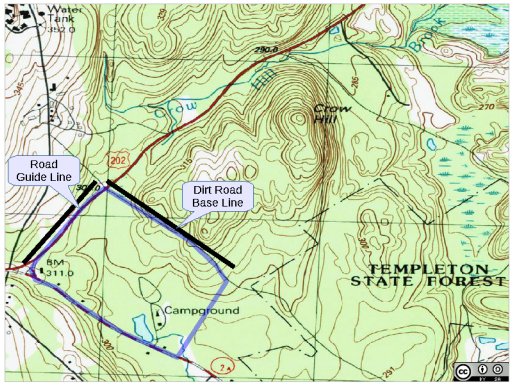
Line the lines in the back of the dial up with the grid lines on the map.

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

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

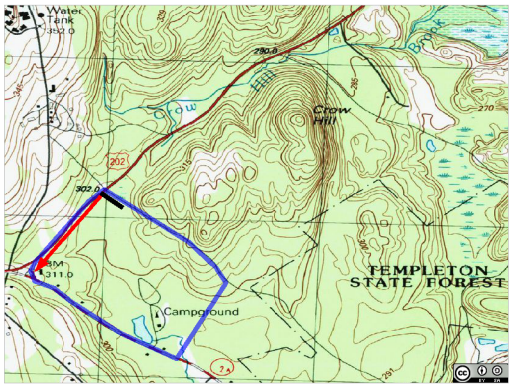
Here, 60 degrees true (there's a declination dialed in (how can you tell?)). (What's the declination?)

What is the backbearing?

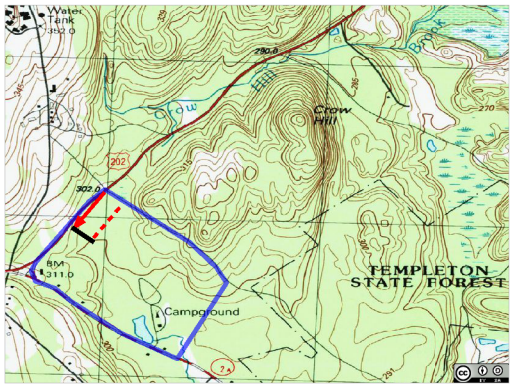


A Segment – Assignment, grid with a Type III grid.

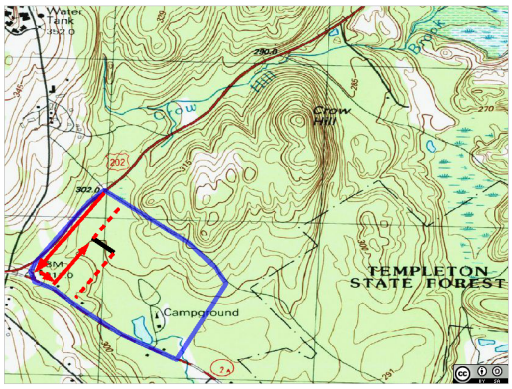
You have a clear guide line – the road down the West boundary of the segment, and a clear base line, a dirt road on the North boundary of the segment, and a clear far boundary, the road along the South end of the segment.



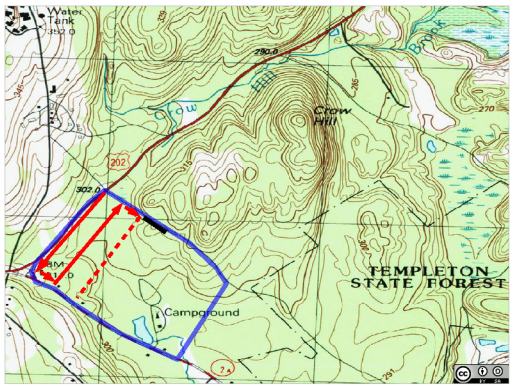
Searchers can start lined up along the dirt road base line, navigating off a guide person along the road.



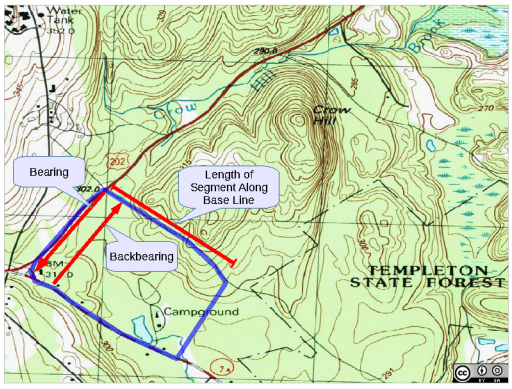
As the grid line advances, someone at the East end of the line can be tasked with flagging the line that will become the guide line for the next sweep.



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



And repeat.



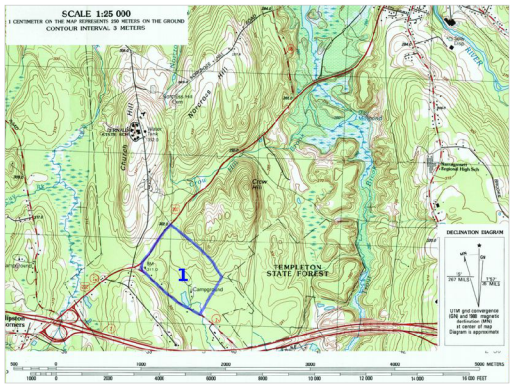
To navigate this well bounded segment, you need three pieces of information: Which are?

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

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

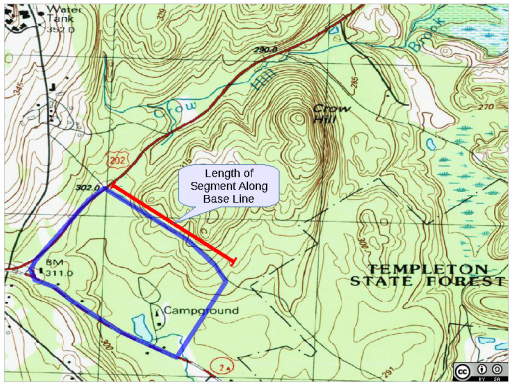
For a Type II grid or a Type III grid that is navigating by distance from a guide person, the guide person has the road and flagging guide lines to work from, but needs the bearings as a backup (what if they can't see the next flagging) and as a sanity check.

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



So, let's measure those bearings and distances.

