Land Navigation IV
Map and Compass

NEWSAR SAR Field Team Member: Unit 12: Map & Compass. March 3, 2020

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Unit 12, Land Navigation IV. Map and Compass.
Date Last Updated March 3, 2020

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Compasses

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

Compasses

- Orientering/Baseplate
  - Good backup

- Lensatic
  - Can't set declination

- Orientering/Baseplate & Mirror

- Pocket Transit
  - Too expensive – more than needed.

Four typical styles:

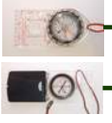
Baseplate/Orienteering – good for basic navigation, make a nice backup, hard to be accurate enough with them for accurate grid navigation.

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

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

Geologist's pocket transit – overkill.

Compasses



- Protractor/Orienteering
  - Can be used as a protractor to measure bearings on a map.

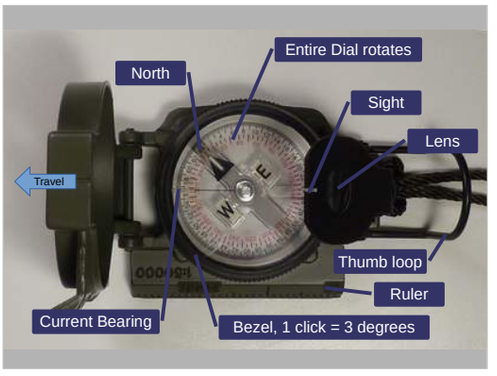
- Lensatic
  - Need a separate protractor

- Pocket Transit
  - Need a separate protractor

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

Lensatic Compass

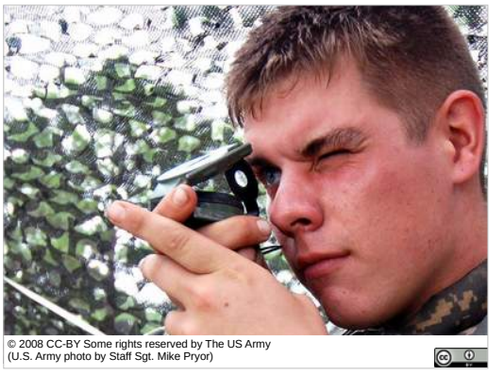
Let's look at the Lensatic compass.



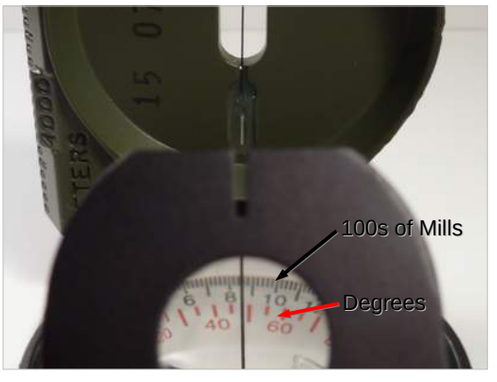
Parts of a lensatic compass

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.



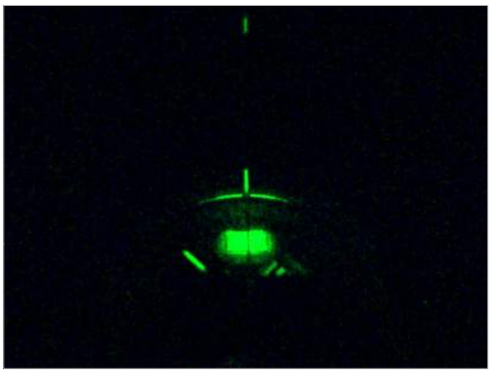
Lens lets you read the bearing on the numbered disk while you sight on a distant object.

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 rotate, so you need to be careful 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.

Angles

- Mill
  - **one mill is 1 meter at 1 km**
  - There are 6400 mills to 360 degrees
- Degree
  - one degree is 17.8 mills
  - **one degree error is about 18 meters in 1 km**
  - 5 degrees error is about 90 meters in 1 km

Mills are useful for thinking about precision of navigation.

One mill is one meter at one kilometer.

About 18 mills to one degree. Thus one degree difference is about 18 meters difference at 1 km of travel.

One bezel click on a lensatic compass is 3 degrees, a navigation error of one click means over a 50 meter error in location when traveling one km.

5 Degrees error is about 90 meters in 1km, about 30 meters in 500 meters. A grid line 500 meters long with a 5 degree error in navigation will end up about 30 meters off – if your grid spacing is 100 meters, that's one third of your grid spacing...

Baseplate/Orienteering Compass

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

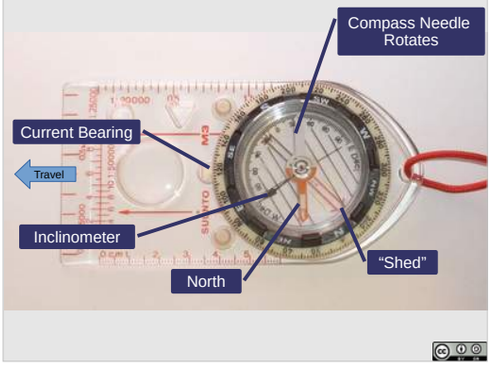
May have adjustable declination.

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.

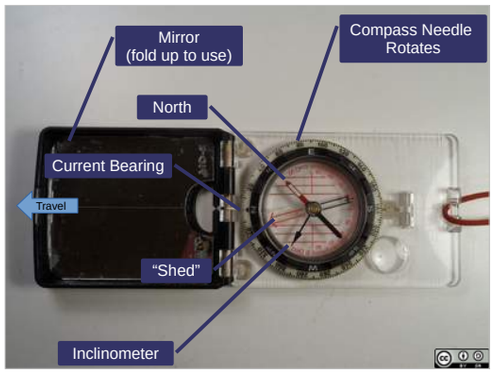
Holding a baseplate compass

- Shoulders square to target.
- Hold at waist level.
- Look straight ahead at target.
- Look down at compass, adjust and read bearing.
- Navigating on a bearing: Move, looking at compass and target until you are square to the target.

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.

Holding a compass

- Baseplate
  - Waist level
- Lensatic
  - To eye
  - Waist level (folded flat)
- Mirror
  - Eye level, away from face
  - Waist level (folded flat)

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.

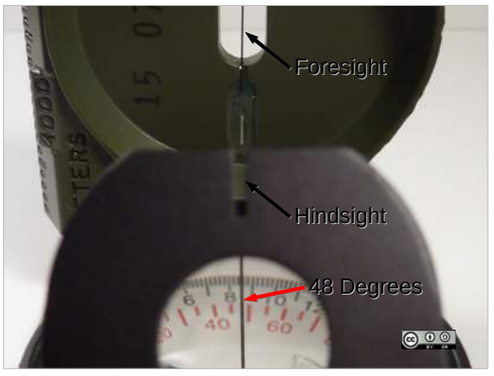
Not next to metal objects...

- Compass needle orients to north in the local magnetic field.
- Nearby magnetic objects (vehicles, radios).
- Nearby metal objects (metal tables, rebar in reinforced concrete)
- Iron Ore deposits
- Local natural magnetic variation

Be careful of where you hold your compass – magnetic objects will affect it, metal objects can affect it. In some areas, there is local natural magnetic variation, particularly in areas where there are iron ore deposits (e.g. Michigan).

Sighting and shooting a bearing

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

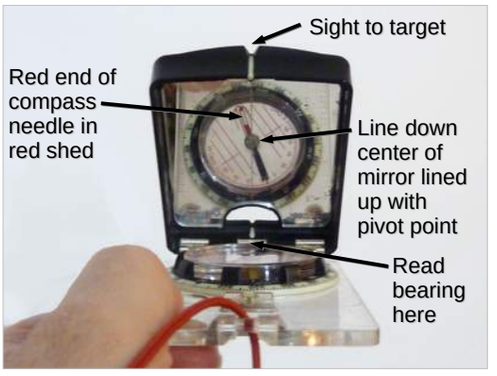


With a lensatic compass, line up the foresight, the hindsight and the thing you want to navigate towards.

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.



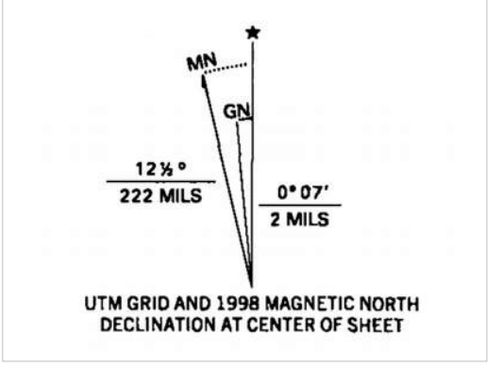
With a mirrored base plate compass, hold level (move side to side to make sure the needle swings free), line up the line down the middle of the mirror with the pivot point of the compass needle.

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?

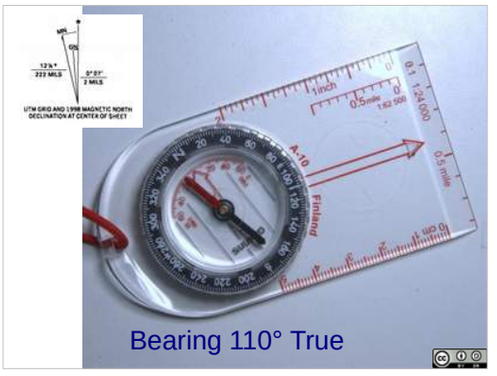
Declination & Adjustable Compasses

- 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.

