SAR Systems, Search Crucials



“Emperor Fraser hits reef and sinks near Dunraven”

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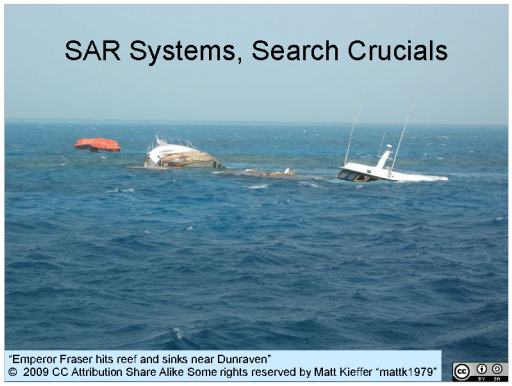

Unit 1, Overview of global SAR systems and introducting the "Search Crucials" - phrases that describe key elements of SAR.

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Search and Rescue

- Search
  - Locate Persons in Distress
- Rescue
  - Retrieve Persons in Distress
    - Access, Stabilize, and Transport persons in distress (LAST)

Two distinct concepts:

Search: looking for a subject who's location is not known.
Rescue: Stabilizing and bringing to safety a subject who's location is known.
(Or: Recovery: Retrieval of the remains of a deceased subject.)

Some SAR missions are purely rescue – the person in distress is at a known location and just needs to be brought to safety, most are primarily search with a much shorter rescue (or recovery phase).

An amplification is LAST: Locate (Search), Access, Stabilize, Transport (Rescue).



What's not quite right with this picture?

Canine is a search resource, not a rescue resource...

Maritime and Aeronautical SAR: International Agreements

- Convention on International Aviation
- International Convention on Maritime Search and Rescue
- SOLAS – International Convention on Safety of Life At Sea

  Parties agree to provide Maritime and Aeronautical SAR coordination and services
- US: NSARC: National Search and Rescue Committee.

There are international agreements concerning SAR for Air and Sea – in essence, governments have agreed to search for missing ships and planes in their territories, regardless of who is on board.

A (simplified example a) Panamanian flag ship in distress off the coast of India will be assisted by Indian authorities, and an Indian plane that crashes in Panama will be searched for by Panamanian authorities.

In the US, to oversee implementation, at the federal cabinet level is the the National Search and Rescue Committee.

Global Coordination

- ICAO: International Civil Aviation Organization
- IMO: International Maritime Organization

- Produce the IAMSAR manual: International Aeronautical and Maritime Search and Rescue manual (3 volumes, with national supplements).
- US: NSARC produces:
  - US National SAR Plan (Federal Inter-Agency)
  - US National supplement to the IAMSAR manual

Global coordination of SAR preparedness activities is through the international civil aviation organization and the international maritime organization – they produce the international aeronautical and maritime SAR manual. Individual countries produce national supplements laying out how they will fulfill their treaty obligations for aeronautical and maritime SAR.

In the US, the National SAR Committee produces a federal cabinet level inter-agency document, the US National SAR Plan that spells out at the policy level the responsibilities of **federal** departments and agencies in Maritime, Aeronautical, and Land SAR. US NSARC also produces the US national supplement to the IAMSAR providing implementation guidance to federal agencies (including the Land SAR Addendum to the US national supplement to IAMSAR).

Land SAR

- There is no international treaty governing land search and rescue within national sovereign territories
- Aeronautical SAR over land :Governed by the Convention on International Aviation
- The US National SAR Plan includes Land SAR responsibilities for Federal agencies.
- Key Agencies: DoD, USCG, FEMA, and the NPS (National Park Service)
- In the US, NIMS/ICS applies at all levels (local/county/state/federal)

Land SAR is not governed by international agreements (except where planes are in distress on land).

The US National SAR plan, however, includes Land SAR responsibilities for federal agencies (in particular the National Park Service for SAR incidents on NPS managed land).

US Federal Land SAR missions may be Aircraft Missions, Distress Beacon Missions, or Non-Aircraft missions.



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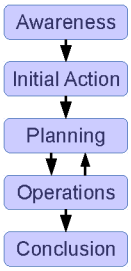
Lets look briefly at systems for maritime and aeronautical SAR

IAMSAR Manual: SAR Stages



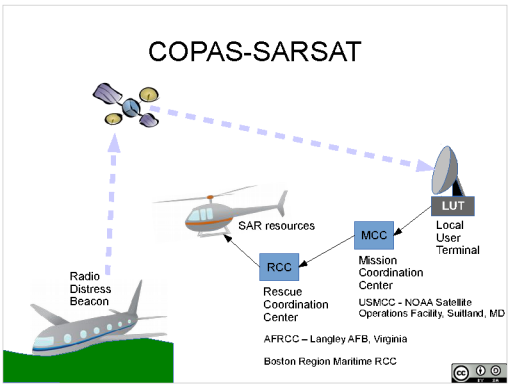
IAMSAR provides a broad picture of the process of SAR operations – dividing into Awareness, Initial Action, cyclical phases of planning and operations, and finally, conclusion.

LAST – locate, access, stabilize, transport – describes objectives during the planning/operations cycles.



Awareness of SAR incidents can come from distress beacons.

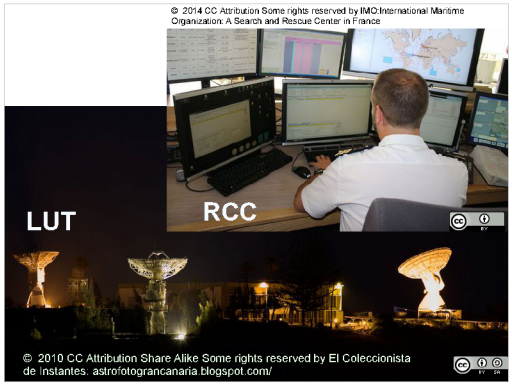
These are supported by a global network of satellites and grounds stations known as COPAS/SARSAT.



COPAS/SARSAT functions through transmission of a signal from a radio distress beacon.

Radio distress beacon sends out a signal, received by satellites, passed on to ground stations (Local user terminals), forwarded on to a MCC which deduplicates satellite signals, adds beacon registration information, and forwards to the appropriate (Rescue Coordination Center), which can then deploy resources.

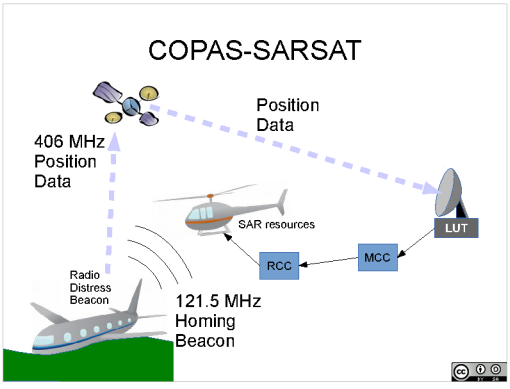
The radio distress beacon may not provide position data, and may need to be triangulated with several satellite passes.



Here's a LUT in the canary islands, and a RCC in france:

Distress beacon->satellite->LUT->MCC: Awareness phase.

RCC coordinates the remainder of the response.



Radio Distress Beacons transmit distress information for reception by satellites on 406 MHz, this can include GPS position data, depending on the beacon.

Radio Distress Beacons also transmit a homing signal on 121.5 MHz for direction finding by SAR resources.

Radio Distress Beacons

- PLB – Personal Locator Beacon
  - Manual activation
- EPIRB – Maritime – Emergency Position Indicating Radio Beacon
  - Activates when submerged in water
- ELT – Aviation – Emergency Location Transmitter
  - Activates on high G forces (sudden deceleration)

Several forms of Radio Distress Beacons that will trigger a COPAS/SARSAT response.

PLB – personal – manual activation.

EPIRB – maritime – activates when submerged.

ELT – aviation – activates on sudden decelearation.



PLB © 2010 CC Attribution Share Alike Some rights reserved by "F1jmm"
EPIRB © 2013 CC Attribution Share Alike Some rights reserved by "GMacMaritime
ELT © 2013 CC Attribution Share Alike Some rights reserved by "Coop-ch"

Examples of EPIRB, ELT, and PLB.

PLB



"ACR ResQLink 406MHz Personal Locator Beacon (PLB) with GPS"
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Another PLB.

Personal Locator Beacons work with the COPAS/SARSAT system.

Non-COPAS/SARSAT SENDs

- SEND - Satellite Emergency Notification Device
- Like a PLB – Personal Locator Beacon
  - Manual activation
  - Can Include Non-Emergency messaging functions
  - Annual Subscription
  - Use Satellite Phone Communication (Iridium or GlobalStar)
  - Contacts a 911 center, rather than an RCC
    - Notification may not reach authority having jurisdiction
- SPOT, inReach, Spidertracks, Yellowbrick

There are also personal devices – SENDs (Satellite emergency notification devices) that can send out distress signals, but which don't use the COPAS/SARSAT system.

These use Satellite phone systems, have annual subscription costs, and may be able to send non-emergency messages as well as emergency messages.

SENDs contact a PSAP (public safety access point, a 911 center). The notification may not go to the authority having jurisdiction.

Non-COPAS/SARSAT SEND



"A SPOT Satellite GPS Messenger in a floation case."
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An example of a SEND

Land SAR

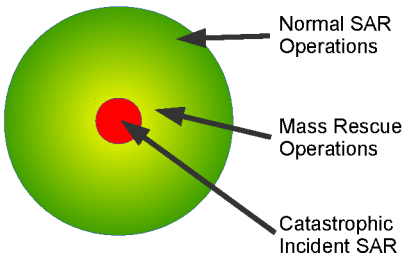
- Federal
  - NSARC: National Search and Rescue Committee
    - US National Search and Rescue Plan
    - National SAR Supplement to the IAMSAR manual
  - National Land SAR Coordinator: AFRCC
  - National Park Service (Lead SAR Agency in National Parks)
- State/County/Local
  - State SAR Plans
  - State/County/Local Authorities having Jurisdiction
- NIMS: ESF 9: Search and Rescue

In the US, Land SAR (other than aeronautical), is governed, at the federal level, by documents produced by NSARC: The US National Search and Rescue Plan, and the National SAR Supplement to the IAMSAR manual. These designate the AFRCC as the national land SAR coordinator, and the national park service as the lead SAR agency in national parks.

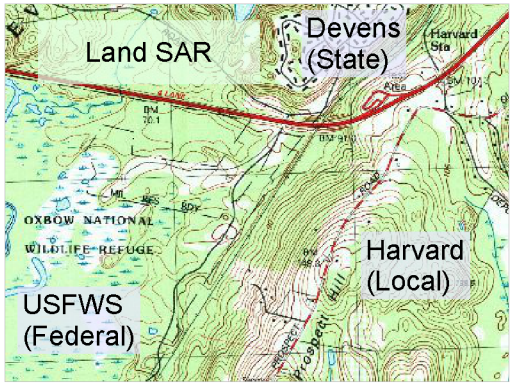
At the state/county/local level, there is substantial heterogeneity. State SAR plans may apply, pre-planning documents produced by state, county, and local authorities having jurisdiction may apply. In most of the country, the county sheriff is the authority having jurisdiction over land SAR incidents.

Under NIMS (in catastrophic incidents), SAR is Incident Support Function 9.

The Olive model for SAR incidents



NSARC introduced a model of SAR operations that draws a clear line (declaration of disaster or state of emergency) that separates catastrophic incident SAR operations (where NIMS and SAR as support function 9 comes into play), and other SAR operations which vary in scale and complexity from normal day to day operations to more complex mass rescue operations.



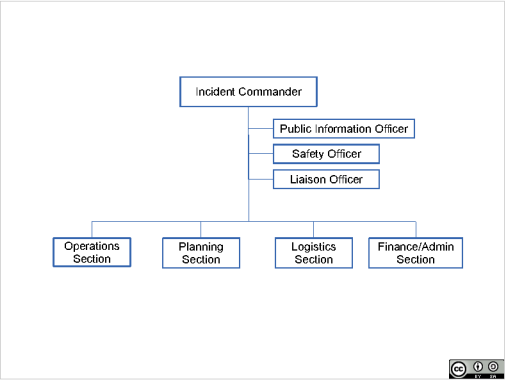
Even simple day to day SAR operations are complex.