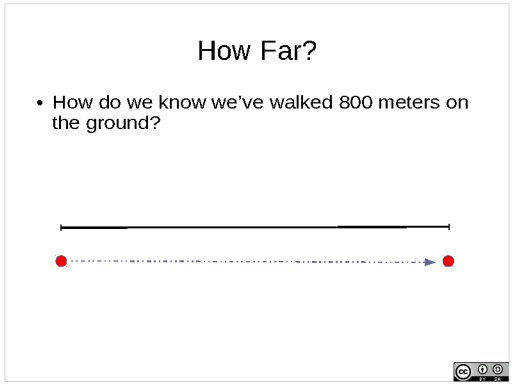
Practical Evolution 1: Measure on map.



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

How do we measure this distance on the ground?.

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



Pace counting.

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

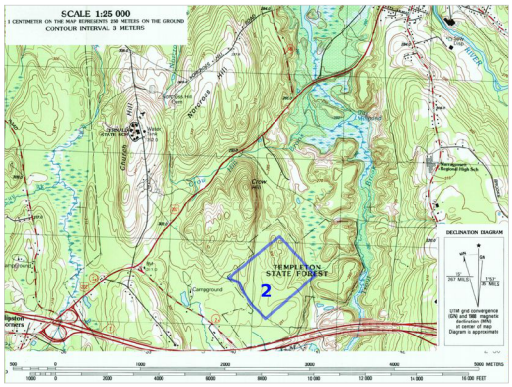
Walk it, counting paces (number of times one foot (e.g. left) hits the ground).

Typically 60-70 paces to 100 meters.

Repeat.

Repeat at different locations on different terrain.

Key: Walk with constant stride.



How about this segment?

Only one marked boundary.

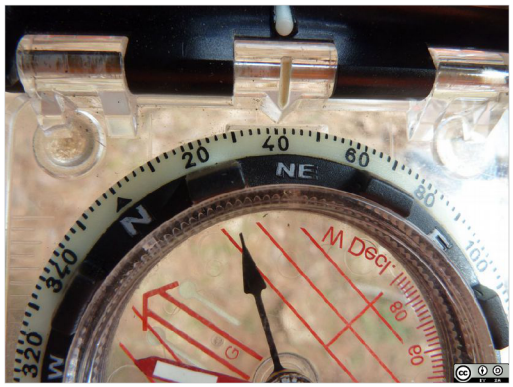
Everything else needs to be done by compass and pace count.

How do you navigate this? [Discuss]

How do you know where to start?

What landmarks tell you you've reached the N segment boundary?

Practical Evolution 2: Measure on map.



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

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

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

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

Hold the compass up at eye level.

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

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

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

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

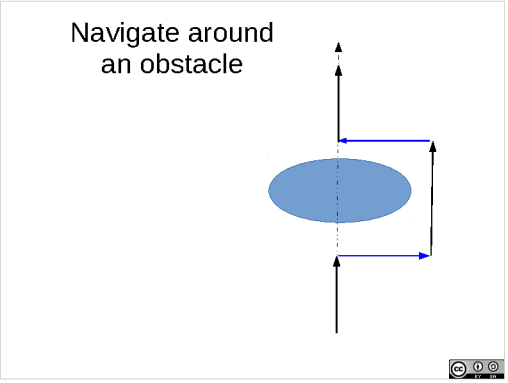
Then put the compass down, make sure you can still identify the thing you saw down bearing, and start pacing towards it.

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

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

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

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



To navigate around an obstacle

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

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

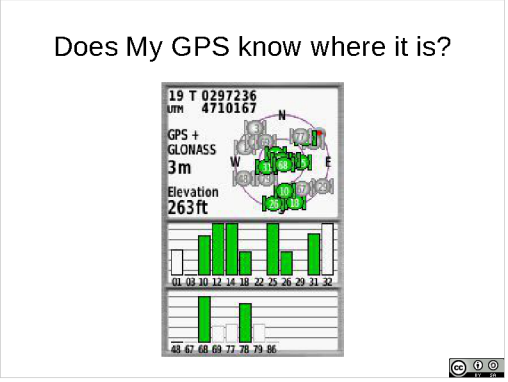
Pace on your original bearing past the obstacle (adding the distance paced to your total distance traveled).

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

Now you are back on your original bearing, continue.

Now let's look at GPS, or rather GNSS (global navigation satellite system) receivers.

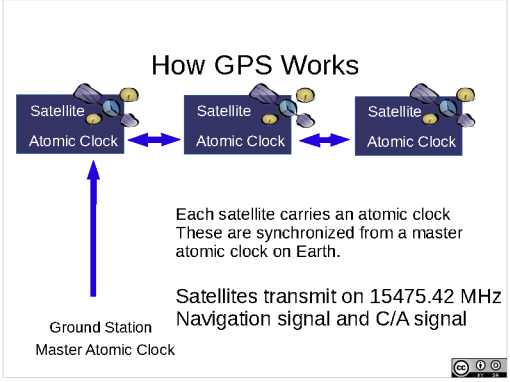
(Note: cartoon is CC-BY-NC, no commercial use)



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

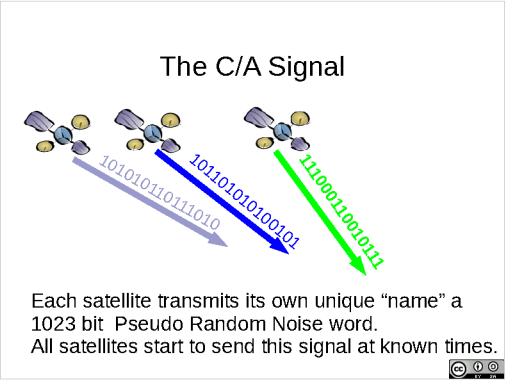
(1) The GPS will give you a position.
(2) The GPS will give you an estimated position error.

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

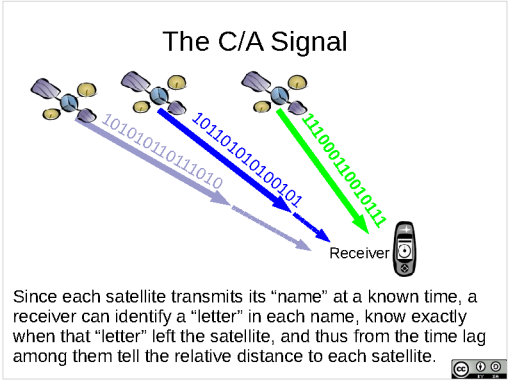


The GPS system is a marvel. It depends on very precisely synchronized atomic clocks carried on each GPS satellite. The satellites transmit a variety of spread spectrum signals in the low microwave bands. The key civilian signals are the Navigation signal and the Coarse/Acquisition signal.