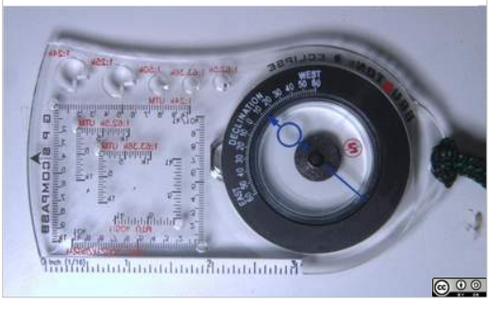
The bearing (at the direction of travel end of the dial) is 110 degrees, thus 110 magnetic.



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.

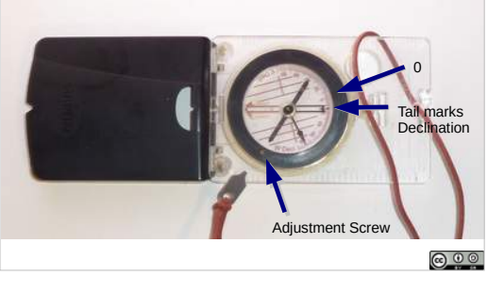
Declination Adjustment



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.

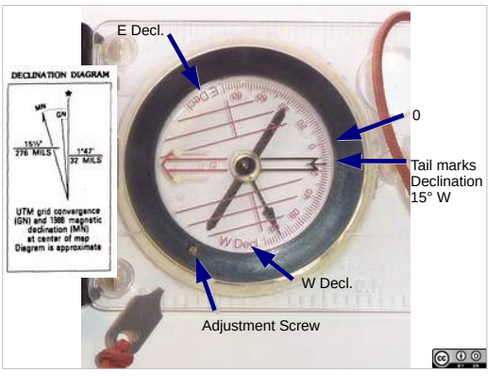
Adjustment is a friction fit in some compasses (press the capsule with the compass needle in it between thumb and forefinger and twist the bezel)

Declination Adjustment



Mechanical adjustment screw in other compasses.

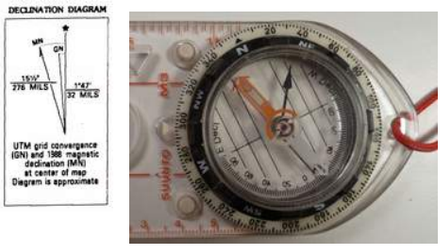
Here the tail of the orienting box (the black end of the shed) points to a declination scale marked in degrees E and W declination.



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.

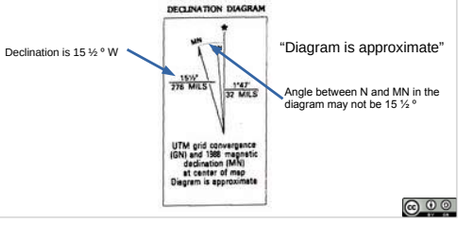
Magnetic-True Conversion Handout.

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.

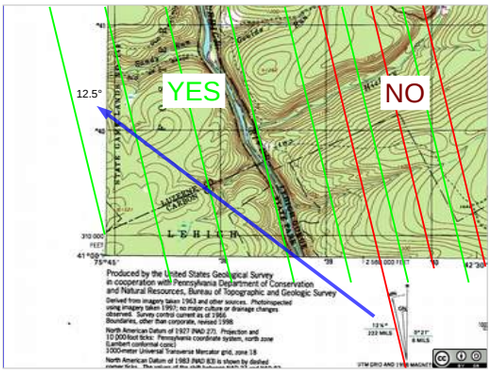
Most effective way to work when compasses can't be adjusted for declination is to put all communications in magnetic north, conversion only happens when someone needs to work with a map.

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



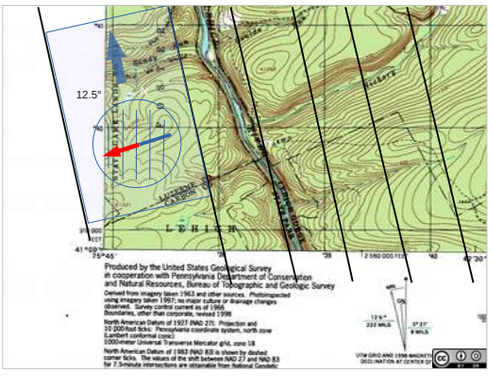
You can also mark up a map with magnetic north-south lines, and read magnetic north directly off the map.

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.

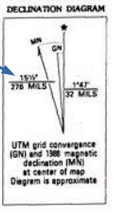


You can use your compass as a protractor to start the lines – set the dial to the number of degrees of declination, line up the lines on the base of the dial with the edge of the map, sanity check that the edge of the compass is lined up with the magnetic north line on the declination diagram, and draw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

What happens if you don't account for declination?

15 ½ ° W



Here, the declination is 15.5 degrees west of north.

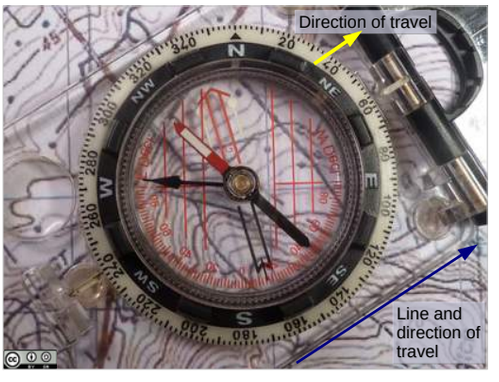
If you travel 500 meters on a bearing in this area without accounting for declination, how far will you be off?

Recall: about 18mil per degree, one mill 1 m at 1km.

5 degrees, about 90 meters at 1km, 15 degrees, about 270 meters at 1 km, 15 degrees, about 130 meters at 500m.

What if you dial in the declination, but put in 15E instead of 15W? About 270 meters error at 500 meters traveled...

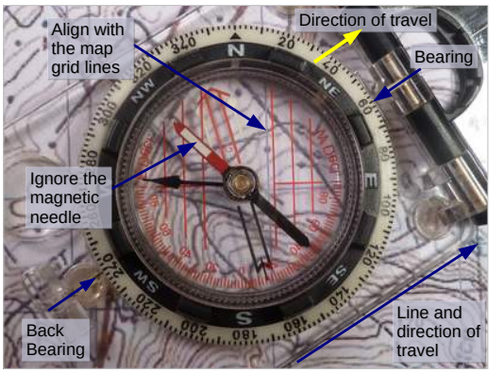
You can use your baseplate compass as a protractor to measure bearings from one point to another on a map.



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

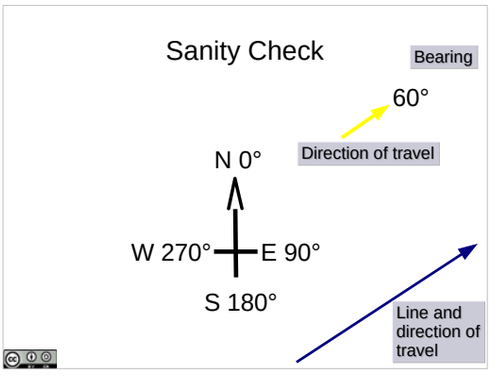
Lay the compass on the map, edge of the compass along your line, the mirror (or direction of travel arrow) of the compass pointed in the direction you want to travel.

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



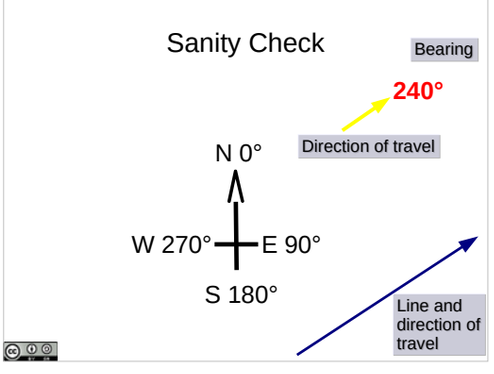
Rotate the compass bezel until the lines in the back of the dial line up with the north-south grid lines on the map.

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



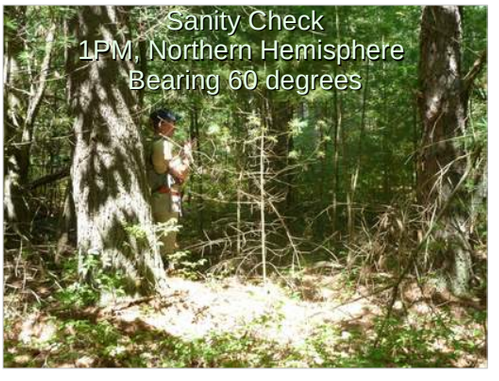
Now sanity check your results.

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.

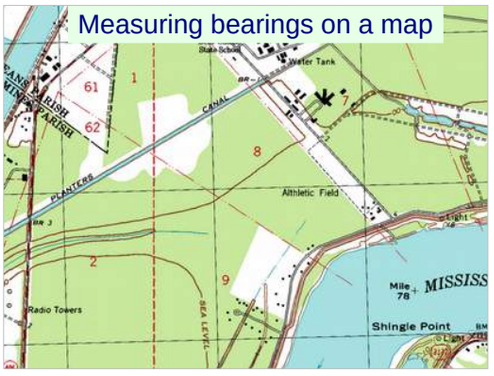


It is 13:00 in the northern hemisphere. The searcher is traveling on a bearing of 60 degrees true.