They frequently span multiple jurisdictions.

Here, Town of Harvard, Devens (unincorporated, state police), Oxbow National Wildlife Refuge (DOI), just off the map, Towns of Ayer and Bolton, Devens Reserve Forces Training Area (DOD)...

MA State SAR Plan: Local authorities call out MA State Police, State police activate resources including volunteer SAR teams as resources.

NIMS: Use ICS.

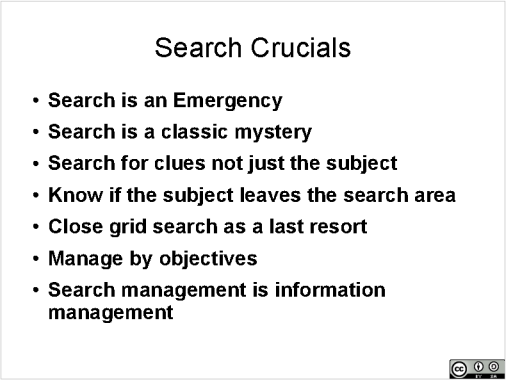


ICS, The Incident Command System is the system under which Land SAR operations run in the US.

ICS provides a common management structure for incidents of all kinds.

ICS accommodates resources from multiple agencies and different jurisdictions. It is a language that all responders of all sorts speak.

ICS scales up and down with incident complexity.



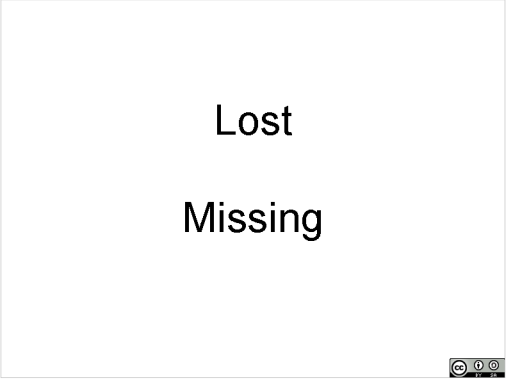
For many years, ERI has been teaching a series of short phrases that capture key ideas in land SAR.

We will return to these ideas multiple times in this course.

Let's see how these apply.



What does it mean to be lost?



What is the difference between Lost and Missing?

Lost is from the subject's perspective – and will affect their behavior – if they feel lost they will behave like a lost person.
Missing is from family/friends/authorities/our perspective – the subject isn't where they should be and we don't know where they are.

[*Note: What follows is a sequence of scenarioes, asking lost or missing, highlighting each of the search crucials.* ***Bring out search crucials in discussion of each scenario on slides that follow.***]

Lost or Missing?

- Subject, uncharacteristically, stopped at a bar on the way home and stayed there late into the night.
- Wife, concerned that he hasn't come home dials 911.

He knows where he is – he's not lost.
She doesn't know where he is.
Classic bastard search.

Is this an emergency?

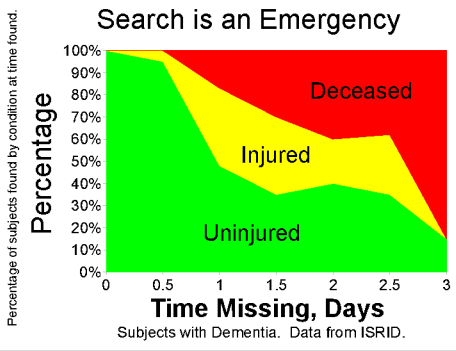
Yes – she dialed 911.
Yes – we don't know that he's not at risk.
Yes – Search is an Emergency

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

A search is always an emergency.

Search is an Emergency



For missing subjects with dementia, probability of a bad outcome increases substantially the longer that they are missing, with mortality increasing after 12 hours.

The data here are from ISRID, the international search and rescue incident database, compiled by Robert Koester.

Different categories of subjects have different probabilities. For example, children 1-3 have very high probability of surviving even after several days, while despondent subjects and subjects that abandon vehicles have much lower survival probabilities.

Note on the graph: The graph shows percent of uninjured/injured/deceased of the subjects found at 12 hour time increments (it isn't a survivorship graph, and the sample size decreases with time missing – thus more people happened to be found uninjured at 2 days than at 1.5 days).

Lost or Missing?

- 82 y/o female with dementia wanders out of her nursing home at some point during the day, drops her cane in a field across the road, and gets stuck in bushes 400 meters away.
- Her absence is noted at dinner, and at 8 PM the nursing home staff call for help.

Missing – the subject may not be aware that she is lost, though she will probably show characteristic behaviors of a critical elderly wanderer.

Dropped her cane – Had a cane – Mystery and clues – investigation can turn up that she had a cane. Clue aware searchers may find cane prints in the field (the subject left hundreds of clues), and may find the cane – leading them to the subject – search for clues and the subject.

Clue Log – key document

Search Crucials

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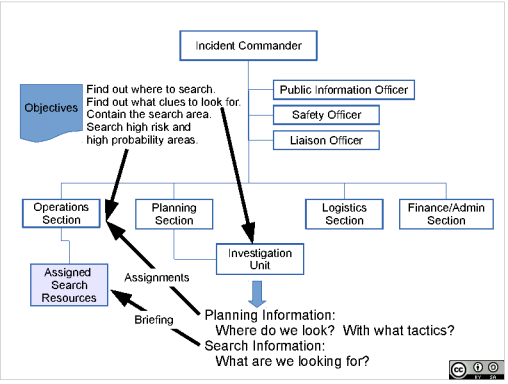
Search is a classic mystery – clues lead you to the subject, so you need to search for clues as well as the subject.

Thus, clue aware searcher.



Sign – a print from a cane.

Clue aware searchers need to observe it, know that it is a potential clue, and transmit it back to the overhead team.



Command function sets the objectives, investigation function elicits planning information (where should we be searching, what sort of tactics should we be using), and searching information (what does the subject look like, what sort of clues might they leave behind (subject walks with a cane), what are the searchers looking for). Planning information and objectives feed into resource assignments made in the operations section. Search information gets fed to the assigned search resources (the field searchers) in briefings (subject walks with a cane).

The investigation function **may** be carried out by an investigation unit within the planning section.

Search Crucials

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- **Search management is information management**

IC makes investigation an objective, cane can be elicited. ICS is key for managing disparate resources from different agencies – using them effectively means the IC setting objectives for the operational period.

Information about cane needs to be recorded, and make it into the briefing for search teams, and discovery of cane print as a clue needs to get recorded (clue log) and followed up on. Search management is heavily about information management (cane might not have: been written down from interviews, might not have been included in briefings, might not have been reported, might not have been logged and followed up on).

Lost or Missing?

- 26 y/o male day hiker takes a wrong turn at a switch back, ends up in the woods over the ridge, can't find the trail, bivouacs for the night, then continues hiking down a drainage in that valley the next morning.
- Family reports him overdue the first evening.
- His car is located at the trailhead.
- A party camping at a lean-to in the trail system, reports seeing someone matching his description on the trail that day.

Lost and missing.

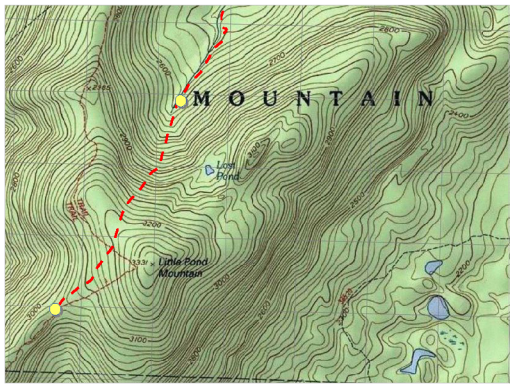
Probably behaving like a missing hiker. Hiker, may just keep moving – contain the search area.

Car and report are clues pointing to where to search (trail, and areas hiker may have lost the trail). Clues may be information elicited by searchers questioning people they encounter.

Switchback is a typical decision point where people make mistakes. Sending a wilderness air scent canine task up the drainage in the valley past the switchback is a very plausible task emerging from investigation and knowledge of lost person behaviors.

Close Grid search very unlikely to help locate subject.

Initial tactics include resources that can cover large routes quickly (e.g. mountain bikes on the trails, air scent canines on likely travel routes).



Map

Subject following the brown trail.

Subject takes a short cut through a switchback at the bottom yellow point.

Anticipated travel from the decision point is the red line, missing the trail, going over the ridge, getting sucked into the drainage. Find at upper yellow point.

Air scent canine task up the valley is a logical task to consider.

Search Crucials

- Search is an Emergency
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Search is a mystery – you need to elicit information to solve it.

There are many more clues than subjects – look for clues that can lead you to the subject.

Contain the search area – subjects may keep moving, making the search area grow and grow.

Missing persons are likely to cross trails and roads and just keep going in what they think is the right direction.

Lost or Missing?

- 42 y/o hunter follows wounded game, becomes disoriented and unable to find his way back to his car. Following folklore, he goes down hill to a stream and follows it (away from roads into dense brush), where he falls and breaks an ankle on a rock.
- That night, his wife reports him overdue.

Lost and missing.

Behaving like a lost hunter.

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Route search resources along likely travel corridors. For example, wilderness air scent canine resources working drainages.

Many categories of missing subjects may be anywhere within a large search area (of many square miles – close grid searching is very inefficient resource intensive – most of the time start with efficient tactics that are more likely to locate the subject with fewer resources.

Close grid searching is also destructive – efficient, clue aware resources are more advantageous most of the time.

Lost or Missing

- Toddler disappears from family picnic in backyard. Family calls 911 within minutes.
- Police, Fire department, ambulance, neighbors show up on scene in minutes.
- More firefighters and Police with canine from neighboring jurisdiction on the scene about 15 minutes later.
- State police and helicopter on scene about 10 minutes after that.

Missing. Too young to have a sense of lost.

Very likely to be close by, curled up in a hollow log, under dense brush, etc, not responding to searchers.

Exception that proves the rule – some categories of missing person don't travel far, and grid search of area immediately around where the person in these categories went missing has a high probability of locating the subject.

Rapidly expanding incident, multiple resources with different command structures from different jurisidictions – recipe for chaos – Use ICS, manage by objectives – It's 13:30, by 14:30, have thouroughly searched area within 300 m of back yard, looking in all spaces where child would fit.

Search Crucials

- Search is an Emergency
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Close grid search as a last resort, except for categories of missing person that tend not to travel far.

Manage by objectives – use ICS, set objectives for an operational period, plan, and carry out the plan.

The missing person response

- Preplanning
- Notification
- Initial Response
- First operational period
- Subsequent operational periods ↻
- Suspension
  - Transition to Limited Continuing Search
- Critique

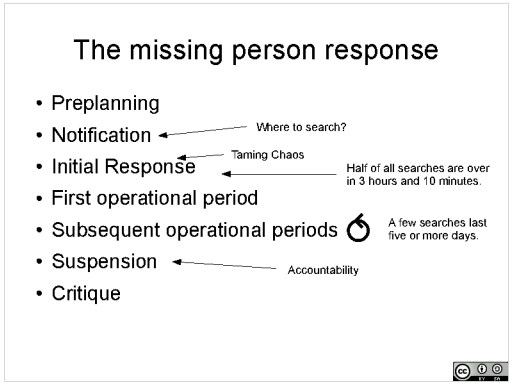
The alert student may note that this isn't quite the same as the IAMSAR Manual's scheme (Awareness, Initial Response, Planning, Operations, Conclusion).

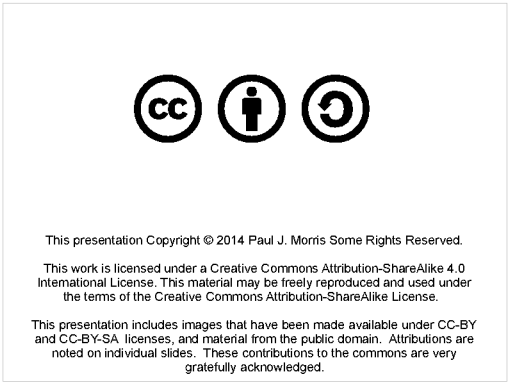
Preplanning is added.