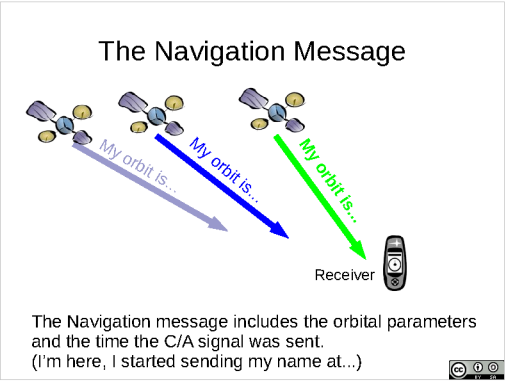
[The Navigation signal is transmitted at a low bitrate and takes 12.5 minutes for complete transmission. It is modulated with the Coarse/Acquisition signal running at high bitrate (repeated once per millisecond), in a CDMA spread spectrum signal, where all satellites transmit on the same frequency, and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



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



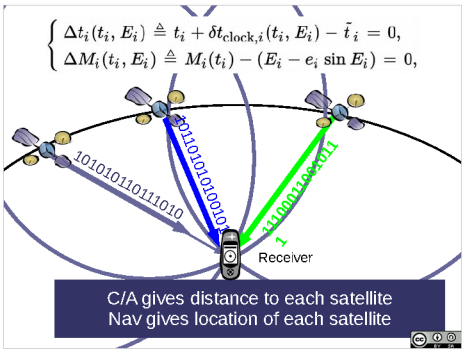
Because the names are transmitted at known times, a GPS receiver can listen for the time lag between signals transmitted by different satellites and calculate the relative distance to each satellite.



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

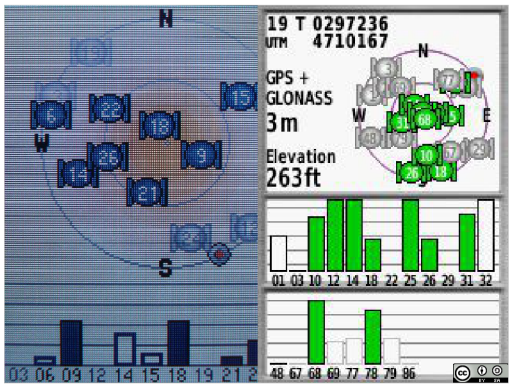
The receiver can identify the particular part of the pseudo random noise signal (in the C/A) signal it is hearing, match it to a particular satellite, and know at exactly what time that part of the signal left the satellite. Knowing the speed of light, the receiver can calculate the distance to each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

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



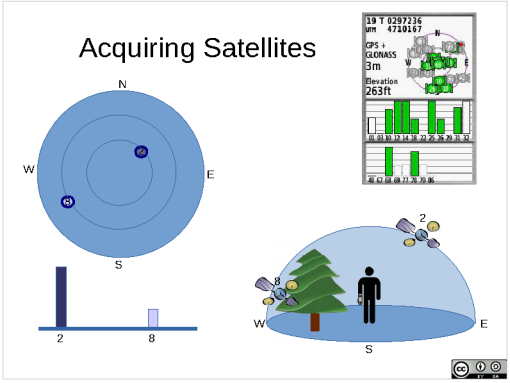
Then it is just math...

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



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

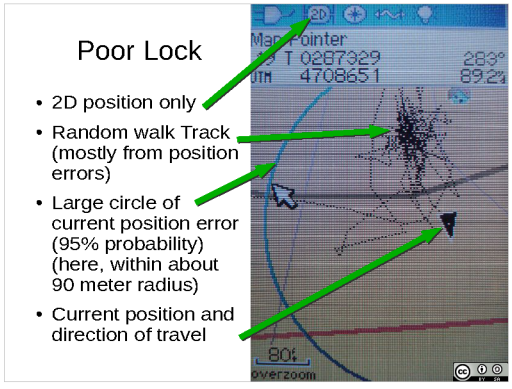
Typical view is a circle representing the sky, with satellite positions in it, and bars indicating signal strength and lock (have I got enough information from this satellite to use its signal to calculate a my position).



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

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

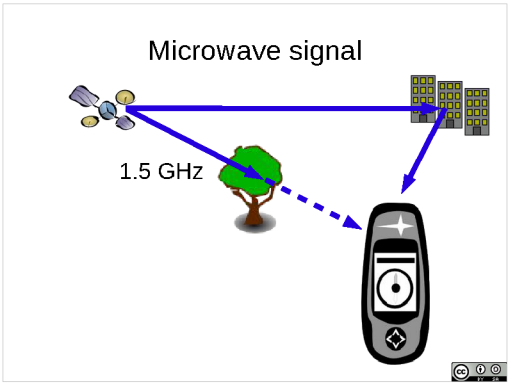
Satellite 8 has a weaker signal and hasn't got a lock yet. How could you improve this? (move to get a clear view of the satellite in the sky (not blocked by trees)).



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

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

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



The GPS signals are on microwave frequencies.

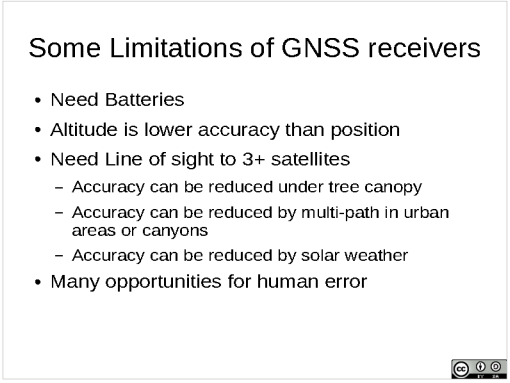
Tree leaves are good at attenuating microwave signals, thus GPS receivers get weaker signals from satellites under tree canopies.

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

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

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

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



GNSS receivers have limitations.

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

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

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

Complex tools, practice with them regularly.

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

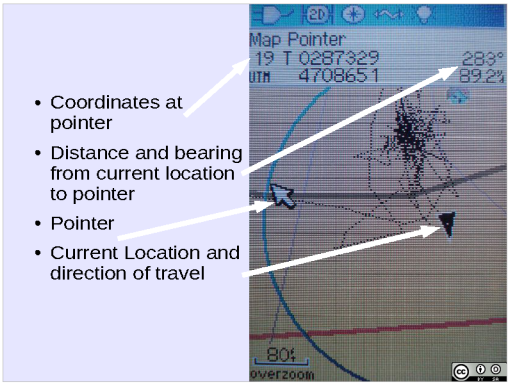
Here are two examples of a GNSS receiver displaying location on a map.