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 (1) Determine Bearings on map.

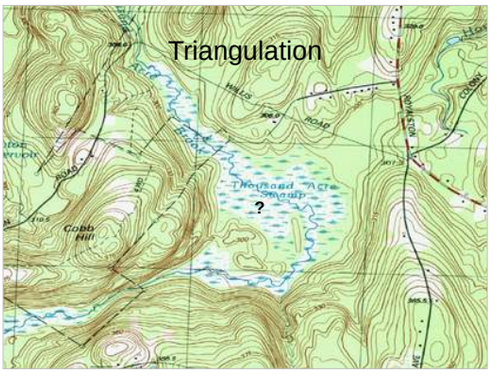
On USNG Training map:

Set declination (1 degree east).

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

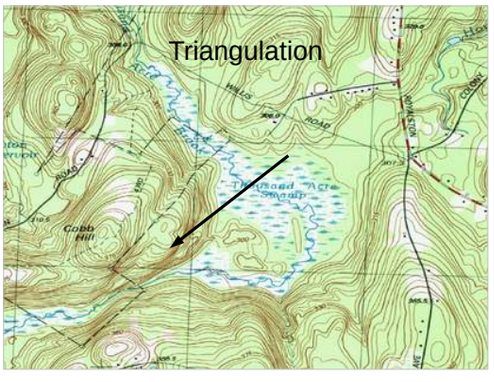
Measue the back bearing (from the water tank to the light).

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.

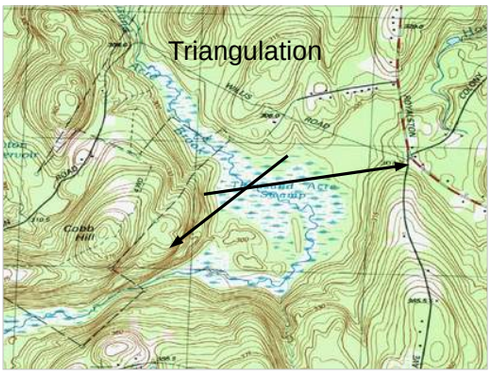
Where in the swamp am I?



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.

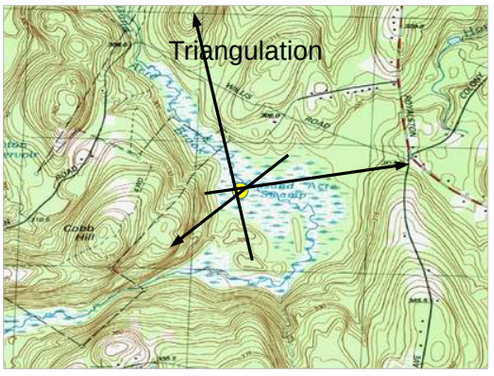
Draw a line on the map passing through where you think you are and the landmark. You are somewhere on the line.



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.



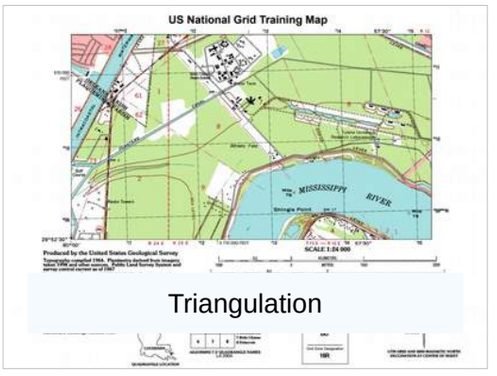
Add a third line.

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 (2) 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). Why not?

Go outside and do practical evolutions 3-7
(3) Orient Map to North with a compass.
(4) Orient Map to North by landmarks.
(5) Shoot Bearing, (6) Shoot bearing and plot on map.
(7) Triangulate location.

Hazards and Risk Mitigation

Unit 13: Hazards and Risk Mitigation

Date last updated: February 21, 2020

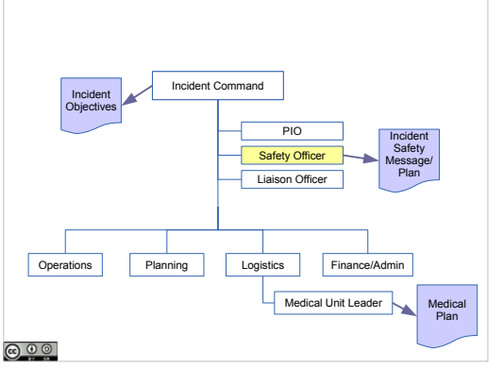
Hazards and Risk Mitigation

- Goal: Everyone goes home safe.
- Objective: Ensure the safety of all responders and the general public throughout the entire duration of the incident.
- Follow a Risk Management Process

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.

Then follow a formal process for operational risk management. We'll talk about the Cyclical Risk Management Process here.



ICS embeds several functions and documents to support safety and risk management.

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.

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.

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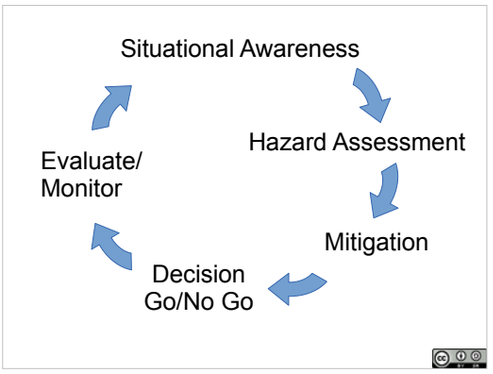
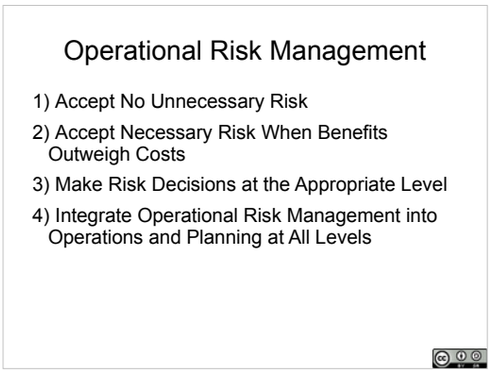


Here's a way of thinking about managing risk:
Cyclical Risk Management Process:

Starts with situational awareness.
Then assess the hazards.
Then determine mitigation measures.
Then make a Go/No Go decision. Weigh the risks after mitigation and the benefits.
Then evaluate and monitor.
And back to situational awareness – is the situation changing?

Continually update and revise your image of the mission.

This model is for **everyone** in an incident, not just the safety officer. Maintain situational awareness and analyze the situation.



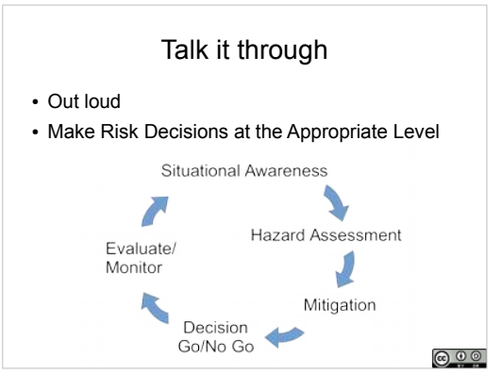
A number of federal agencies involved in SAR have adopted an Operational Risk Management approach.

This includes asking if risks are necessary, and performing a risk benefit analysis.

That's sometimes expressed as: Risk a little to save a little, risk a lot to save a lot.

Then there's what we are doing here – thinking about risk management a all levels, including the lowest level responders in the field.

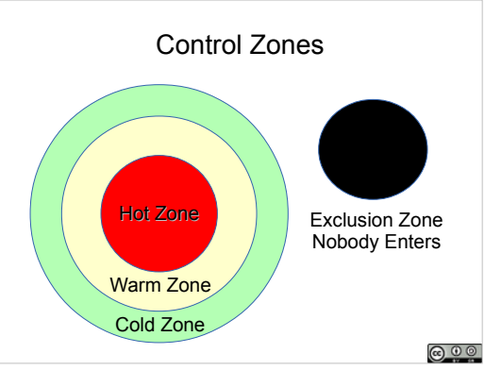
With that goes having the right people in the ICS structure make risk management decisions.



Talk the situation through out loud (even if you are alone – this slows down your brain and helps you think through the situation more clearly).

Don't be afraid to go up the chain of command in assessing risk.

It is always appropriate to raise safety concerns up the chain of command. Site Safety Officer, IC, Safety Officer could all be appropriate levels for assessment of hazards, consideration of mitgation measures, and a go/no go decision. That all depends, however, on you maintaining situational awareness, monitoring changing conditions, and communicating about hazards.

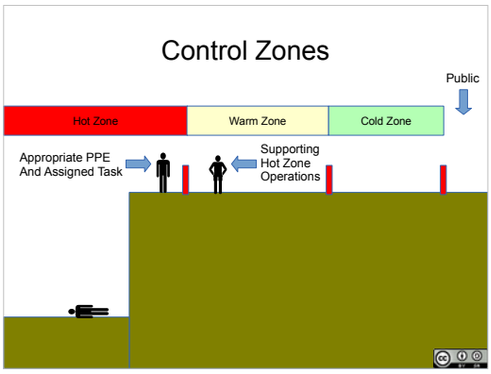


One tool for risk mitigation is Hot/Warm/Cold zones.