Initial response, followed by cycle of planning and operations.

Good phrase, rather than saying that the search is suspended, is to say that it is transitioning to a limited continuing search (i.e. primarily investigation, possibly with planned weekend searches by volunteer resources).

Critique is explicitly emphasized as important.

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Highlighting some key bits along the way:

To put boots on the ground, you need to know where to put them.

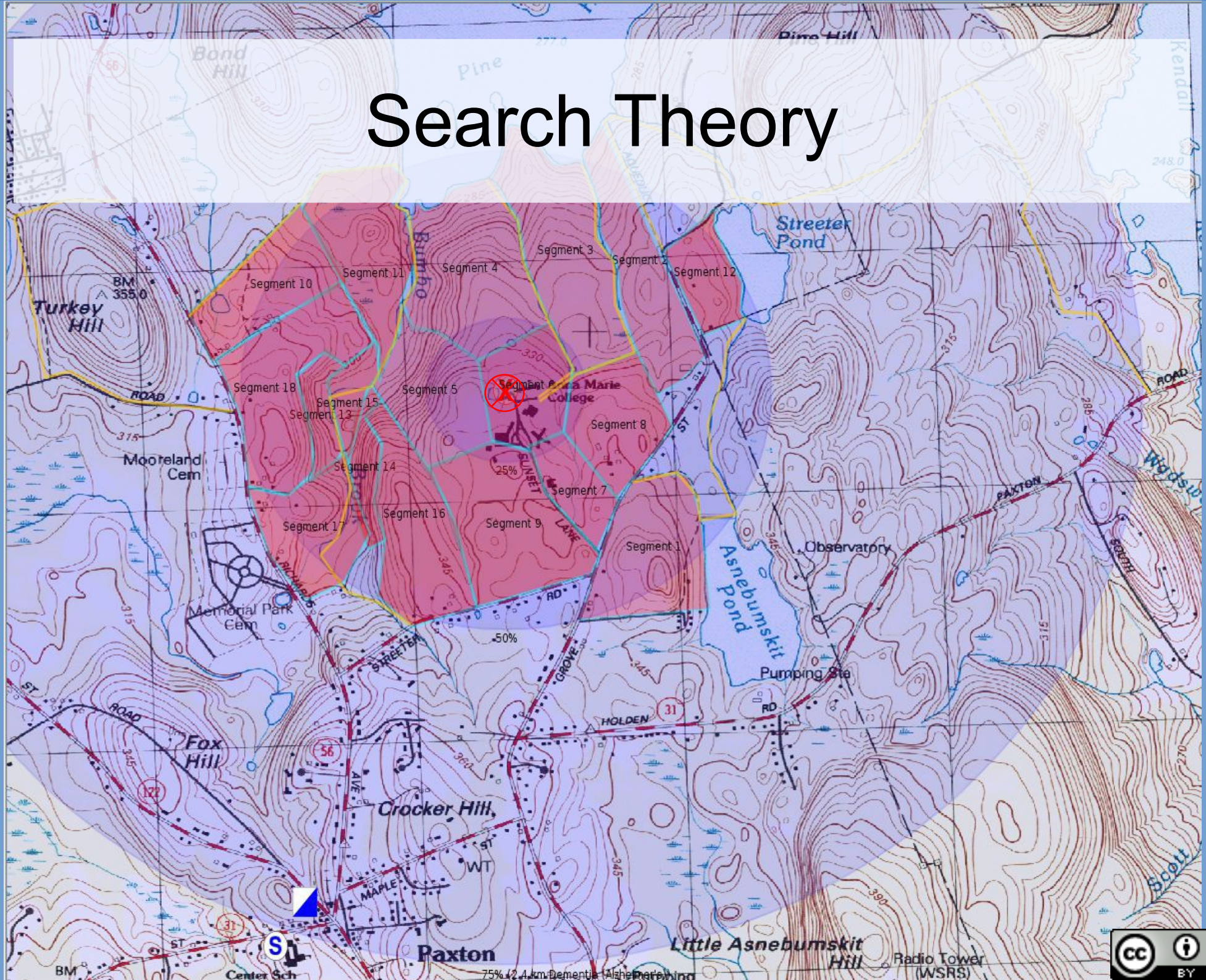
The initial response is all about taming chaos.

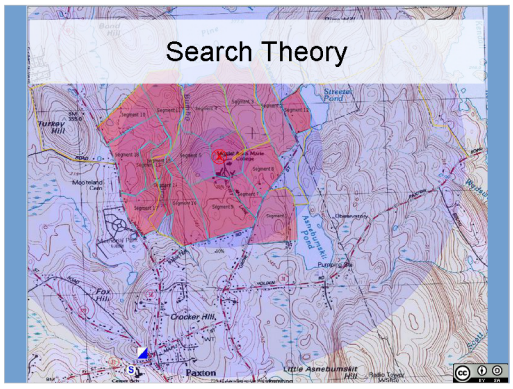
Half of all searches (by SAR resources) are complete in 3 hours and 10 minutes – initial response is very important.

Some searches last for days – and get very large – need to scale.

As people go home, key piece is making sure everyone gets home safe – accountability runs throughout a search.

Search Theory





Unit 2, Overview of Search Theory.

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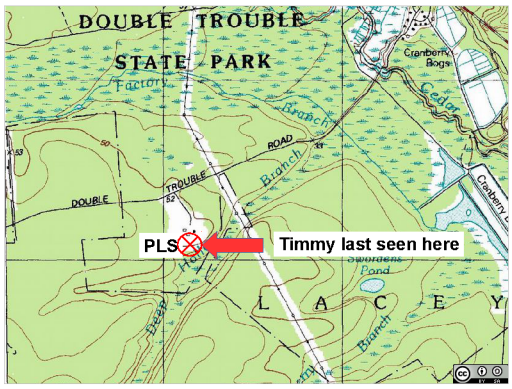
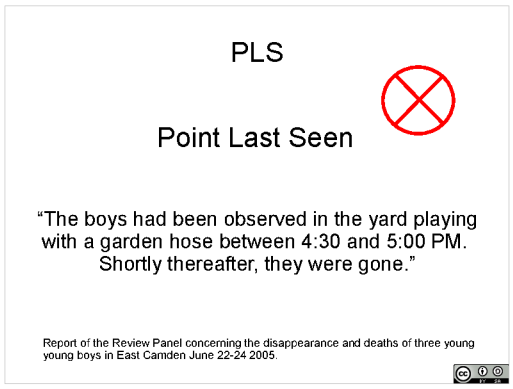
What do we need to know to start a search?

To put boots on the ground, investigation needs to determine where to search.



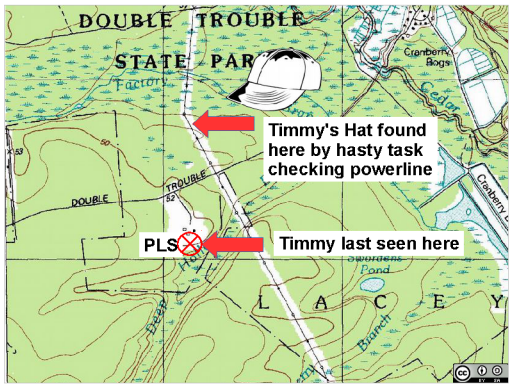
Timmy was last seen at a picnic area in Double Trouble State Park.



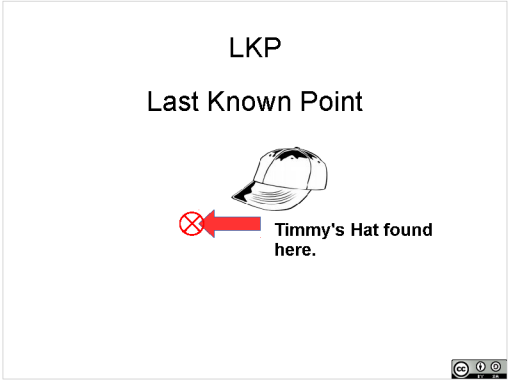
PLS: Point Last Seen

Place where the missing person was last reported as having seen by someone.

Can change over the course of a search (e.g. if the subject is seen by searchers).



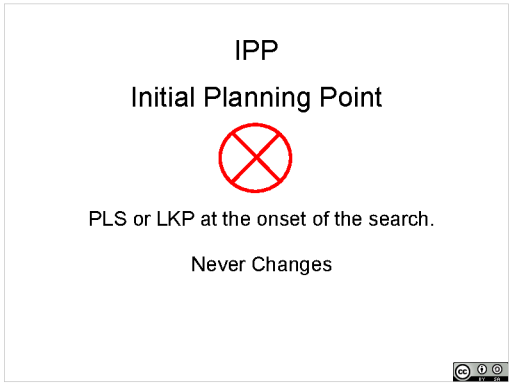
Searchers are called out, run a hasty task along the powerline and find a hat that is identified as Timmy's.



LKP: Last Known Point

Location at which there is evidence for the subject having most recently been there.

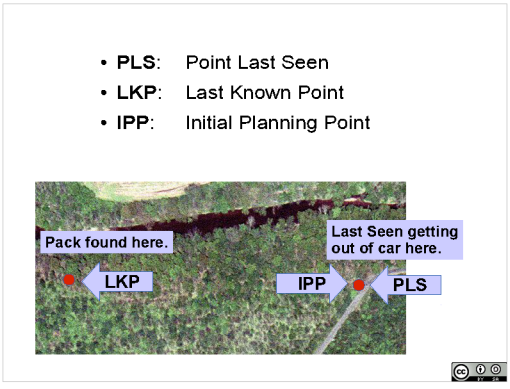
Can change over the course of a search (e.g. discovery of a trail register with an entry by the subject, or with the discovery of clothing or equipment abandoned by the subject).



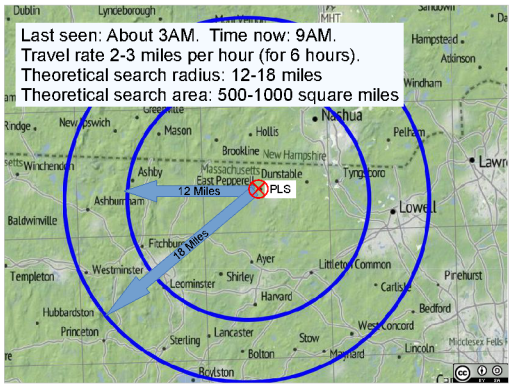
At the start of the search, the place where the subject was most recently known to be (whether it be a PLS or an LKP), is the Initial Planning Point.

The initial planning point remains fixed. Subsequent information may lead to new points last seen or last known points, and the focus of the search may change, but the IPP remains the initial planning point.

Lost person behavior statistics provide distances relative to the IPP.



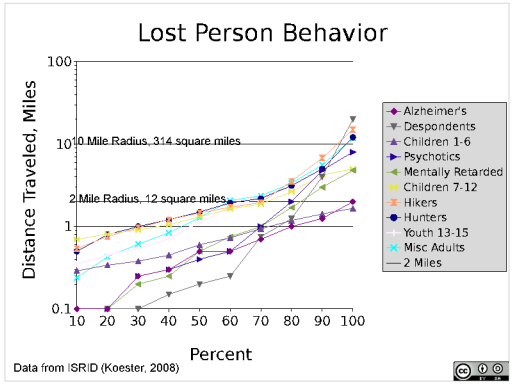
Reviewing, PLS,. LKP, IPP.



A person on foot can walk at 2-3 miles per hour.

The theoretical search radius is the distance that they could walk in a straight line in the time since they went missing.