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

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

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

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



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

What are we seeing here?

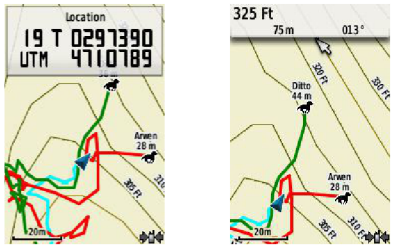
Pointer (left center)

Current position (black triangle, right center)

Circle: Estimated position error.

Black squiggly line – drifting position error by the GPS.

Displays Vary (Learn Yours)



Current Location (Blue Triangle)

Distance and bearing to pointer (and label of contour line 325 Ft)

Here's a Garmin Astro (tracking two dogs), displaying the coordinate of the current location, and then scrolling the map, showing the distance and bearing to the pointer (and confusingly in this case, the label of the contour line the pointer is hovering over (the pointer is on the line 325 Ft 75 meters away on a bearing of 13 degrees))

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

Simple Navigation

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

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

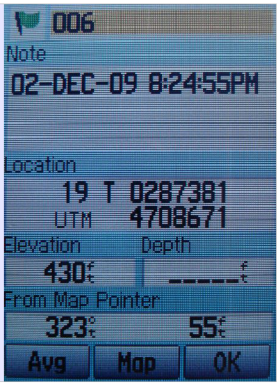
In a GNSS with a movable map pointer, we can obtain the bearing and distance to a point.

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

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

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

Waypoints



You can store a location. This is a waypoint.

You can give it a name (Truck, Clue, Staging, etc.)

Often button "Mark" on the GNSS.

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

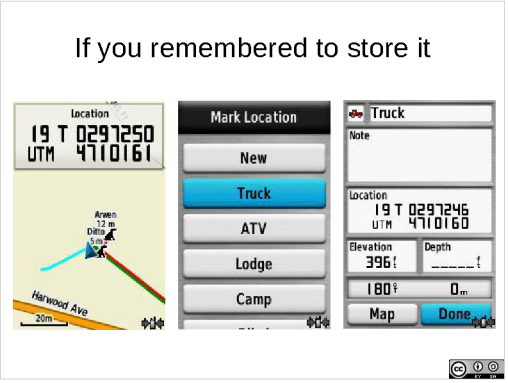
Go To Waypoint

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

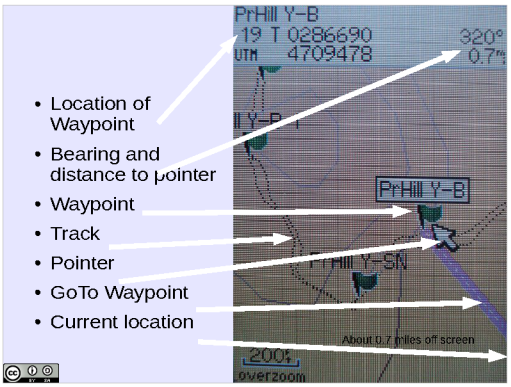
You can navigate back to the dropoff point...

287 degrees (True)

180 meters.

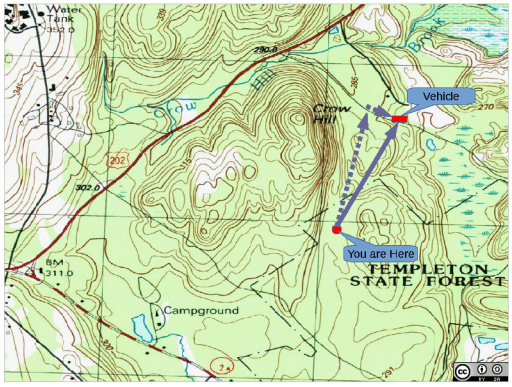


Assuming you remembered to mark the dropoff point.



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

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



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

Why?

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

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

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

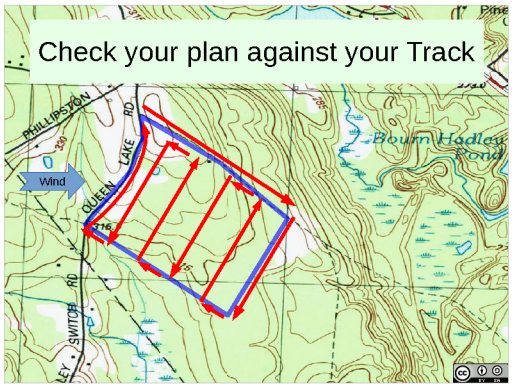
At a location, you can project a waypoint some distance on a bearing.

You need to:

Be at a known point.

Have a known distance you want to travel.

Have a known bearing you want to travel on.



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

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

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

Building your own map

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

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

You have three tools for this:

Waypoints: Stored Locations.

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

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

All of these capabilities can be exploited in SAR.

Finding your way back to a pickup point

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

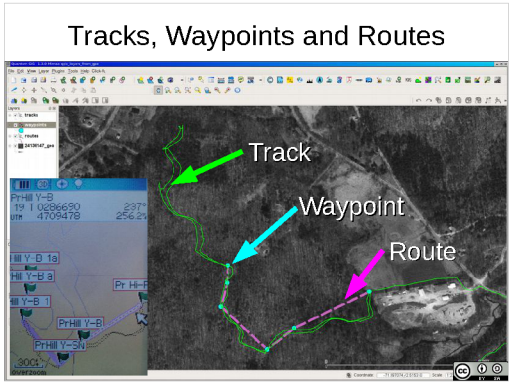
We already touched on one of these – if you remember to mark a waypoint at the dropoff point, and you mark a waypoint when starting to search a segment, you've got information in your GNSS to help you get back to the dropoff point.

Documenting where you have searched

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

Your GPS can help document where you searched.

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

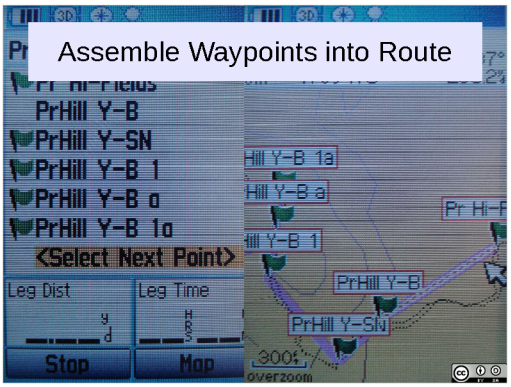


Tracks are the GPS's record of where it has been.