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.

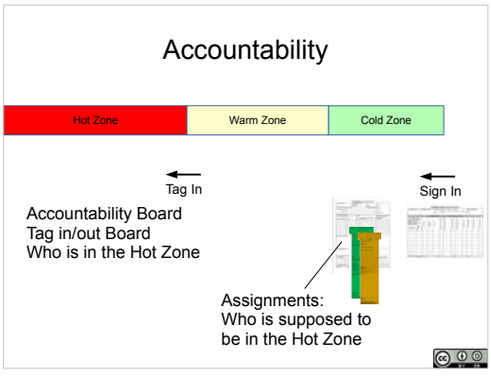


This course doesn't prepare you to operate in the hot zone, or to support operations from the warm zone.

Treat 10 feet from an edge as a hot zone.

Gravity is dangerous.

Who is in harness in this image?



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? (poison ivy)

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

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.

Discuss.

What is 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

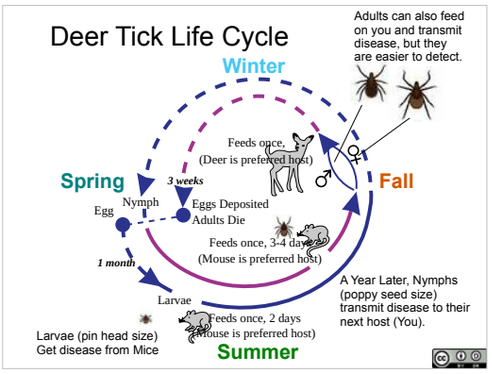
Wetlands – shady swamps and bogs.

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

Poison Ivy and Poison Sumac are 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.

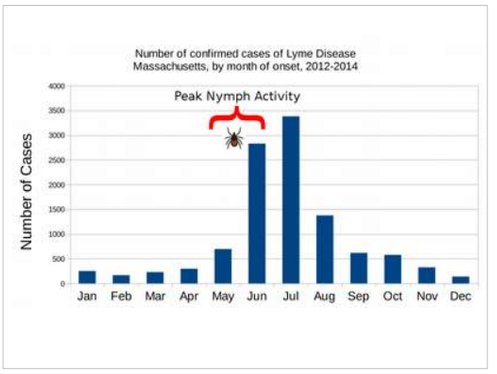


Deer ticks have 2 year life cycle. But, Ticks can be about at **any time of year**. Disease transmission peaks in Spring/Summer, but happens year round.

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.

Emphasize the year-round message for everyone in April-May, before the peak nymph activity.

Sunburn.

Short term: Painful
Long term: Increased risk of skin cancer.

Mitigation: Clothing, sunblock.

Human Hazards

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

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?

What do we have here?

What hazard can't we see here?

Bear cubs come with a mother bear.

What hazards exist in searching this terrain?

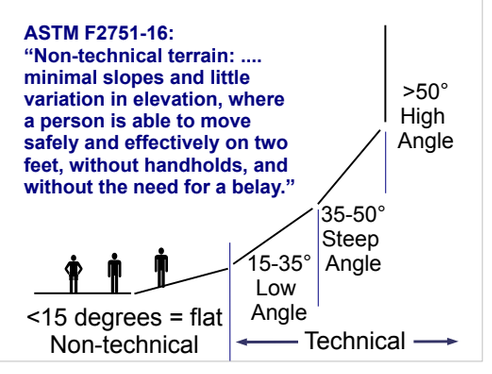
Gravity.

Gravity moving large rocks.

Slip and break an ankle/leg/neck/head.

Risks: Fall hazards, falling objects, trip hazards, unnecessary personnel.

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



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 (non-technical)
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.

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.

Stay out.

You may get or seek out high angle rescue training.

Water

- Drowning
- Hypothermia
- Currents
- Contaminated water
- Unsafe shorelines
- Electrocution
- Confined spaces
- Low head dams, strainers.

Water has multiple hazards associated with it.

Discuss.

Drowning machine.

Very dangerous. Recirculating current at the base of the dam traps things there (including objects that can strike a person trapped in that current). Air bubbles in the water reduce buoyancy – someone wearing a lifejacket can sink in that foaming water.

Trapped in recirculating current, tumbling with logs, striking rocks on the bottom, unable to escape, unable to surface.

Here's a strainer. The branches can catch a body being carried downstream. Or, falling into the water next to it, an undertow can carry you down and trap you in the branches underwater. Likewise a risk for overturning a canoe.

Shorelines can also be dangerous – undercut banks and , slippery ground, can drop you in the water. There can be debris along the shoreline.

Potentially difficult places to search.

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.

Extensive training, support, equipment, and documentation is needed for working in and around permit confined spaces.

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.

What sort of hazards do you see here in a disaster environment?

(Visible are at least: potential for Secondary collapse, Hazardous materials, Risks of fire, damaged utilities, electrocution, Debris....)

This is a very different sort of environment that search and rescue operations in a missing person incident.

Many many more concerns, including safety and logistics. Seek additional training for operations in this environment (including wide area search). Wilderness SAR resources may be asked to help in early phases of response in a local disaster.

A Fish and Chip shop in North New Brighton, Christchurch, NZ, on Feb 23, 2011, following Feb 22 earthquake.

But in normal missing person incident search and rescue incidents we:

Check Structures.

Structures can be abandoned....

What hazards might be present here?

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

Structural Collapse

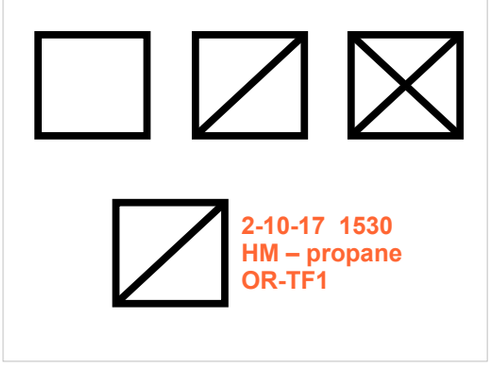
Risks in abandoned buildings and disasters

- Secondary collapse
- Toxic atmospheres
- Hazardous materials
- Risks of fire, explosion, damaged utilities, electrocution
- Collapsed floors, rotten floors, unsound floors
- Debris
- Animals
- etc...

Both abandoned buildings and disaster situations can have similar hazards around structural collapse.

Don't make assumptions about abandoned structures (the floor might not be there).

Maintain situational awareness. Assess hazards.



In a Disaster, USAR Structural Engineers mark for hazards:

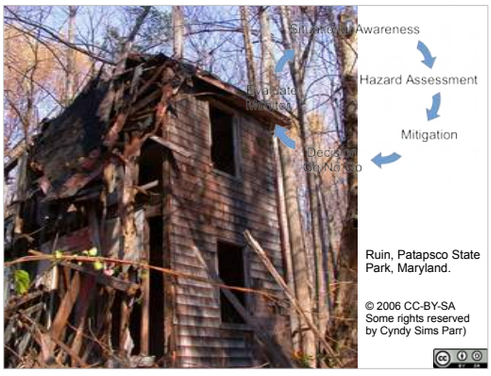
FEMA USAR Structure/Hazards Evaluation marking system.

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.



So, here's a structure you encounter during a missing person search.

Discuss (Cyclical Risk Management Process).

What is the situation?

What hazards might be present?

What mitigation measures can you take?

Go/No-Go decision.

What are you going to monitor and evaluate if you enter?

How are you going to mark this structure?

Risk Mitigation

- Stay out
- PPE
- Obtain properly trained and equipped help.

Situational awareness – it's an abandoned building, it has hazards.

Hazard assessment – what are the hazards

Can we mitigate them? Do we have the appropriate PPE, equipment, training, etc?

Go/No go decision – may very well be: No Go, mark the structure, call it in for properly trained and equipped resources to search it, and move on.

General risk management process applies to all technical rescue settings: water, confined space, structural collapse, high angle, etc.

Weather

- Heat
- Cold
- Lightning
- Snow
- Avalanches
- Rain, floodwater

"Lightning" © 2006 Attribution Some Rights Reserved Przemek Więch "PeWu"

Weather poses hazards (both in training and in searches)

"Lightning strikes" © 2014 Attribution Some Rights Reserved John Fowler "snowpeak"

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.

Fatigued driving has killed searchers.

In extended deployments, make sure that accommodation (including for canines) is quiet and restful.

Exposure to bloodborne pathogens is a risk. You should be receiving regular OSHA compliant bloodborne pathogens training and refreshers.

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.

Prolonged incidents, with fatigue, with media attention.

Prolonged incidents where the subject was not found.

All sound familiar to experience searchers.

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 (by trained professionals)
- 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 stressful incident, seek critical incident stress debriefing from trained professionals (should be offered, but not mandatory.) What are agency processes for setting up CSID debriefings?

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?

That's very much in the domain of the handler: Training a strong recall, strong leave it, train critters as distractions.

And, work to expunge self rewarding crittering behaviors.

Hazards for SAR Canines

- Poisons
- Human foods that are toxic for canines
- Other Animals (Porcupines, Snakes, etc.)
- Paw/Limb injuries
- Heat
- Automobiles
- Tick Borne Illnesses

Some hazards.