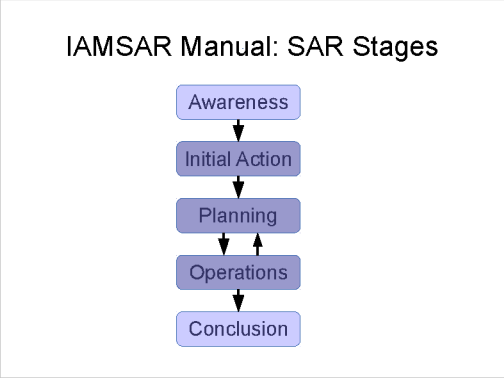
Theoretical search radius is just that – theoretical – the usual area within the theoretical search area is typically hundreds of square miles, much more than can be searched in a land search.



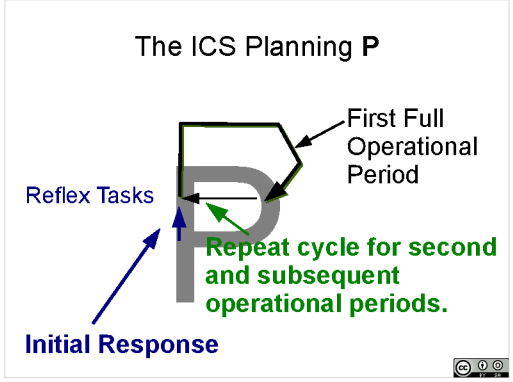
Lost people, however, tend not to walk continuously in a straight line. They tend to meander and stop.

Distance traveled varies by behavioral category. A very large portion of most lost person categories travel less than 2 miles from the IPP.

A small portion of a few categories (hunters, hikers, mentally retarded) travel more than 10 miles from the IPP.



The International Aeronautical and Maritime SAR Manual describes the stages of a SAR operation as awareness leading to initial actions leading to cycles of planning and operations.

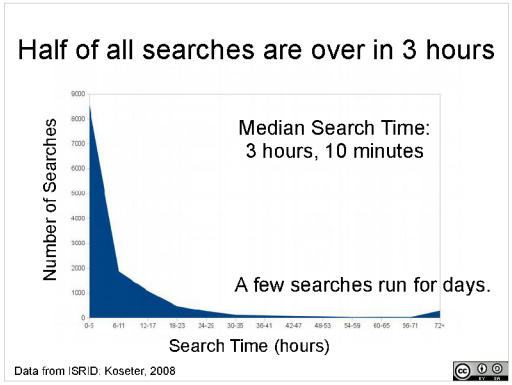


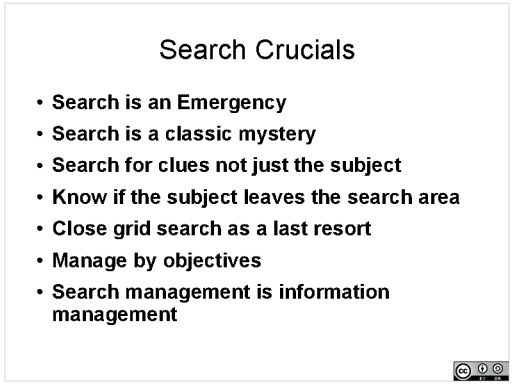
The Incident Command System has a concept very similar to the Initial Action + Planning and Operations Cycles: The planning P.

There is an initial response. In SAR, in the initial response we carry out reflex actions – hasty searches down travel routes, containment, securing the IPP.

Then, as the search extends beyond a few hours, it goes into operational periods that cycle planning and operations.

Initial actions should continue in parallel with the planning for the first full operational period (don't stop searching to plan).

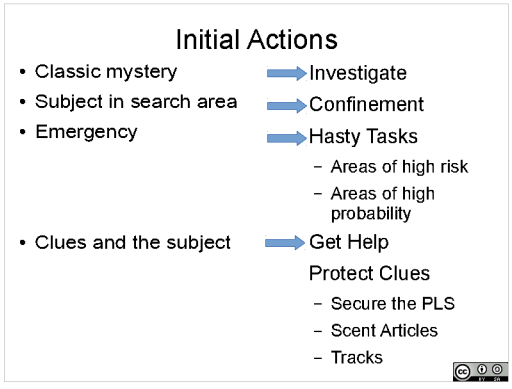




Most searches are over quickly.

Half are over in 3 hours and 10 minutes.

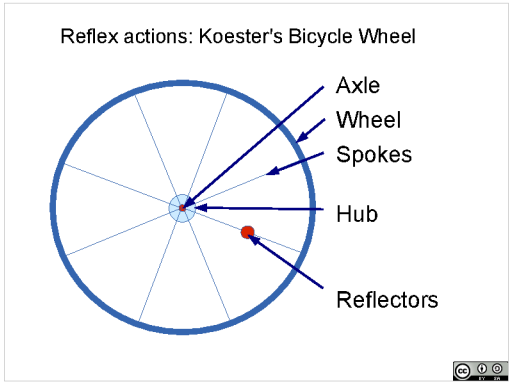
A few searches run on for days.



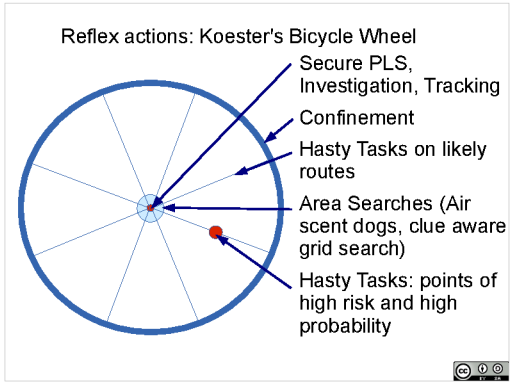


Flowing logically out of the search crucials are actions. Search is a classic mystery – investigate. Know if the subject leaves the search area – contain. Search is an emergency – search areas of high risk and high probability first. Search for clues and the subject – Protect the scene, protect clues, get help from specialised resources (dogs, mantrackers, search managers, etc).

Robert Koester came up with a powerful visual metaphor that can help you remember the set of systematic initial actions to take: The bicycle wheel.



A bike wheel has an axle, a hub around the axle, spokes that run from the hub to the wheel, the wheel itself, and reflectors.



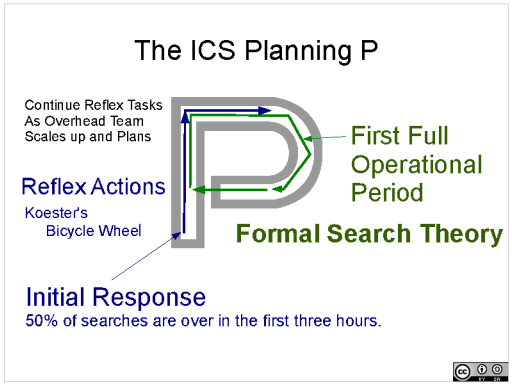
Axle: PLS – Secure it, investigation, resources that can provide a direction of travel.

Hub: Area searches in small area near PLS with high probability.

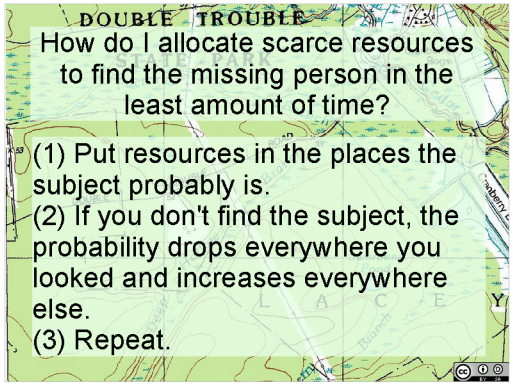
Spokes: Hasty tasks along travel corridors.

Wheel: Confinement – boundary to the search area - know if the subject leaves the search area.

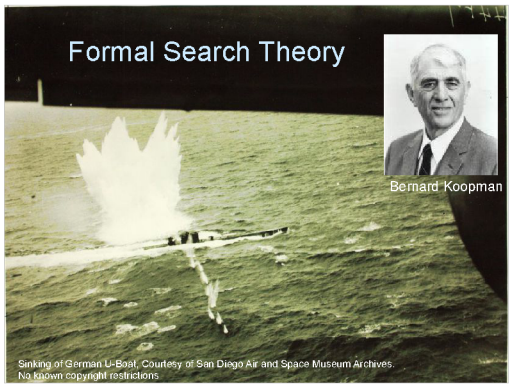
Reflectors: Points of high risk or high probability – hasty tasks to check those points.



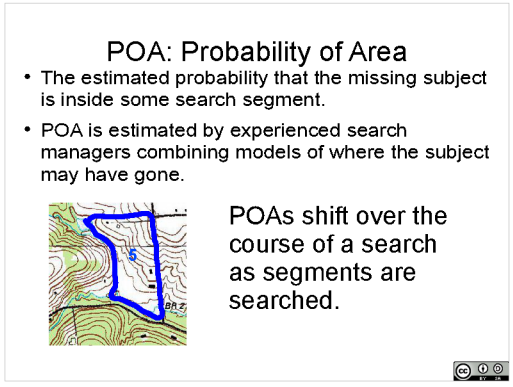
In SAR, we think of the initial response of the Planning P as these reflex actions (which make the find about half the time). Then, as the search moves into cycles of full operational periods, there is a shift from reflex tasks to a search planned with formal search theory.



Formal search theory is all about resource allocation – where do we put limited resources to have the best chance of finding the missing person the soonest, and when you don't find them, shifting probabilities.



Formal search theory comes from world war II, with Bernard Koopman's application of bayesian statistics to the problem of locating enemy submarines that were attacking convoys in the Atlantic.

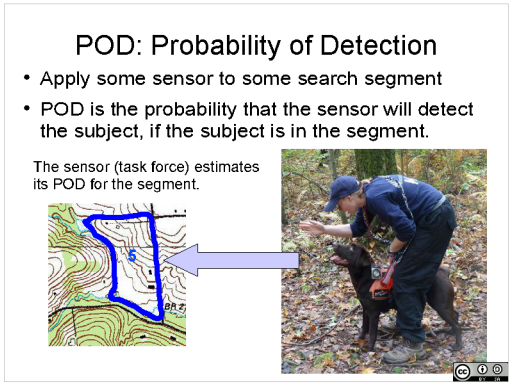


We start by assining a probability that the subject is in a search segment to each segment – Probability of Area.

A map of the search area is divided into segments.

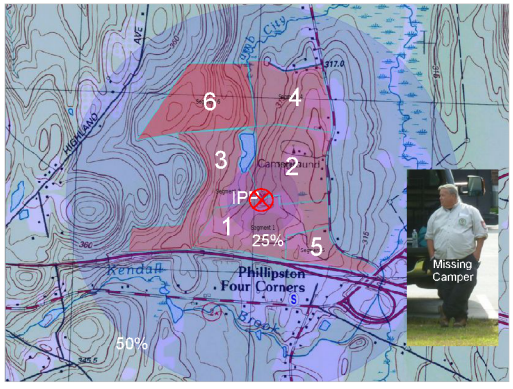
Search managers go through a consensus process that simultaneously considers multiple scenarioes of what happened to the missing person to assign POAs to each search segment.

A a segment is searched, the POA in that segment drops and is shifted elsewhere.



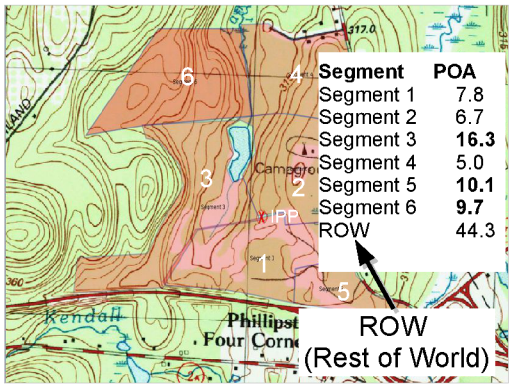
As each segment is searched, the searchers report a probability that they would have detected the subject, if the subject was in their segment.

POD – probability of detection.



So, let's consider a hypothetical search for a missing camper.

The area around the IPP has been divided into 6 segments (covering distance within which 25% of missing campers are found, and for this simple example, about half the area where 50% of missing campers are found (so we'd want more segments for a real search, but for this example we'll keep it to 6).



The search managers get together and estimate initial probabilities for each segment, leaving, here 44% of the probability outside the segmented area in ROW – rest of world.