Waypoints are point locations that you store in the GPS.

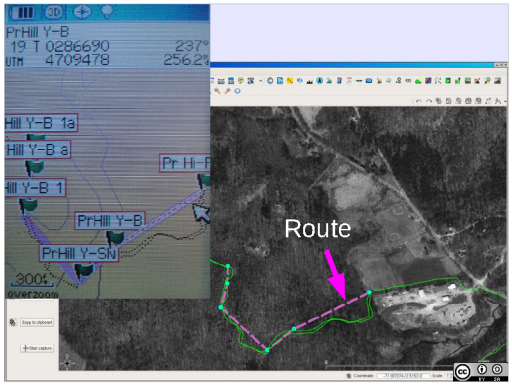
Routes are connected sets of waypoints that can be followed one to the next.

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



Your GNSS may allow you to build a route out of a set of waypoints.

You may also be able to do this in an external application on a computer, and upload the waypoints and route into your GNSS.

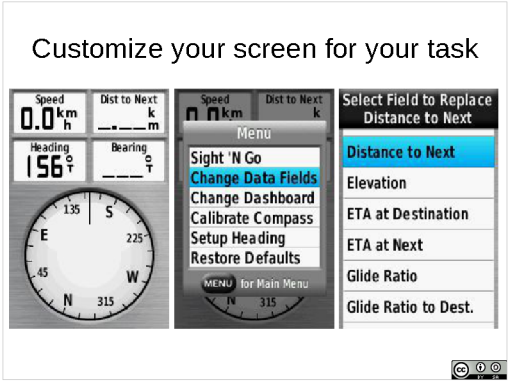


Route connects waypoints with straight lines.

GPS screen and mapping application show a route and the actual track followed while following a trail.

(On the map, trail is in green, waypoints are in blue, and the route is in pink).

In this particular case, the pink route happens to lead through a swamp, the green track around it.



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

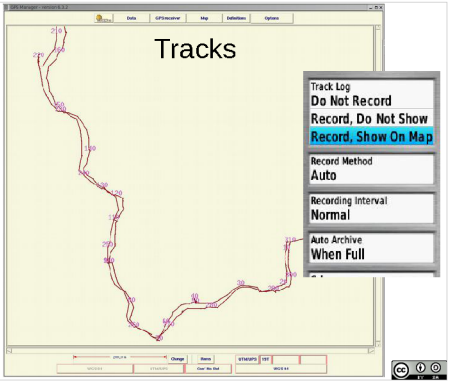
Configure the fields you want to see for the task at hand.

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

Fields on Map View

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

Tracks



Tracks record the sequence of positions recorded by the GPS.

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

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

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

Backtrack

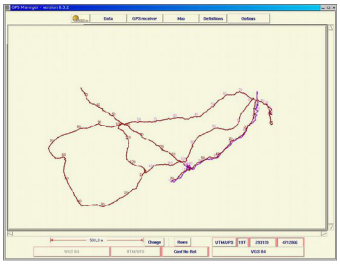
- Manually
  - Use GPS map and pointer to work out bearings to points along track.
- Automatically (some GPS units)
- You need to be recording the track....

You've been following some route through some complex system of trails and you want to find your way back to your starting point.

If you recorded your track with your GPS, that can help.

Some GNSS units have a backtrack function that will treat your track as a route that you can navigate in reverse.

Download Tracks, Waypoints, or Routes from GPS to computer



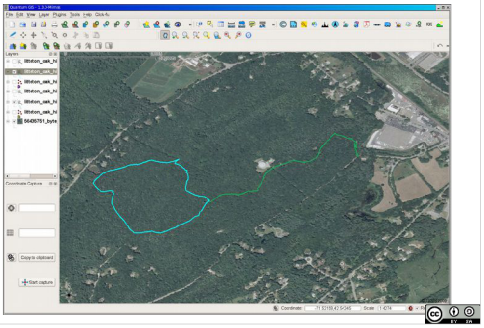
You can download stored data (waypoints, routes, tracks) from a GNSS to a computer.

Older models – serial protocols, require software that can talk specifically to the GPS.

Recent models often simply mount the GNSS as a USB storage device and generate GPX files that you can copy directly off of that storage when you plug them in, no special software needed to move data off the GNSS.

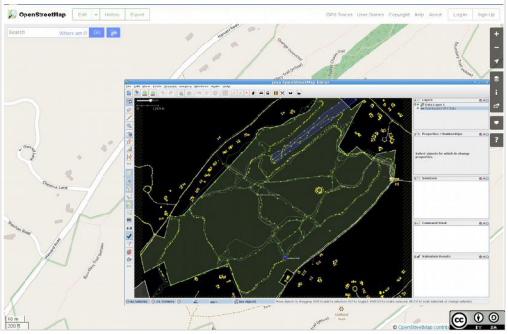
You can also upload waypoints and routes from a computer to a GNSS. For example, segment corners as waypoints.

Add as Layers in a GIS Application



Once you've got data off the GNSS, you can add the data as layers to a geographic information system application.

Contribute to Open Street Map



Or you can contribute to OpenStreetMap

Practice good habits:

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

Get into some good habits whenever you train:

Check your batteries (and spares).

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

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

Waypoints at the start and completion of your assignment document location and time.

(And of course, waypoint significant things you find)

And Calibrate the Compass (often)

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

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

Re-calibrate whenever you start an assignment.

Capabilities and battery draw vary.

Practical Evolutions:

(3) Establish Pace Count for 100 meters.

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

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

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

Applying Search Tactics

Image: BSAR (Brush Search And Rescue Victoria) searchers on Mt. Dom Dom

Unit 16: Applying Search Tactics

Search Crucials

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

Tactics bring us right back to the search crucials.

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

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

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

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

Tactics

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

We can divide tactics into two categories:

Direct: We go and find the Subject.

Indirect: We make the subject come to us.

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

Attraction

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

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

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

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

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

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

Loud, bright flashing lights.

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

Containment

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

Multiple tactics can be used to establish containment.

Sound Sweep

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

As an attractor, you can make noise and listen.

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

Important bit is to listen after you call out.

Can also be coordinated across multiple search assignments.

Not advisable to whistle while working with your canine.