Discuss.

Discuss mitigation.

Note that common foods can be toxins for dogs: Chocolate, artificial sweetener Xylitol.

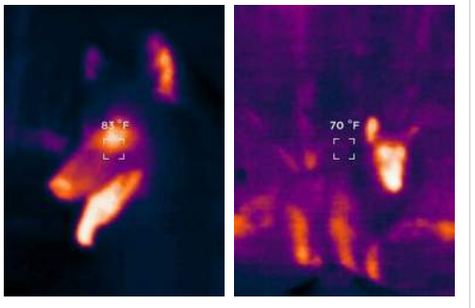
Mitigation (Poisons, Automobiles, Animals)

- 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

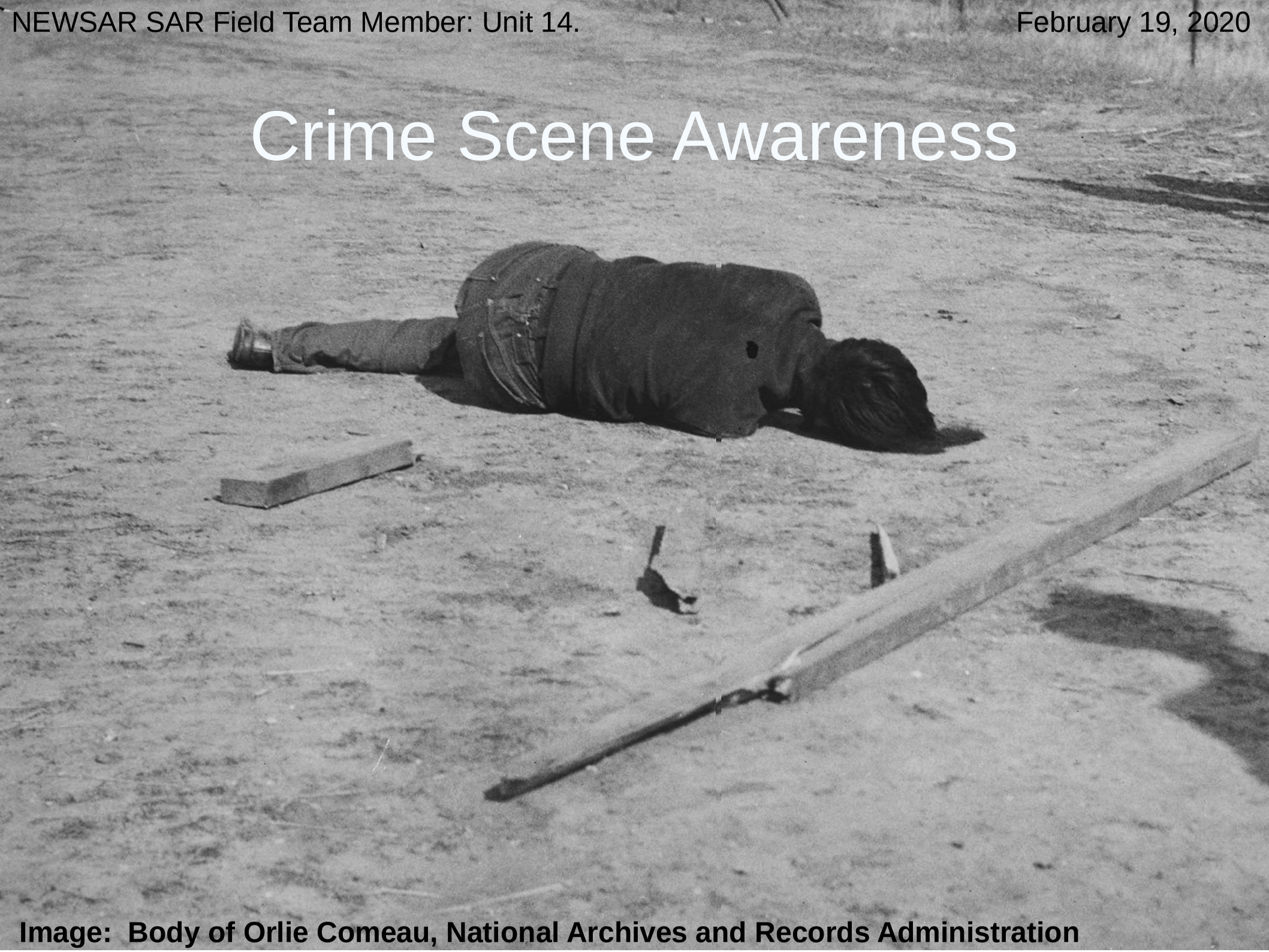
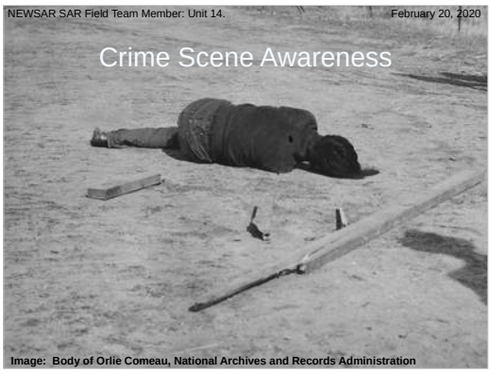


Image: Body of Orlie Comeau, National Archives and Records Administration



Unit 14: Crime Scene Awareness
Date Last Updated: February 20, 2020

What is your first concern?

Safety

- Some Hazards
  - Armed subject
  - Subject with altered mental status
  - Body Fluids (Blood-borne pathogens)
  - Perpetrator
  - Chemical Suicide
  - Clandestine Drug Labs
  - .....

What is your first concern?

Safety.

Your own safety.

Other responders safety.

What are some hazards around clandestine drug labs?

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.

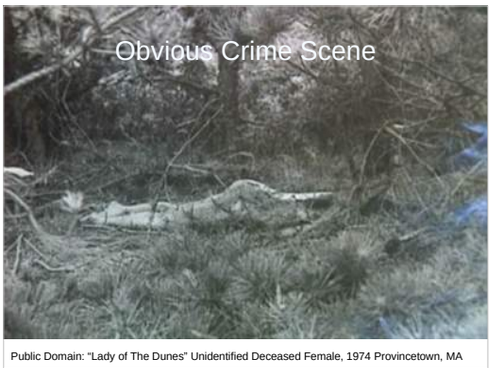
Situations

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

Two sorts of situation to consider:

Obvious crime scene.

Potential clue.
Something which might influence the last known position.
Something which might become a crime scene.



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

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.

Chain of Custody

- The **written** record of **all individuals** who maintained **unbroken control** over evidence.
  - Who had contact with the evidence
  - When was the evidence handled (dates and times)
  - Why was evidence being handled
  - What changes were made to the evidence

Maintain Chain of Custody

Written Record.

Who was involved.

When was the evidence transferred from one person to another – documenting a continuous chain of custody from original collection of the evidence to the courtroom.

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.

Clues can be

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

In clue detection, we thought about clues as being seen, heard (including from investigation), felt, or smelled.

In thinking about crime scenes, we think about these as evidence.

Evidence

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

Evidence can be physical or incorporeal.

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? (you write it down).

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
- **If** the authority having jurisdiction has approved it: 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, but, **if you take an image with your own camera or phone then 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. **But only use with approval of AHJ. Policy varies, some AHJs discourage images for any reason.**

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.

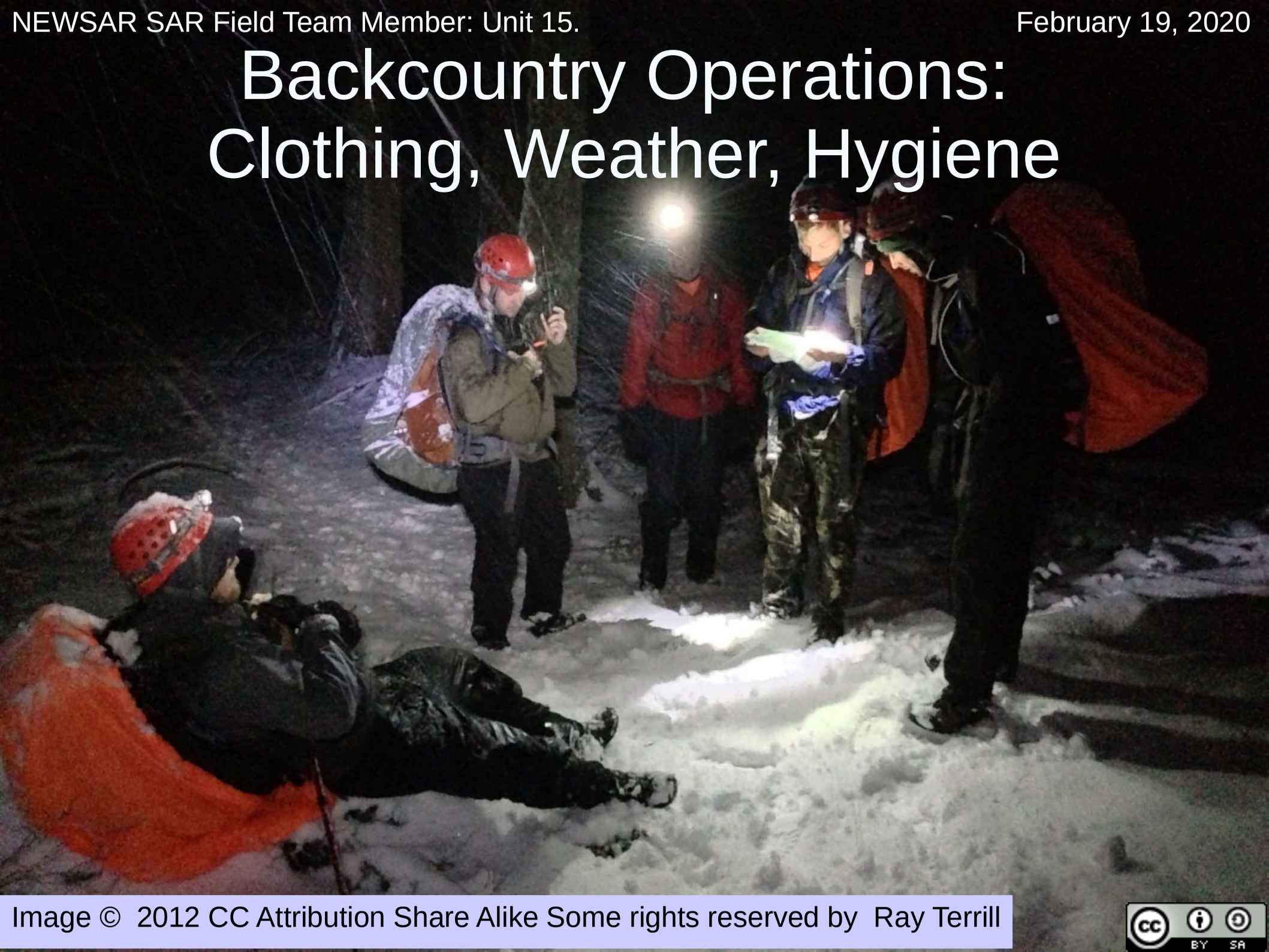
Limit and document contamination of the crime scene.