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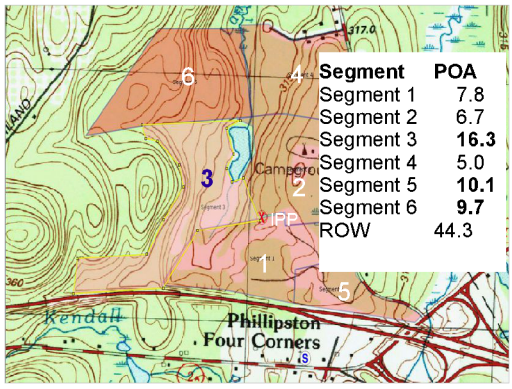
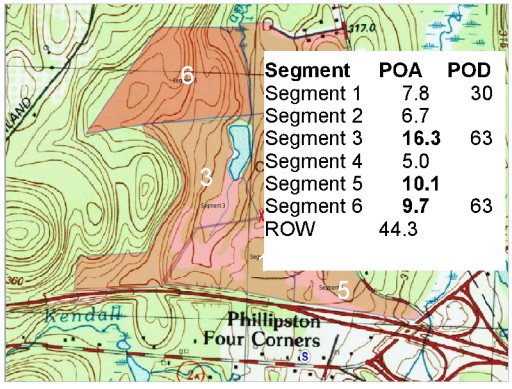
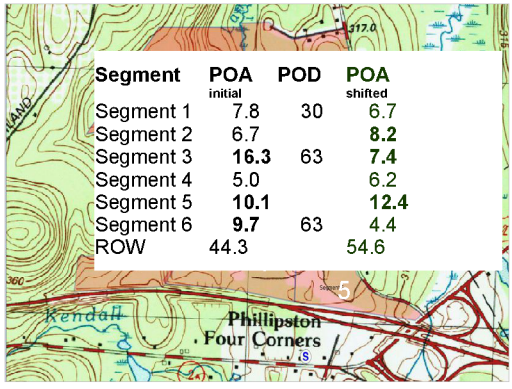


Segment 3 has the highest probability of area.



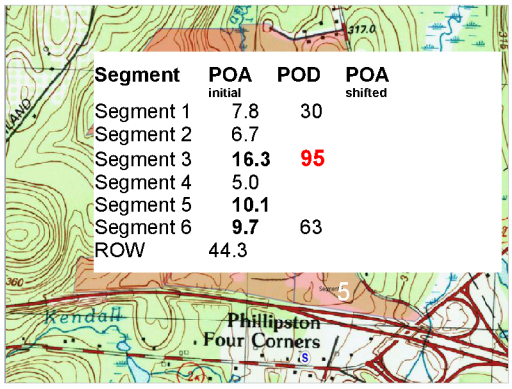
We put resources out to search segments 3, 6, and 1. They return and report probabilities of detection (of 30%, 63%, and 63%).



Now, we plug the numbers into a computer (there's a program CASIE that does this), and let the computer do the bayesian statistics to shift the probabilities around.

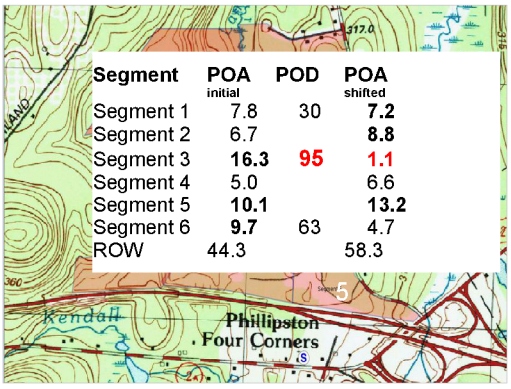
Where searchers reported a POD, the probabilities of area drop – and POAs rise everywhere else (including in ROW).

Top three segments are now 5, 2, and 3 – segment 3 is still very much in play.



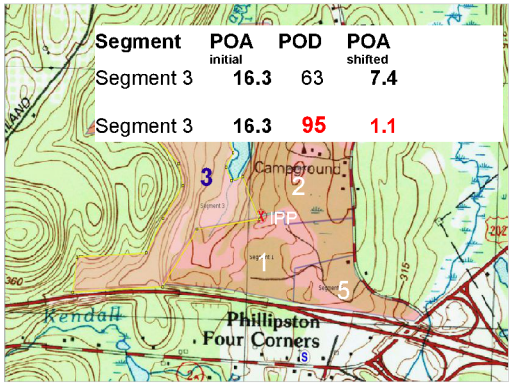
Now, let's suppose that the resource which searched segment 3 reported a 95% POD instead of a 63% POD.

What is the consequence?



Shifted POA for segment 3 drops to the bottom of the list at 1%.

We aren't going back there for some time.



If the resource that searched segment 3 reported a POD of 63%, the POA for the segment shifts to 7%.

If the resource reports a POD of 95%, then the POA shifts to 1%.

Very hard to justify a very high POD – and it very strongly shifts the search effort away from a segment.

Don't use the word “cleared” - carries the implication of a POD of 100%. We never clear segments, we search them.

Excessively High POD reports Kill

Unless all Resources are reporting POD in a uniform way, the adjusted POAs that drive resource allocation are meaningless.

Simple phrase: Excessively high POD reports kill.

More subtle point: Unless all searchers are reporting PODs in the same way, with about the same search effort for about the same segment conditions given about the same POD value, adjusted POAs are meaningless.

Learning More:

- NEWSAR POD/Canine POD course
- NEWSAR CASIE course
- NEWSAR Modern Search Management course
- NASAR Managing the Lost Person Incident





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That's why NEWSAR has a POD course and trains search managers to use CASIE.

Search management courses:

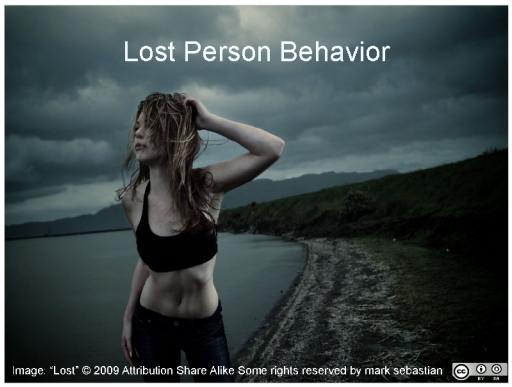
NEWSAR: MSM

NASAR: MLPI

Lost Person Behavior



Image: “Lost” © 2009 Attribution Share Alike Some rights reserved by mark sebastian



Unit 3, Introduction to Lost Person Behavior

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Lost? Missing?

- Hiker underestimates time on trail, doesn't get home for dinner as planned, spouse calls 911.
- 82 year old with dementia wanders away from home.
- Hiker follows a game trail off trail into the woods.
- 4 year old wanders out of their home range
- Despondent parks their car and walks to a rocky overlook.

Are they lost?
Missing?
Is it an emergency?

Lost

- You feel like:
  - You don't know where you are
  - You don't know how to get to where you want to be

What is lost?

Your point of view.

Missing – someone else doesn't know where you are.

Response to being Lost

- Error at a decision point
- Fuzzy feeling that something isn't quite right
  - Denial
  - Early recognition of problem, more likely to backtrack.
- Panic Reaction
  - High Stress level
  - Reduced Performance at complex tasks (navigation)
- Anger to Bargaining to Acceptance
- Survival Strategy or Self Rescue Strategy

You act like you are lost if you feel lost.

Behaviors (Ken Hill)

- random traveling
- direction traveling
- route sampling
- direction sampling
- view enhancement
- backtracking
- using folk wisdom
- staying put

Lost people try things to get unlost.

Ineffective Strategies

- Discard Gear (75% injured or dead [n=4])
- Do Nothing (44% injured or dead)
- View Enhancing (33% injured or dead)
- Travel Cross Country (33% injured or dead)
- Wander (33% injured or dead)

Data from New Zealand Study

Some things don't work well.

New Zealand data.

View (and cellphone signal) enhancing is a strategy some experienced hunters and hikers use. In New Zealand it isn't a good strategy.

Strategies

- Seek Shelter (8% injured or dead)
- Route or Direction Sampling (11% injured)
- Travel towards landmark (15% injured or dead)
- Backtracking (16% injured or dead)
- Staying Put (24% injured or dead)
- Following a travel aid (25% injured or dead)
- View or Cellphone signal enhancing

Data from New Zealand Study

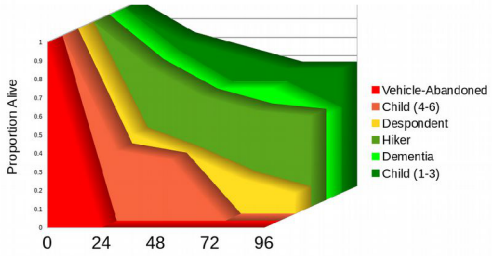
Some strategies are more effective – seeking shelter and direction sampling both seen as more effective.

Behaviors in Yosemite (74 cases)

- **Route Traveling** 41.9%
- Staying Put 25.7%
- Backtracking 16.2%
- Random Traveling 5.4%
- View Enhancing 4.1%
- Route Sampling 2.7%
- Direction Traveling 2.7%
- Doing Nothing 1.4%

Route traveling common amongst lost persons in Yosemite.

Survivability



Data from ISRID (Koester, 2008)

Survivability varies substantially with subject category.

Vehicle, abandoned very high risk.

Child 4-6 very high risk.
Child 1-3 much lower risk.

Factors Affecting Survivability

- Time
  - Most significant relationship
- Clothing, Equipment, Mental State, Fittness
  - Some relationship
- Experience, Survival Training
  - Minimal or no relationship

Time has greatest effect on survivability.

Experience and survival training have minimal to no relationship to survivability.

Lost Person Behavior Research

- 1973, Dennis Kelley: 308 cases, Colorado
- 1977, William Syrotuck: 229 cases, NY, WA
  - First subject categories
- 1985, Barry Mitchel: 3511 cases, CA, CO, East US
  - Regional differences
- 1986, Ken Hill – Behaviors when lost
- 1992, Robert Koester – Alzhemier's, VA
- 1997, Heth & Cornel – Dispersion
- 2011, Perkins, Roberts & Feeney: 1271 cases, UK
- 2012, Robert Koester: 16,863 cases ISRID

Long history of research on the behavior of lost persons.

ISRID: International Search & Rescue Incident Database



- Global Data Set
- Compiled by Robert Koester
- Initial 2002 funding from USDA
- 2008 (Lost Person Behavior book): 31,100 cases
- 42 Behavior Categories
- 2014 > 60,000 cases

Key tool in studying lost person behavior is ISRID.

Summarize some of Robert Koester's findings from there.

Statistically observed behaviors All differ among categories

- Distance from IPP to Find
- Travel Uphill or Downhill
- Time mobile (generally hours)
- Where found (structures, brush, woods, etc)
- Distance found from Roads/Tracks

Identifying a behavioral category for a lost person is important – people in different behavioral categories have statistically different behaviors.

Behaviors and Search Tactics

- Active or passive tactics?
- Call the Subject's Name?
- Where to search
  - Where to put field searchers?
  - Where do the field searchers look in their segment/route?
  - Investigative directions to elicit planning data.
- Decision points (map and field)

Subject behavioral category can suggest approaches to search – at both the larger planning scale and in the tactics to employ by searchers in the field.

Related idea is decision points – identifying places where the subject may have gone wrong and analyzing where they might have gone after an error at a decision point.

Some Categories

- Child 1-3
- Child 10-12
- Autism Spectrum Disorder
- Dementia/Alzheimer's
- Despondent
- Hiker
- Hunter
- Abduction

Categories have refined over time, here are some common ones distinguished in ISRID.

We'll walk through these categories.

Child (1-3)



- Tend to be very close to the IPP
- Tend to shelter/hide in structures, brush, inside logs – look anywhere they can fit.
- Check anywhere they may fit within abandoned vehicles.
- Often drawn to animals or water.
- Can sleep through loud noises.

Image © 2014 CC Attribution Share Alike Some rights reserved by Travis Swan "swambo"

Very young children don't tend to travel far.