Type I - Hasty

Type II – Purposeful Wandering

Type III - Grid

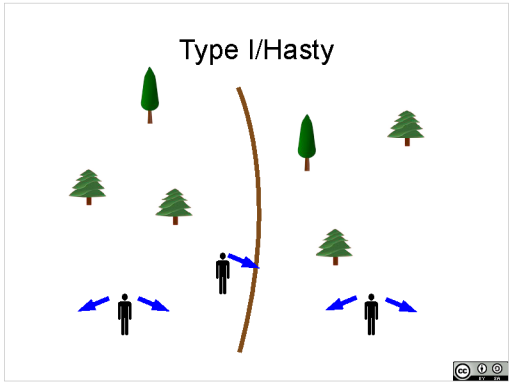
Type IV - Evidence

Efficient

Thorough
Destructive

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

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



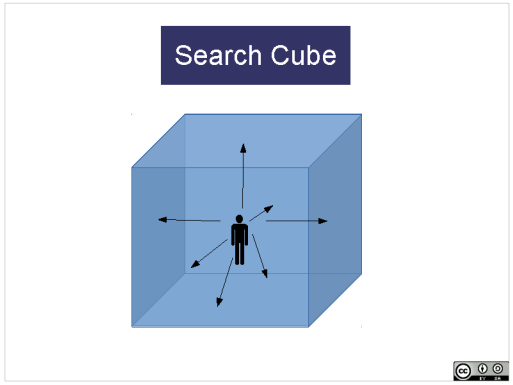
A hasty search assignment could involve an efficient search down a travel route.

What are we looking for?

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

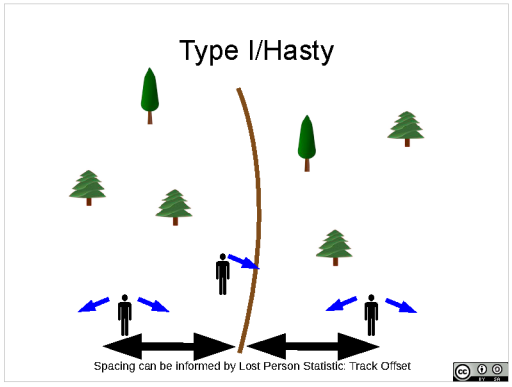
What can searchers look for in the winter?

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



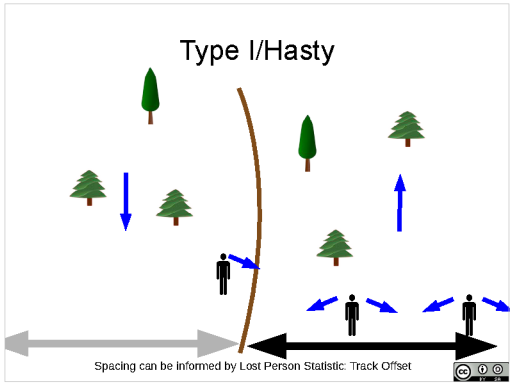
And all of the searchers should be clue aware, and checking all 6 faces of the search cube as they move along.

Search for___ ?



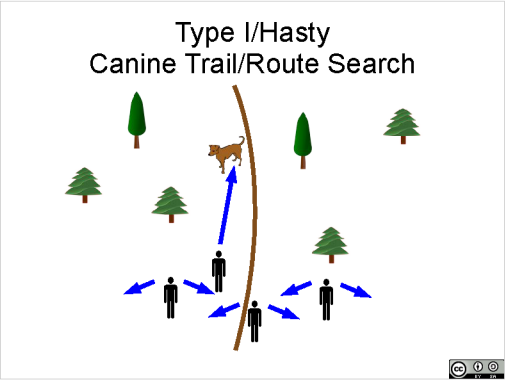
One searcher can travel just off the side (which side? - away from the sun) of the travel route, two (or three) off on either side, searching the area just off the travel route.

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



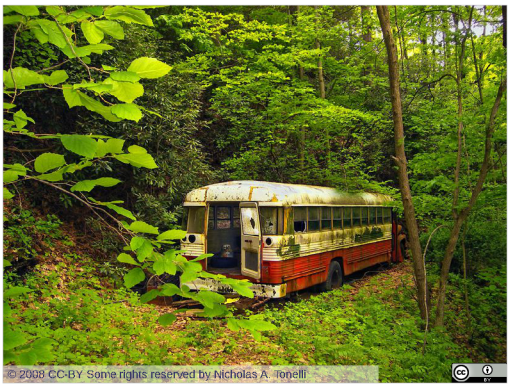
Behavioral categories with large offsets, could put everyone on one side going out, on the other returning.

Sweep one side out, one back.



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

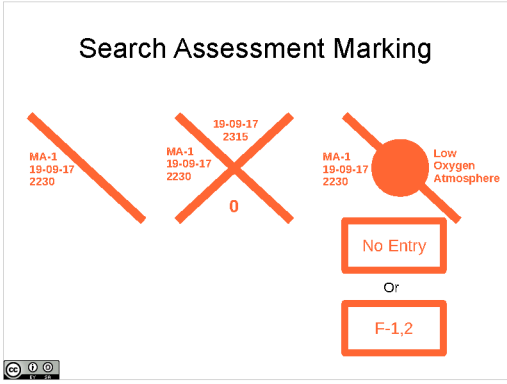
4 person team, handler can focus on the dog, others can focus on clue detection.



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

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

Structures – check structures.



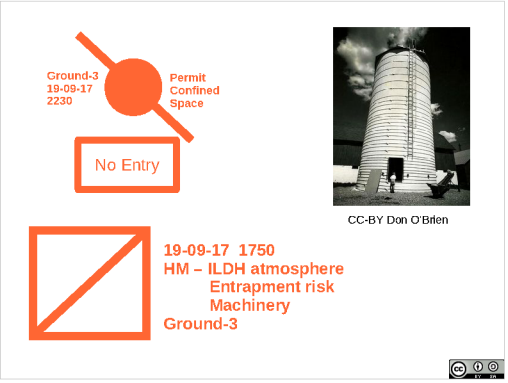
FEMA Search Assessment Marking

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

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

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

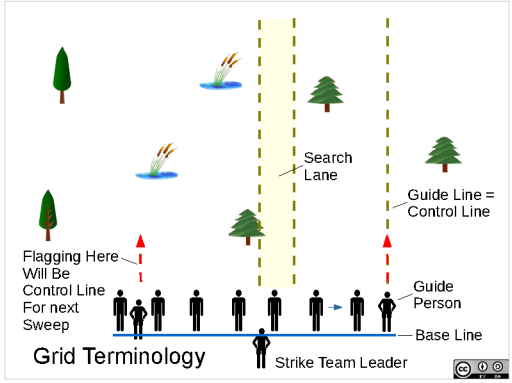
With an orange grease pencil or lumber pencil, use the Search Assessment Marking for marking abandoned vehicles, outbuildings, etc. in your search segment.