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 15, Backcountry operations: Clothing, Weather, Hygiene
Date Last Updated: February 20, 2020

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.

Fittness

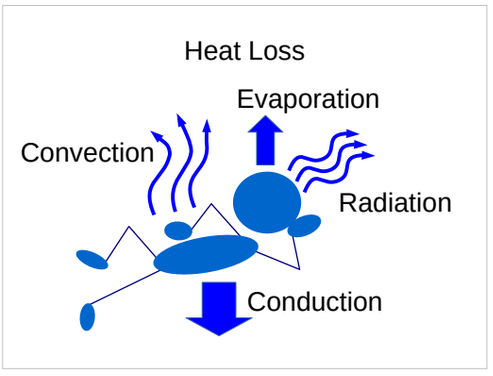
- One possible benchmark: US Forest Service Wildland Firefighter Moderate Work Capacity Test (NWCG PMS 307)
  - 2 mile hike
  - with 25 lb pack
  - in 30 minutes (4 mile per hour pace)

How fit? Consider the mission: Typically: Hiking, off trail, in irregular terrain at a walking pace, carrying a 24 hour pack for 4-8 hours. In a litter carryout, add a 30-40 pound load.

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.

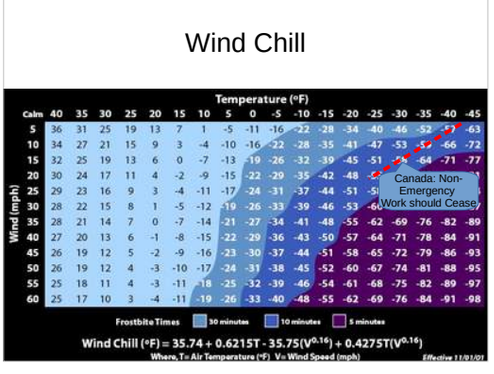
- Air is a good insulator
  - Unless it is moving
- Water is good at conducting heat
  - Evaporating water is very good at removing heat.
- The ground is good at conducting heat

- 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

Key concepts for controlling heat loss:

Air is a good insulator.
Unless it is moving, convection/bulk transport of air are good at removing heat.
Water is good at conducting heat. Things that are wet are poor insulators.
Evaporating water is good at removing heat – it takes lots of heat to change water from a liquid to a gas.
The ground (rock, soil, damp leaves, etc, tends to be good at conducting heat).

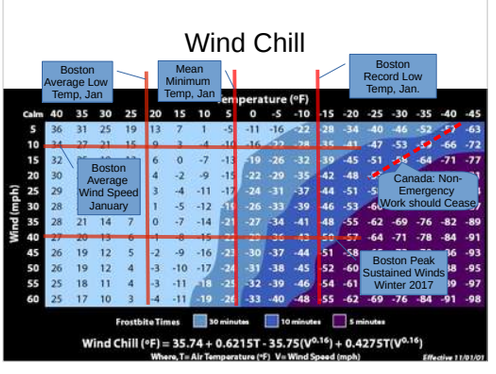
So Exploit these key concepts to stay warm or cool:
Stay warm: Stay dry, trap air (insulator) next to your skin.
Stay cool: Let moisture evaporate from your skin, let the wind transport air away from your skin.



Air is a good insulator – unless it is moving.

Convection – air next to your body warming and rising because it is warm, or (usually more significantly) Bulk Transport, 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.

In Canada, there is a recommendation that all non emergency work should cease below wind chill conditions that run about down the middle of the frostbite in 10 minutes region of this chart.



Now consider typical conditions in your area of operations.

Here are average January low temperatures and wind speeds in Boston (meeting at around a wind chill of 10 degrees F), and mean minimum temperature (and record low temperature) along with the peak sustained wind speeds in the winter of 2017.

In New England, in January, operations into wind chill conditions that get into the time to frostbite for exposed skin of 30 minutes are very plausible. Conditions down into the time to frostbite of 10 minutes are possible.

Search assignments are likely to be several hours in duration. In New England, you need to plan to have workable winter clothing for search operations into exposure periods where frostbite of exposed skin can be anticipated within the time of an operational assignment.

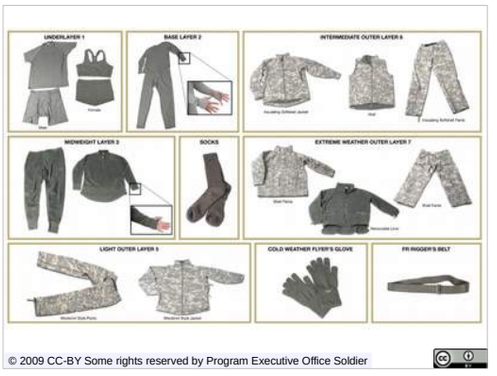
Adjust to Change

- The Environment Changes
- Your Activity Levels Change

But, if you just bundle up very warm, and go trekking through the woods, what happens?

You are exerting yourself and you sweat. What is sweat next to your skin? What does it do?

Your means of keeping warm or cool - your clothing system needs to be able to adjust to change.



Thus, wear layers.

Here is an example of a military clothing layering system.

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

Layered clothing – with ventilation

You can open or close layers.

You can open or close ventilation openings (e.g. armpit zippers).

Wicking

For layers: Think three functions: Wicking, Warmth, Wet/Wind

Innermost layer: Wicking: Draw moisture away from your body.

Why?

(Water is good at conducting heat. Air is a good insulator.)

This is the ECWCS GEN III: Lightweight Cold Weather Undershirt/Drawers, "silk weight" polyester.

Warmth:

Layers for warmth.

Add more when you are inactive (before you start feeling cold).

Wet/Wind: Outer shell.

Outer shell to block wind or water.

Why block wind? (block bulk transport of warm air from your body)

Why block water? (water conducts heat away from your body, you want to trap air in dry fabric as insulation).

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).

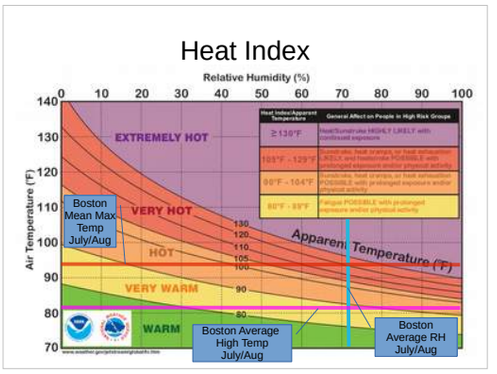
Do you think this person could focus their attention on a search assignment?

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.

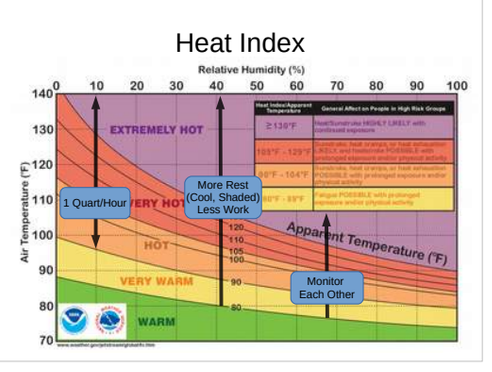
What are the risks of working in the heat?

What can you do to mitigate those risks?

Drink plenty fluids when working in hot weather.

Aim for about 1 quart per hour.

Avoid Caffine.