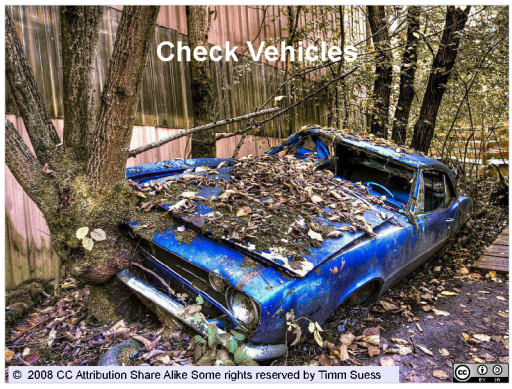
They tend to shelter/hide/curl up and sleep somewhere small.

Look anywhere they may fit.

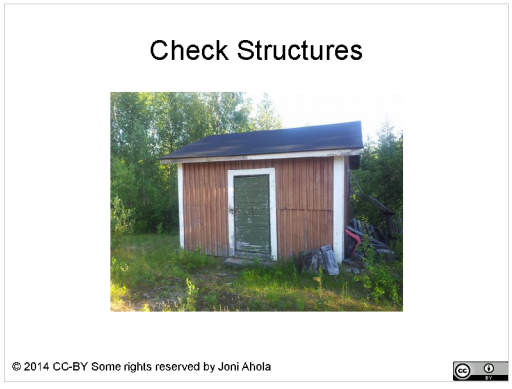


Will shelter and hide anywhere they can fit. Will shelter in a hollow log in the back yard.

Can go to sleep and sleep through searchers walking right past them calling their name.



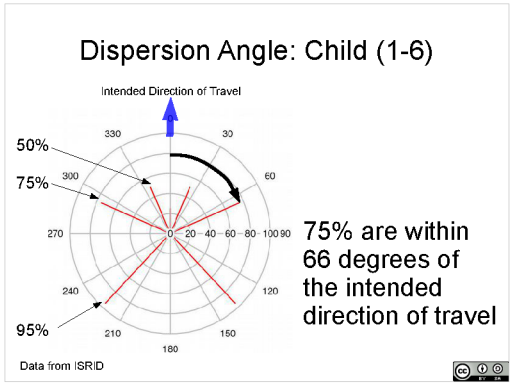
Check any place a missing child may fit.



Abandonded vehicles, structures, old appliances, etc.

Anywhere they may fit.

Many categories of lost person are found in structures.



Top of circle is intended/last known direction of travel from IPP. Red lines indicate proportion of subjects found within that angle from the direction of travel.

50% within about 30 degrees.
75% within 66 degrees
95% within about 140 degrees – a small portion found off in the opposite direction.

Check Structures (Temperate)

- Mental Retardation: 34%
- Child (1-3): 29%
- Child (4-6): 29%
- Child (7-9): 29%
- Child (10-12): 29%
- Abduction: 29%
- Despondent: 26%
- Child (13-15): 25%
- Worker: 25%





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Structures are a pattern for many subject categories, including all children.

Check Structures (Urban)

- Child (13-15): 80%
- Mental Retardation 57%
- Child (4-6): 56%
- Child (7-9): 56%
- Child (10-12): 56%
- Child (1-3): 50%
- Despondent: 47%
- Dementia: 35%
- Hiker: 24%





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Even more pronounced in urban/suburban areas.

Less often found in structures

- Dementia: 20%
- Mountain Biker: 14%
- Snowmobiler: 14%
- Hiker: 13%
- Hunter: 8%
- Runner: No cases (small sample size)
- Skier – Nordic: No cases (small sample size)

A few subject categories are less likely to be found in structures.



Let's look at children 10-12.

Child (10-12)

- Often adventuring, exploring, fantasy play,
- Often take shortcuts.
- Often make mistakes at decision points.
- May be well outside home range.
- Signcut and evaluate field decision points.
- Check anywhere they may fit within abandoned vehicles.

Very mobile and explore.

Can be well outside their usual home range. Home range as reported by the parents is usually an underestimate.

Look for decision points.

Check structures, check abandoned vehicles.



Substance Abuse

Substance Abuse

- Often investigative finds (29%)
- Very high mortality rate (42% Urban)
- Typically poorly dressed for the weather
- Point last seen often a bar or party, subject leaving on foot
- **Often drawn to water**

About a third not lost but found through investigation. Tend to be poorly dressed. Typical pattern, seen at a bar or party, left on foot.

Often drawn to water.

Autism Spectrum Disorder

- **Attracted to lights, water, reflections**
- May be attracted to animals, transportation.
- May have catastrophic reaction if overstimulated.
- Often in structures.
- Very unlikely to respond to searchers.

Autism Spectrum Disorder.

General pattern of attraction to lights, water, reflections. Check nearby water.

May have specific attractor, often transportation related or animal related.

Unlikely to respond to searchers calling their name.

Upon a find, minimize noises (radio volume), number of people, and work to provide a calm, quiet environment.

Dementia

- Stop moving within hours
- Very unlikely to respond to searchers calling their name
- Tend to leave few clues other than sign
- Often in drainages, creeks, or brush
- May be stuck in dense brush.
  - **Keep going until they get stuck**
- Tend to leave or cross roads
- May have catastrophic reaction

Characteristic of critical elderly wanderers:

They keep going until they get stuck.

Like Autism Spectrum Disorder, upon a find, minimize noises (radio volume), number of people, and work to provide a calm, quiet environment.

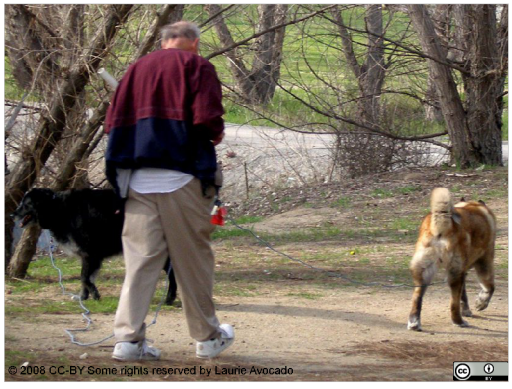
Dementia

- IPP is residence or nursing home
- Oriented to the past
  - May attempt to travel to former place of work
  - May attempt to travel to former home
- May have wandered before
- May use public transportation
- **Look for decision points where the route turns but the subject could have kept going straight.**

Tend to be oriented to the past and may be thinking they are going to work or going home or going to church, or some activity that they used to do frequently.

They may use public transportation, even if they don't have money for a fare (some nice person may have paid the fare for the little old lady or gentleman...).

Tend to cross and leave roads – more generally, tend to travel straight unless they encounter a barrier.



Characteristic picture.

Unsteady on their feet, so they tend to look down.

Dementia tends to affect short term memory – thus affects the ability to use landmarks for navigation (look up, see the landmark, look back down and forget it).

Effects of Dementia on Navigation

- Short term memory problems
- Reduction in Peripheral Vision
- Difficulty judging passage of time
- Reduced visual-spatial skills

Can't see or recall Landmarks

Can't estimate Distances

Poor sense of Direction

LOST

Dementia tends to affect sense of time – what's the main thing we use to estimate distance traveled? Time traveled.

Dementia tends to degrade the ability to navigate – less able to use landmarks, less able to estimate distances traveled, reduced sense of direction.

All lead to more easily becoming lost.



Exercise to help understand navigation in critical elderly wanderers – look down (unsteady on feet), hold your hands on either side of your eyes (reduced peripheral vision), walk, keeping looking down (unable to remember landmarks).

Here are students in a lost person behavior class doing this exercise at a location that was the IPP for a missing couple with dementia. The gravel road turns right up ahead at a junction to a trail leading into the woods. Everyone in the class went straight onto the trail (as the lost couple did).

Look for, examine for sign, and report, field decision points where a subject with dementia could have gone straight and missed a turn in a travel route.

They go until they get stuck

Hallmark pattern. Travel in a straight line until they can't go any further.

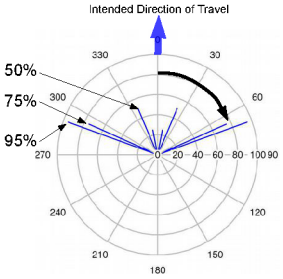
How Far?

North East, less that 1000 feet relief: Temperate Flat

175 cases (global – dementia, temperate flat)
25% within 0.2 miles
50% within 0.6 miles
75% within 1.5 miles
95% within 7.9 miles

Critical elderly wanderers will travel much farther than caregivers think they can.

Direction of travel is strong predictor



Dementia: 75% are found within 66 degrees of the intended direction of travel

75% within 66 degrees of intended direction of travel.

The door they exited from is a very strong predictor of where they will be found.



Despondents

Find Location

- Temperate
  - Structure (26%)
  - Woods (25%)
  - Water (15%)
- Urban
  - Structure (47%)
  - Water (19%)

Most likely:
On a trail, path, or at their destination.
Survivors often in structures.
Often at interface between terrains.
Rarely in Brush
Seldom respond to searchers.

Often just out of sight at an interface between different sorts of land cover (just inside the tree line at the edge of an open area, on the shoreline of a lake).

Tend to be missing, not lost.

Check structures.

Two Patterns

- Get Just out of Sight
  - Urban 50% within 100 meters of IPP
  - Often at urban/rural interface or at treeline
- Travel to Scenic or Significant (to them) Location
  - Viewpoints
  - Just out of sight at that destination

Temperate less that 1000 feet relief: 50% within 0.7 miles of IPP
Temperate more than 1000 feet relief: 50% within 0.5 miles of IPP
Urban, 50% within 0.5 miles of IPP

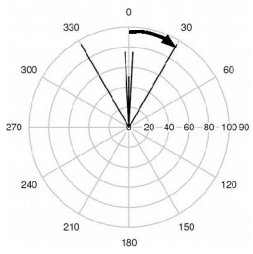
Two typical patterns:

Just out of sight at the IPP.

or

Traveled to a significant place and just out of sight there.

Dispersion Angle: Despondent



95% within 30 degrees of intended direction of travel

Data from ISRID

Direction of travel is very strong predictor of find location, 95% within 30 degrees.



Hunters (rifle,shotgun,primitive,bow)

Hunting tactics (and resulting navigation behaviors) will vary.

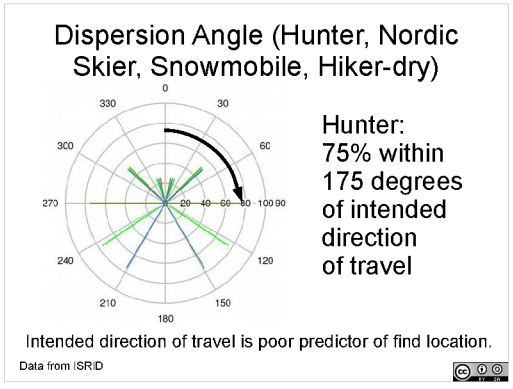
Hunter

- Mostly (70%) Lost
  - May be focused on game, not navigation.
- Often travel at night (40 to 80%)
- Likely to follow a self rescue strategy
- May be comfortable sheltering overnight
  - Particularly older and more experienced hunters
- Follow both linear features and terrain.
- Type of hunter (Bow/Shotgun/Rifle) and game (Deer, Wildfowl, Bear, etc) very important.

Pursuit of game and nightfall most common causes of becoming lost.

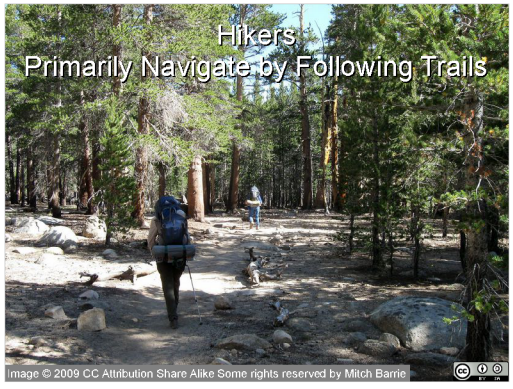
In following game, may get into very dense brush, boulder fields, dense forest, etc.

Go to great lengths to self rescue.