What are these markings indicating?

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

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



Type II, III, and IV searches involve Grids.

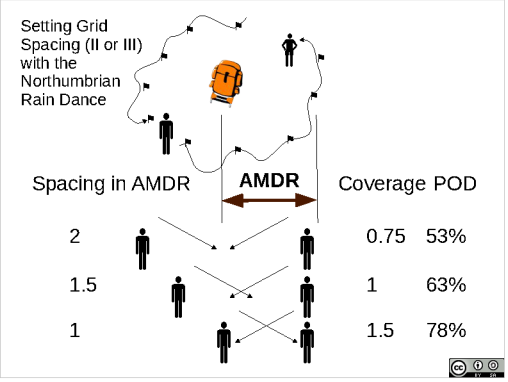
Grids have a base line. A guide person working on a Guide like, and search lanes for each searcher.

What is the span of control?

How do you manage this?

Maintain span of control.

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



Reminder on the Northumbrian Rain Dance as a means for setting the grid spacing for either Type II or Type III grids.

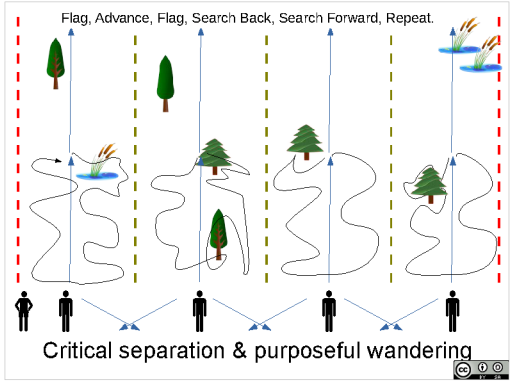
Covered in the NEWSAR POD/POD Factoring class.

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

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

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

(1) Northumbrian rain dance.

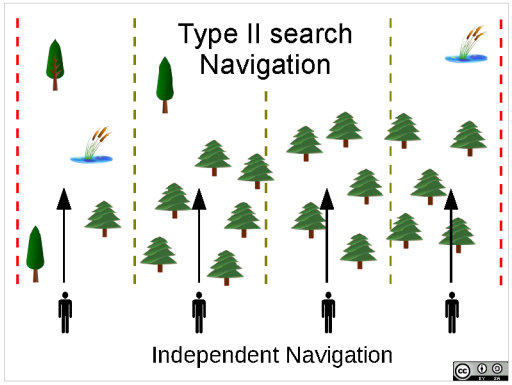


In a Type II search, Searchers can wander purposefully in their search lanes.

Highly effective method:

Flag location, advance. Flag location, purposeful wander back to first flagging, purposeful wander to next flagging. Repeat.

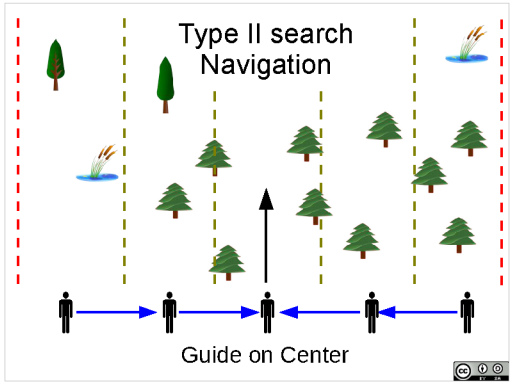
Separates navigation for searching.



Skilled Type II searchers can navigate independently – particularly in dense vegetation

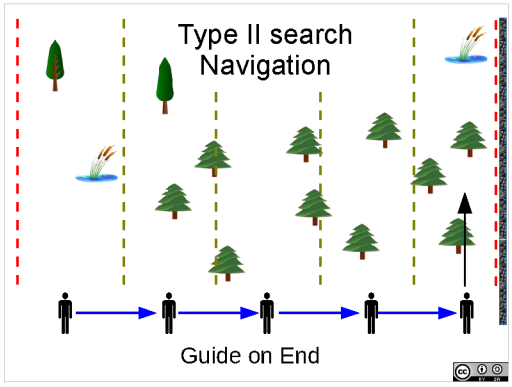
Navigation techniques are both about navigation and about maintaining control of the people.

Type II: Purposeful wandering while searching.



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

Type II: Purposeful wandering while searching.

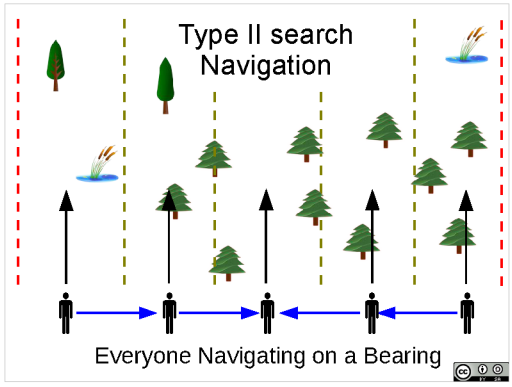


Or, the guide person can be on the edge of the grid line – particularly if there is a boundary (road, trail, flag line, etc) to use as a control line.

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

Constant, within the purposeful wandering in the search lane.

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

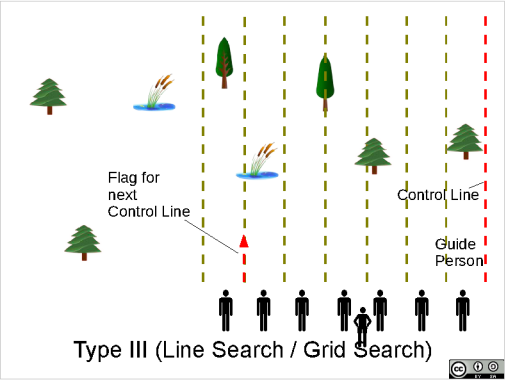


Type II searchers can independently navigate on a bearing.