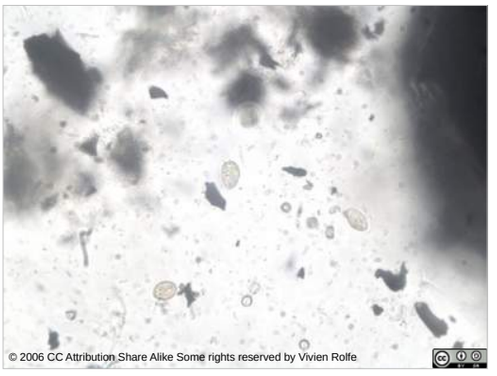
Three things we can do when it is hot:

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.

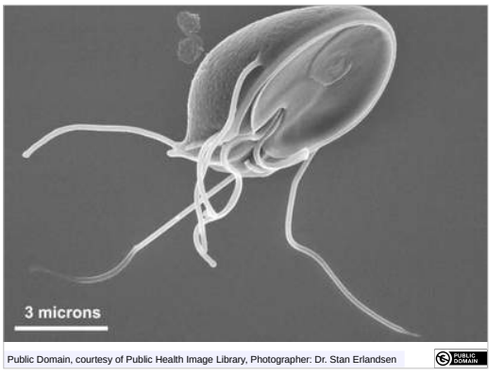
Do you want to drink from here?



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.

CDC preferred method for disinfecting water: boil it.

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. ("if you can't make it clear you can't make it clean")
  - Chemicals: Iodine, Chlorine, Chlorine Dioxide
    Some protozoans, bacteria, viruses.

Specifically CDC recommends: Rolling 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.

Water Disinfection

- UV treatment (combined filtration and UV treatment)
  - Limited to clear water
  - If you can't make it clear you can't make it clean
  - Pre-filter water
  - Follow manufacturer's directions.

Or you can use filtration and UV treatment.

UV treatment methods don't work with muddy water.

Filter it first, then UV treat. Follow manufacture's directions for the UV treatment equipment.

Handout: CDC guidelines

Either Boil for 1 minute minimum (CDC recommendation), or combined chemical disinfection and filtration, or combined UV treatment and filtration.

Toothbrushing is also key for hygiene.

Staying overnight, either in the field, or away from home: Change your socks, brush your teeth. You'll be a happier, healthier, more comfortable, more effective searcher.

Most toothpastes contain the artificial sweetener Xylitol. It is toxic for dogs. You might overnight with a canine, consider careful selection of toothpaste and food for your 24 hour or 72 hour pack supplies.

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.

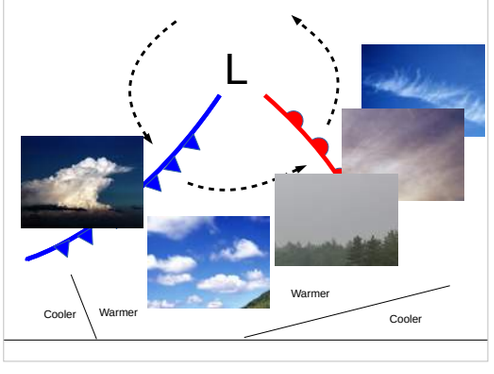
Bury at least 8” deep.

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.

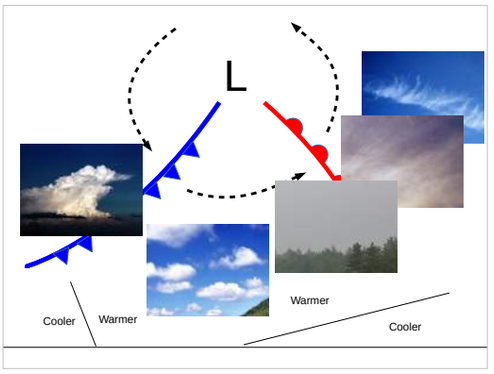
Puffy cumulus clouds.

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?



Frontal theory lets you put wind direction and how the clouds are changing together to think of where you are with respect to low pressure systems, and from there make a rough weather forecast in mid-latitudes.

NEWSAR SAR Field Team Member: Unit 15: Backcountry Operations. February 20, 2020

Basic Survival

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

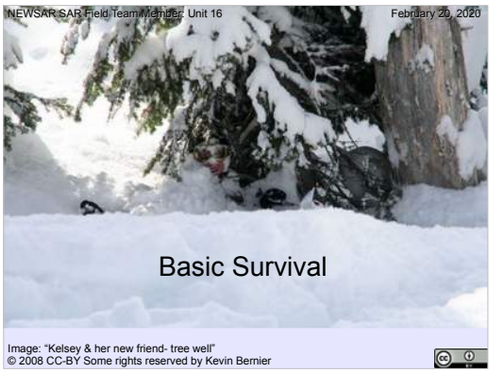


Image: "Kelsey & her new friend- tree well"

Unit 16: Basic Survival
Date Last Updated: February 20, 2020

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.

Talk it through

- Out loud
- To yourself, to a squirrel...
- Out loud

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.

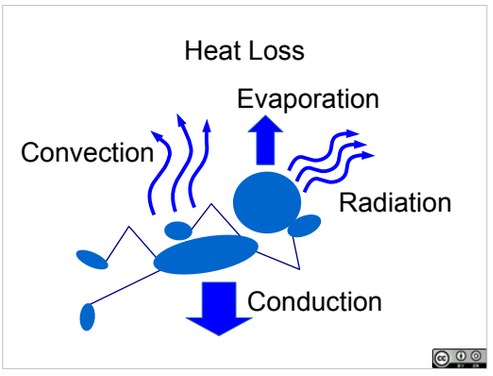
Hypothermia

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). (Mechanism is bulk transport + evaporation).

STOP: Plan: top priorities: first aid, **shelter**, fire, signals, water.

Understanding heat loss pathways can help you build an shelter.

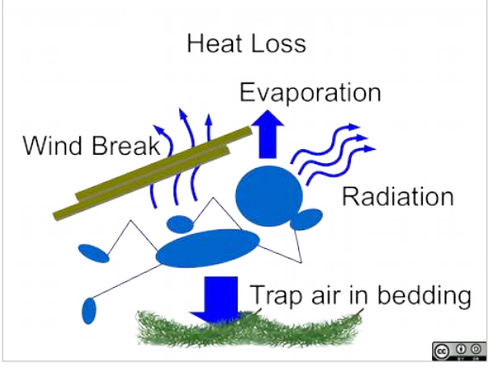
Heat is lost by convection/bulk flow: build a wind break.

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 message: Top priorities in Plan: first aid, shelter, **fire**, signals, water.

What is fire good for?

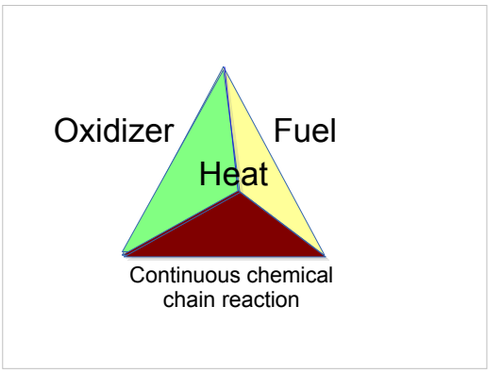
Discuss.

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.

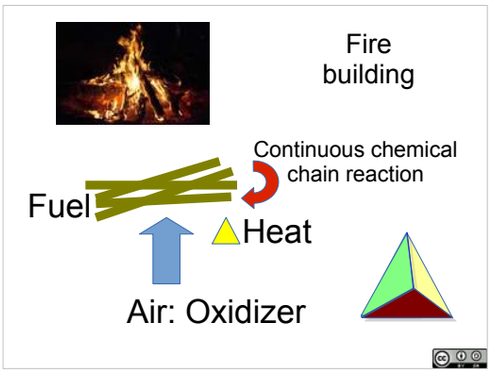
Fuel – something to burn.

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.

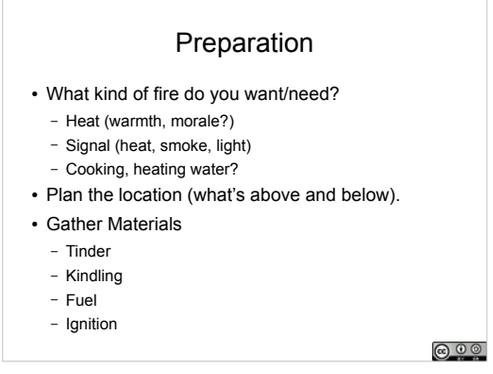
You need to add heat.

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.

There might not be enough kindling for the fire to grow beyond burning the tinder (might not be able to get the enough heat to establish the continuous chain reaction in the main fuel).

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)

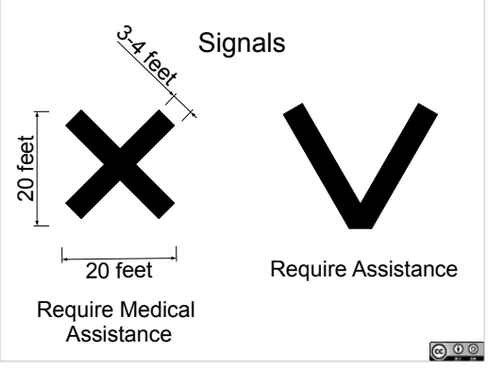
Think about what is below the fire. Will it burn? Does it maintain a draft of air into the fire? Will it shatter when heated (wet layered sandstone)?