May be anywhere – intended direction of travel is poor predictor of find location.

Some other classes of lost person have similar lack of predictability of direction of travel (cross country skiers, snowmobilers, hikers)



Hikers

Follow trails.

As ground searchers, you are expected to have a higher level of skill and be able to navigate effectively off trail. Hikers may well not have off trail navigation skills.

Hiker

- Tend to be on or close to trails or linear features
  - Off trail, often follow terrain onto linear features
- Mostly (68%) Lost
  - Errors at decision points
  - Errors where trails are obscure (field decision points)
  - Leaving trail for game trail
  - Leaving trail for herd path
  - Leaving trail to cut switchbacks
  - Taking wrong direction on trail
- Some (16%) Overdue, errors in estimating time or physical fittness
- Often (30 to 40%) travel at night

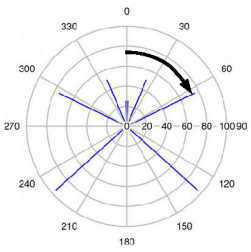
Get into trouble when they get off the trail.

Decision points are very important for missing hikers – pay particular attention to field decision points (check for sign, report).



Can be very easy to get off trail – above tree line, in places where trail system is poorly marked, etc.

Dispersion Angle: Hiker



Hiker: 75% within 64 degrees of intended direction of travel (Temperate)

Intended direction of travel is moderate predictor of find location.

Data from ISRID

Intended direction of travel is poor predictor of find location.

Abduction

- Red Flags
  - White Female, age 5-12
  - Missing from a familiar location
  - Hasn't done this before (no history of running away)
  - No explanation for disappearance
- Rapid Law Enforcement Response is Critical
- Only 16% are found alive

Abduction – stranger abductions.

Multiple Crime Scenes

- PLS
- Initial contact site
- Assault site
- Murder site
- Dump site
  - Body likely to be concealed
  - Likely to be in a different jurisdiction from the PLS. 50% are within 10 miles of PLS.

Abductions have four characteristic crime scenes – the location where the subject was initially contacted by the perpetrator, the site where the perpetrator committed the assault, the murder site, and the site where the perpetrator dumped the body. More than one event may have occurred at the same place.

Be alert for all of these and for clues at each in a known or potential abduction.



Typical pattern for dump sites in abductions.

Dump Site

- Turnoff – within 1/2 mile of a junction
- Near a main road
- Vehicle Access – within 300 feet of vehicle
- Near water or in the water
- Downhill (if there is a slope)
- Remote location: Out of sight

Search carefully for clues and sign at locations with the characteristics of typical dump sites.

Some Other Categories

- Climbers (day climbers, mountaineers)
  - Weather, hazards often involved.
- Gatherers
  - Typically looking for a very specific habitat
- Mental Illness
  - Often Evade Searchers – May attack Searchers
- Camper (Car Camper)
  - Poorly marked trails near campground
  - Often overdue

Plenty more categories.

Distances of Find from Linear Features (50% distance)

- **Autistic :** **15 meters**
- **Dementia:** **15 meters**
- **Mental Retardation:** **15 meters**
- Despondent: 50 meters
- Hiker: 100 meters
- Hunter: 100 meters
- Worker: 2500 meters (small number of cases)

Track offset – some categories are often close to travel routes.

Some tend to be off trail.

Approaching the Subject

Particularly autistic and dementia:

- **May have catastrophic reaction**
- Simplify the environment
  - Reduce noise, turn down radios, etc.
- Approach from the front
- Make eye contact
- Ask simple direct questions.

When you make a find, be cautious approaching the subject.

Learning More:

- Robert Koester's Book: "Lost Person Behavior."
- Robert Koester's Lost Person Behavior course.

Robert Koester has good resources on lost person behavior – applicable to both search management and field tactics.

The material in this unit draws heavily from the writings of Robert Koester. His research and teaching in the field of Lost Person Behavior is very gratefully acknowledged.

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Land Navigation I: Map Reading





Unit 4, Land Navigation, topographic maps, terrain, and map reading

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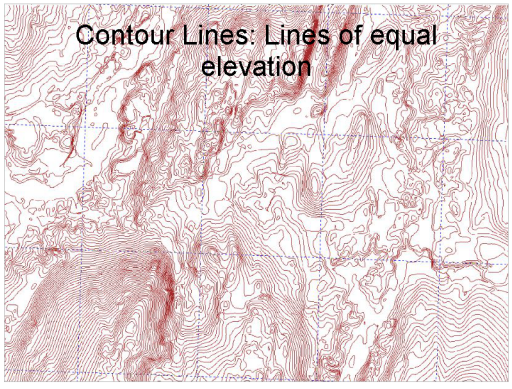
Teaching map reading used to be simple, all about learning to read topographic maps.

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

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

What can we see in the map?

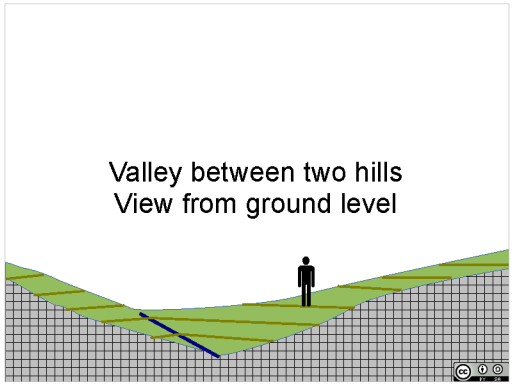
What can we see in the air photo?



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

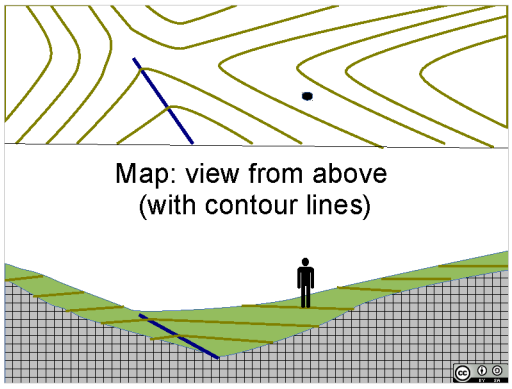
Represented with contour lines.

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



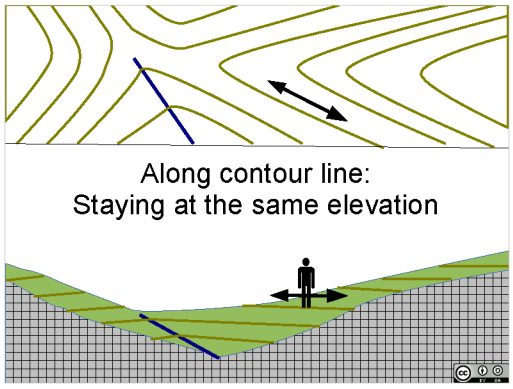
Let's visualize this.

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

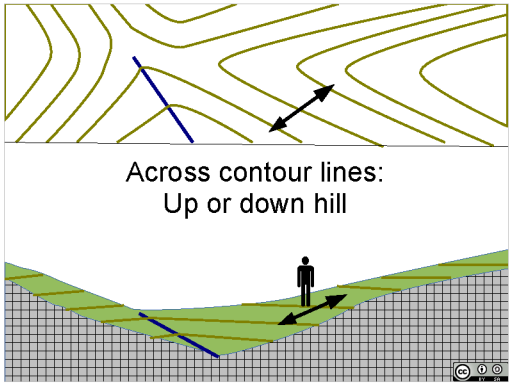


Now, lets look at it from above – in map view.

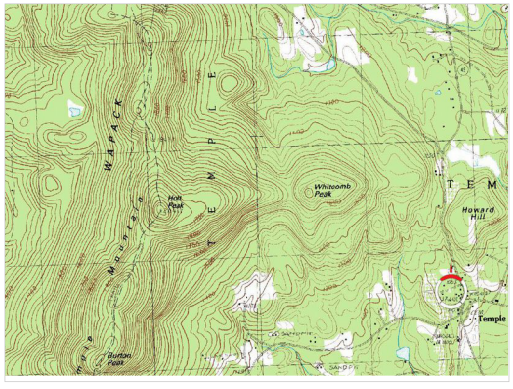
We can see the point where the person is, the stream, and the terrain (a saddle)



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



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

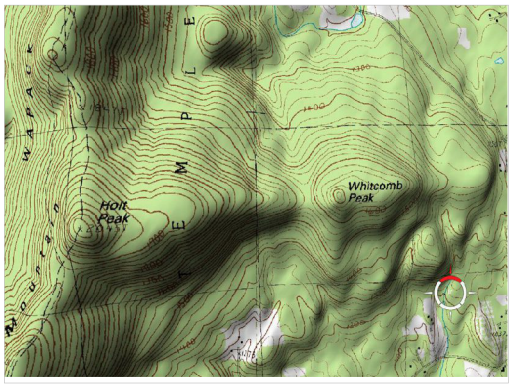


Topographic map

Where are the high points?

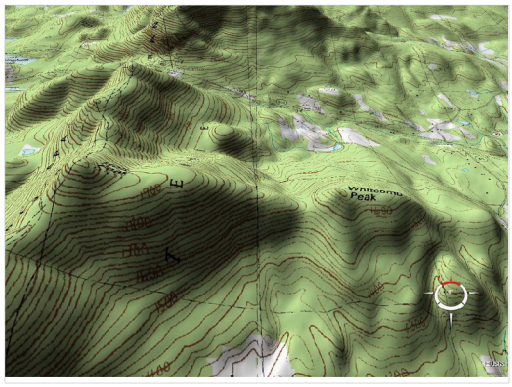
Where is it steep?

Where is it flat?



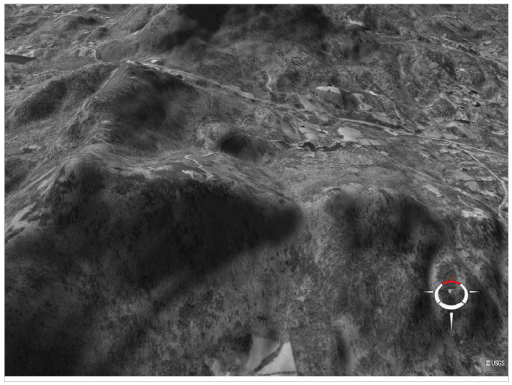
With shaded relief – easier to see the terrain.

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

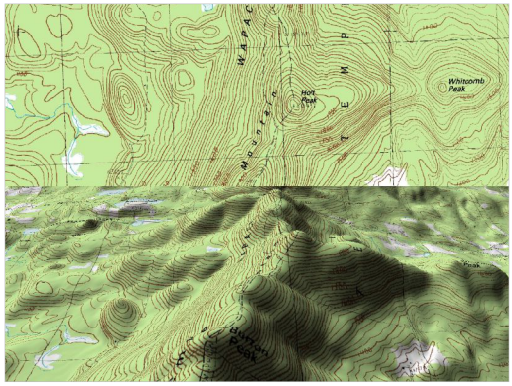


Not looking straight down anymore – tilted to a perspective view as looking out the side window of an airplane

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

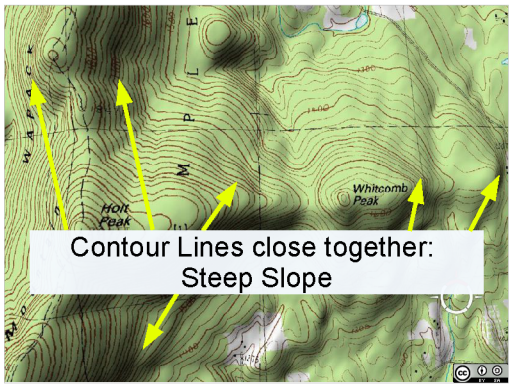


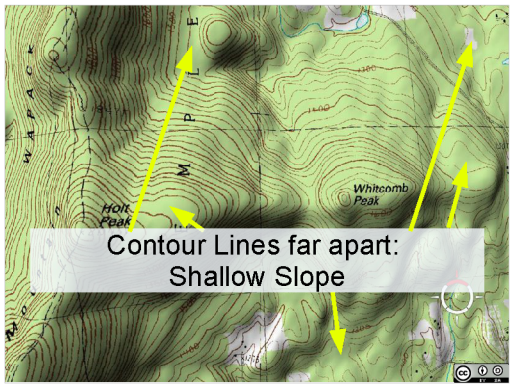
Air photo draped over the terrain. In perspective, with shaded relief.