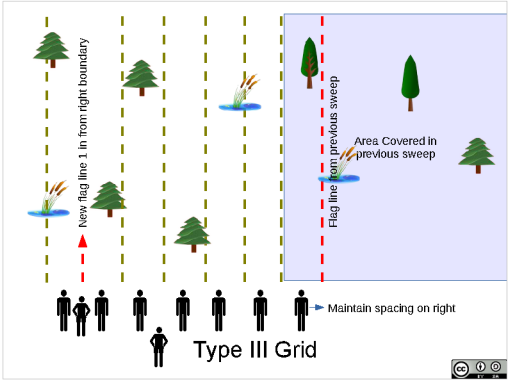
Everyone also seeks to maintain a constant distance between themselves and the person closer to the center (or an edge).

Type II: Purposeful wandering while searching.

Easiest to do with: flag, advance, flag, search back, search forward, repeat

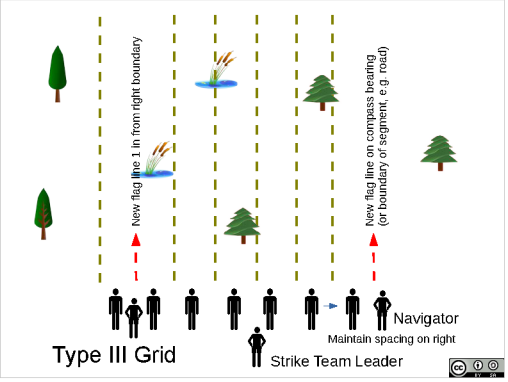


Close spaced grids are inefficient, require large numbers of people, and destroy clues. They use closely spaced subject finders to produce a high probability of detecting a subject in an area.

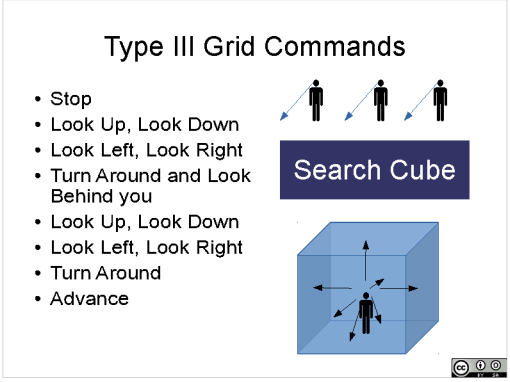


Have one end of the line follow a marked boundary. Instruct each person on the line maintain a constant distance from the person on that side. In this case, everyone walks forward staying six feet from the person on their right.

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

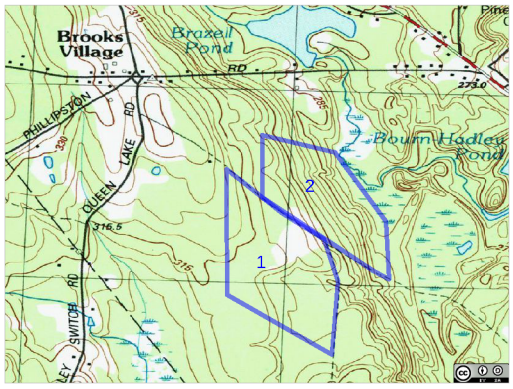


Maintain span of control. Use a relatively small number of untrained searchers mixed with trained searchers.



Area Search Patterns

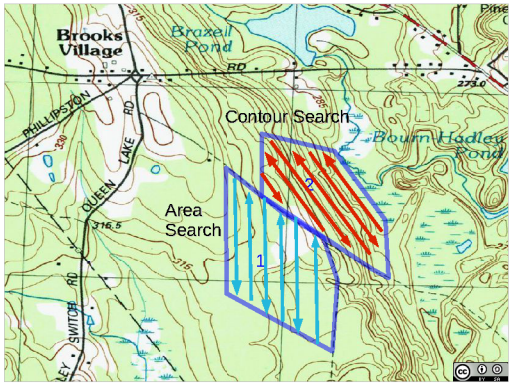
- Area Search (II or III)
- Route (Area) Search (I or II)
- Parallel Route Search (II)
- Expanding Circle Search (II)
- Contour search (II or III)



What is the terrain like in these two segments?

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

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

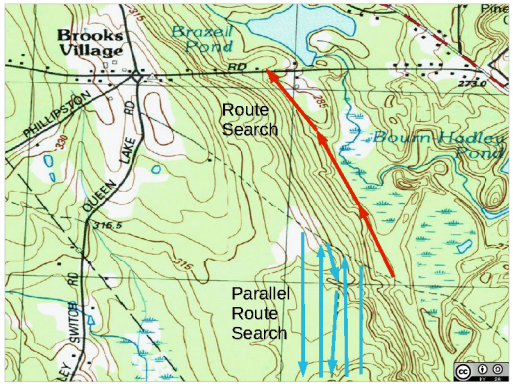


2 might be a good candidate for a contour search: grid sweeps along the contour lines (noting that detection may be higher if you just sweep up hill).

1 is a good candidate for a simple area search.

You could enter a GPS waypoint for the SW corner of 1, or send flag the West or South boundaries prior to starting, or just pace.

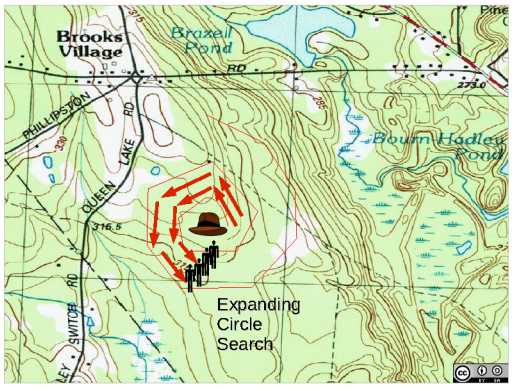
Would the N boundary of 2 be a good candidate for flagging a bump line?



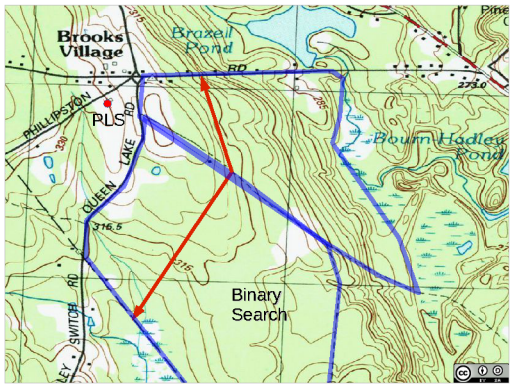
A route search follows a possible travel route.

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

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



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



Binary Search.

Signcut perpendicular to likely direction of travel by the subject.

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

Requires skilled signcutters.

Practical Evolutions:

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

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

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

(4) Type III grid off a base line.