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.

Have all the materials you need gathered and on hand – tinder, kindling, main fuel, and ignition source – before trying to light the tinder.



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

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.

Audience & Methods

- Flashlights
- Strobe Light (flasher)
- Mirrors
- Sound: whistle
- Smoke
- Radios
  - Amateur Radio Wilderness Protocol (2m calling frequency for 5 minutes after each hour)
- Satellite (PLB, ELT, Phone)
- Rescue laser beacon

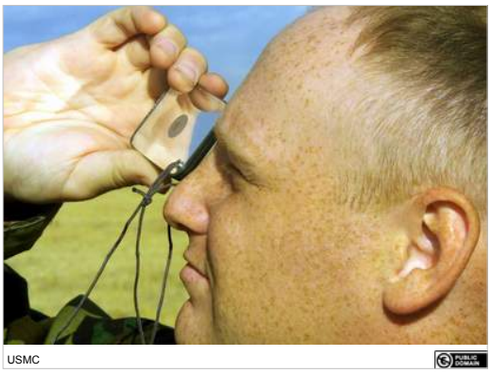
Think – who are you signaling to? Who is the audience for your signals?

How can you signal to them?

Will different sorts of signals have different effectiveness for different audiences? Will a plane hear whistle signals?

What means to signal do you have on hand?

What means do you have to improvise signals?



USMC

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.

Signals Ground to Air Realtime

Require Medical Assistance

All OK

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

Audience: Ground Searchers

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

Think – who are you signaling to?

Ground searchers?

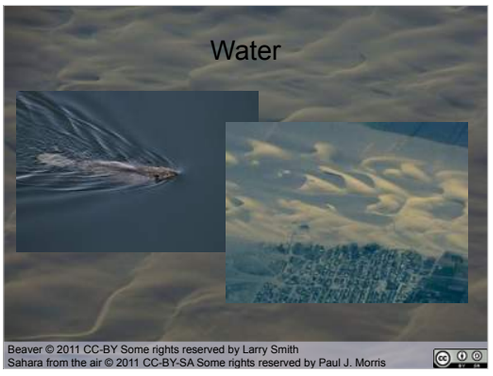
How can you signal to them?

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?

You probably want to respond to sets of three gunshots with sets of two whistle blasts.

What are the advantages and disadvantages of each method?



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.

Improvise

Stop
Observe
Think
Plan

You won't be carrying everything you want.

You will need to improvise.

Key to improvising is thinking about Function.

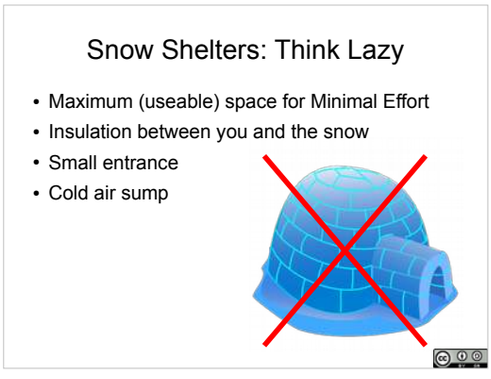
I need to keep my feet dry – what do I have that can serve that function.

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.

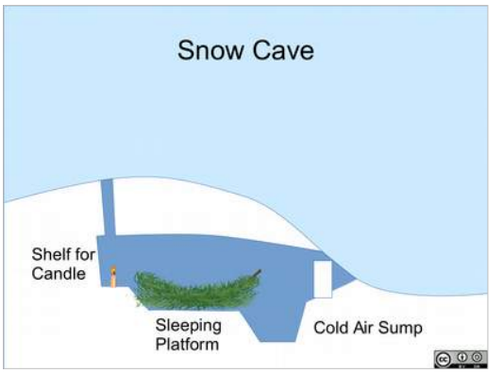
Think Lazy. How can I get the maximum amount of usable shelter space with the least effort?

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?

- What you can count on is what you have:
  - in your head
  - 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.

We'll come back to this.

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 it sure helps on the psychological front
- And it makes a HUGE difference in your ability to keep working (and think rationally)!
- Hot drinks
- High caloric content in low volume & weight

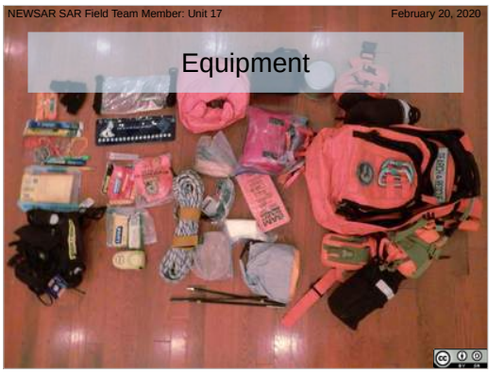
Don't worry about food.

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

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

Which is better for warmth: A cup of hot water, or a cup of cold sugar water? (the sugar, there is more energy available in the calories there than in the heat in the hot water – hot is good psychologically as well).

Equipment



Unit 17: Equipment
Date Last Updated: February 20, 2020

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, resource type….)
  - No point in carrying stuff you don't know how to use
  - Sharing the load
- Survival: Things on your person.

What should you carry for SAR (training and missions)?

Why?

Discuss.

Expectations

- ASTM 2751-16 (Land SAR Member): Self sufficient for 24 hours; perform duties in expected conditions, including darkness.
- FEMA Resource Types:

  The ability to be self-supporting for 24 hours
  - Type IV, III, and II Wilderness Search and Rescue Team
  - Type III and Type II Canine Search and Rescue Team

  The ability to be self-supporting for 72 hours
  - Type I Wilderness Search and Rescue Team
  - Type I Canine Search and Rescue Team

There are some general expectations for what a search and rescue field team member needs to be capable of: ASTM standard for Land SAR Member specifies ability to be self sufficient for 24 hours with the ability to perform functions, including at night.

Resources that seek to conform to FEMA wilderness SAR resource typing again have expectations to be self supporting for 24 hours (or 72 hours).

Discuss (in terms of missions of represented units).

Tradeoffs

- Weight vs:
- Routine needs (e.g. communications, navigation)
- Consumable Supplies (e.g. batteries, flagging tape)
- Mitigation for likely hazards
- Medical supplies
- Supplies for overnighting (with or without a subject)

Gear has weight and volume...

Essentials

- "10 Essentials" List may vary.
- On your person.

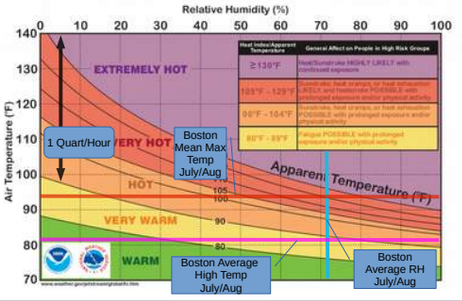
What things do you need to be capable of at all times on a SAR mission or training?

Documentation, navigate, first aid, survival, see at night, etc..

Discuss.

Discuss the importance of these essentials being on your person at all times.

Anticipate 1 Quart/Hour in Summer



Likewise consider local summer averages and extremes.

In July and August in Boston, it is very plausible to be operating in Hot heat index conditions where drinking one quart of water per hour per person is recommended.

This should affect your equipment planning for water carrying needs for summer operations.

Carry out this sort of analysis for the area in which you deploy. What are the typical and extreme summer conditions, and what are the typical and extreme winter conditions.

Food

- High caloric content in low volume & weight
- Water
- Hot Drinks

Estimate your food (and caloric) needs:

Consider:

150-600 cal trail snacks,

2000-3000 cal per day

Hot drinks provide psycholgical comfort.

Drinks with sugar help you warm up more than hot drinks (minimal added heat relative to your cold body mass, sugar can be burned to generate heat).

Food and Overnight

Overnight, hang food out of reach of critters, particularly bears.

Hanging off a small limb at height and distant from trunk...

Pack For the Mission

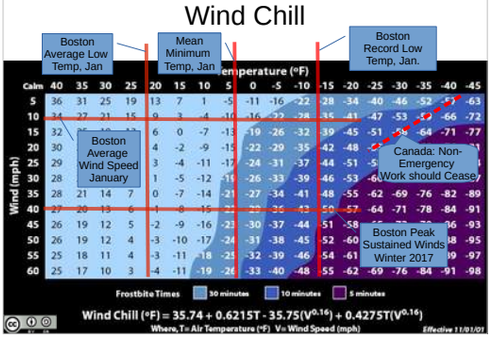
- On Your Person
- Urban/Suburban pack
- 24 hour pack
- 72 hour pack

How do you organize your equipment?

Discuss?

Depends on the mission.

Wind Chill



Consider the extremes of local climate.

Here are average wind and low temperatures for Boston in January – Average low temperature and average wind speed put conditions at a wind chill of 9 degrees F.

And mean minimum temperature, record low, and peak sustained winds for one year in Boston: -20 to -50 windchills and frostbite times of 10 to 30 minutes are quite plausible extremes to plan for in winter operations in the Boston area.

Examine the extremes in your local area. Plan your winter equipment and clothing to match.

Factors

- Weather (including temperature)
- Terrain
- Altitude
- Navigation
- Flora and fauna
- Patient care needs
- Travel time
- Duration of incident
- Logistics (including communications)
- Incident management needs

Discuss how different factors might affect choices of equipment to carry.