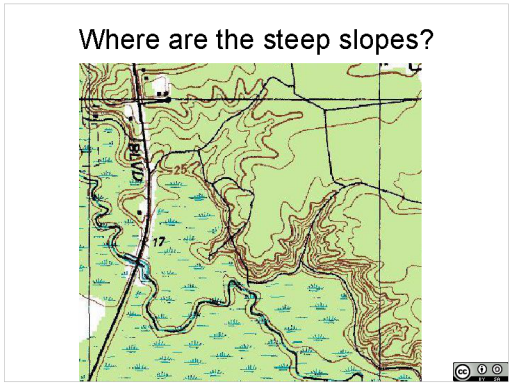
When you look at a topographic map you should be able to visualize what the terrain looks like: Where are the high points, where are the valleys, where is the terrain steep, where is it flat, where are the streams flowing....

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

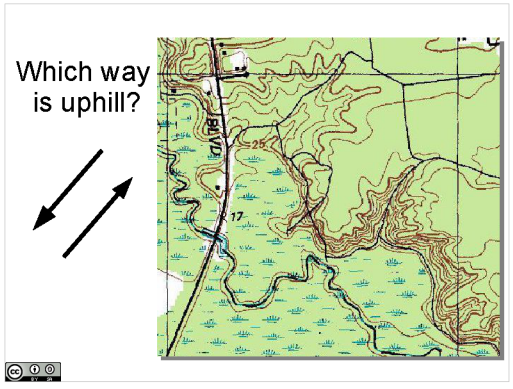




Some places are steep, some are flat.



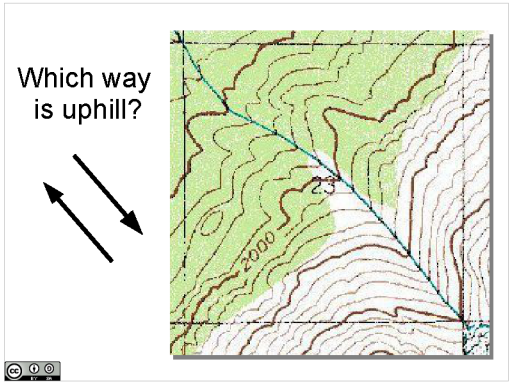
Tightly spaced contour lines between the level ground in the upper right and the swamp in the lower left.



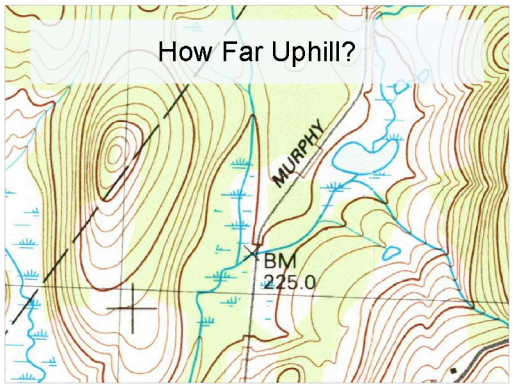
Do the streams drain out of the swamp to the north east (upper right is low ground), or into the swamp from the north east (upper right is high ground)?

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

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

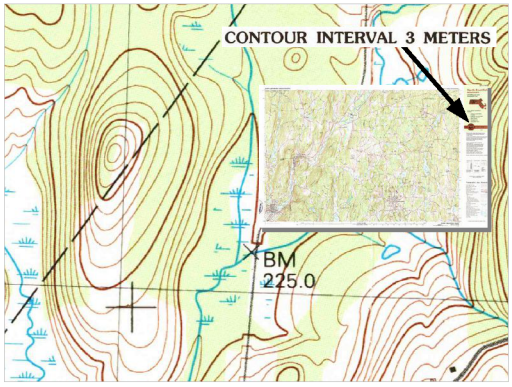


Vs point up hill. Uphill is above the tree line, and has a glacier at the top of the drainage (lower right corner).

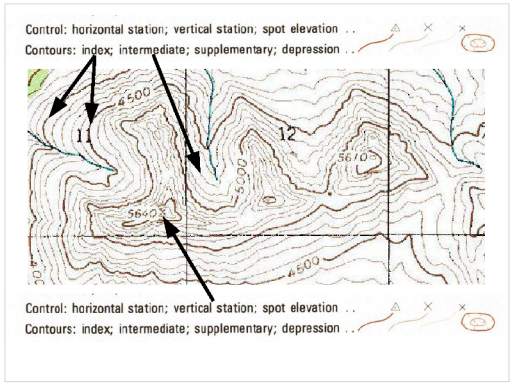


Contour lines also tell us how tall hills are.

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



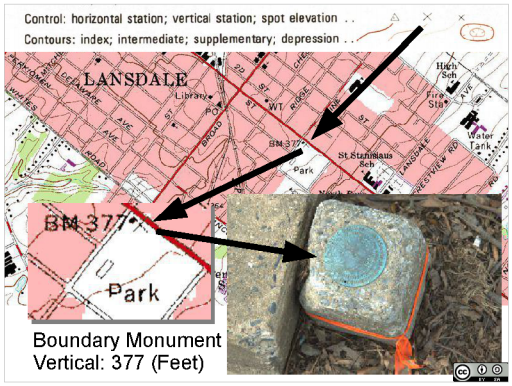
The metadata on the map border can tell us how far apart the contour lines are – what the contour interval is.



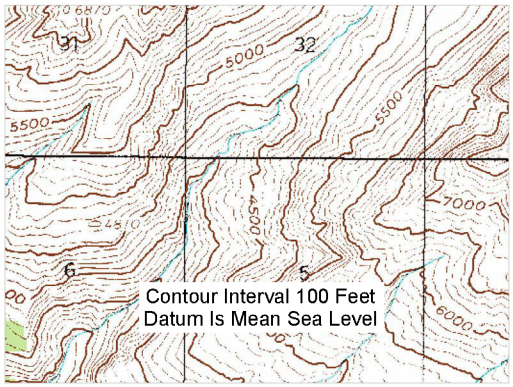
Contour lines are often of two line weights – thick lines with elevations on them (index contour lines), and thin lines without elevations (intermediate contour lines). The contour interval is the (vertical) distance between intermediate (thin) contour lines.

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

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



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

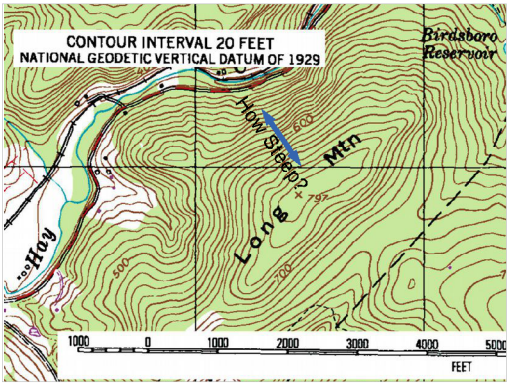


How steep is this?

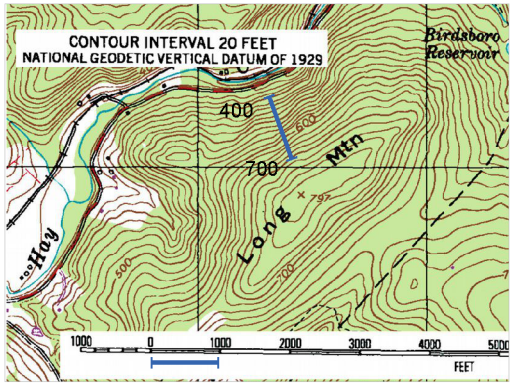
How can we tell?

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

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

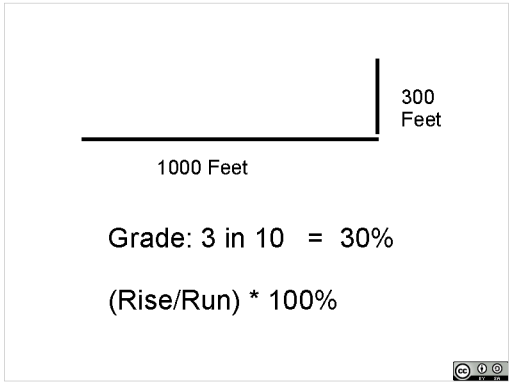


Contour intervals also let us find steep places and flat places – how steep is the NW face of Long Mountain?

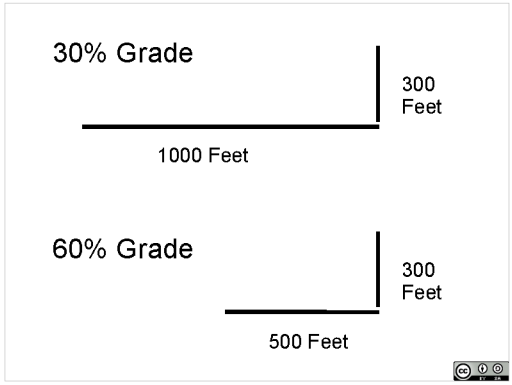


Vertical distance along the blue bar is 300 feet (400 foot contour line to 700 foot contour line)

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

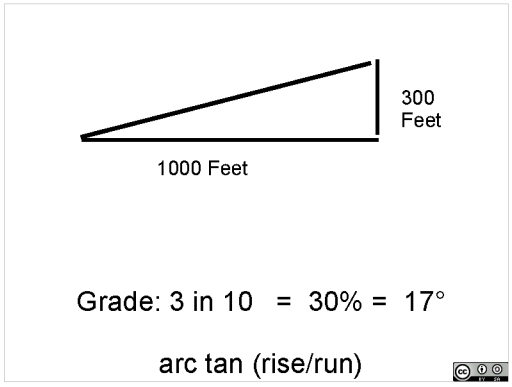


300 feet up a in a 1000 foot run, 3 in 10 grade, or 30% grade. Quite steep.

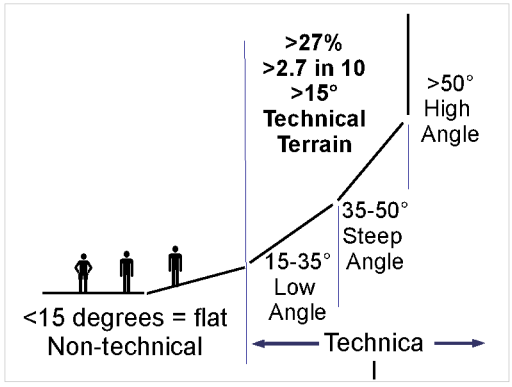


300 feet up in 1000 feet of run 30% grade

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



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



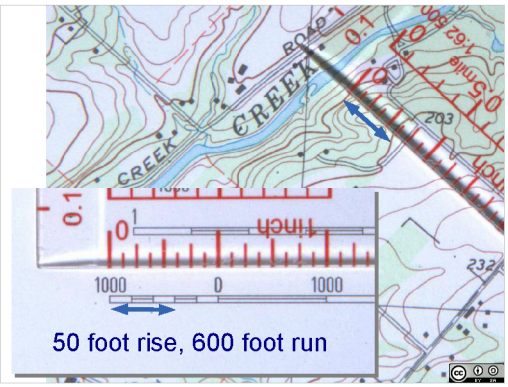
Definitions for high/low angle conditions vary:

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

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

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

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



How steep is this?

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

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

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

Less than 15 degrees or 27% grade, so probably can operate here without technical rescue assets.

Slopes

- High Angle
  - Weight is supported by a rope
- Low Angle
  - Weight is supported by the ground
  - May use rope for an assist



Top Image: Public Domain, Glacier National Park, NPS Image by: Jacob W. Frank, 2016/NPS.
Bottom image: © 2009 CC Attribution Share Alike Some rights reserved by AusAID: Department of Foreign Affairs and Trade. Members of the Namuka village (Fiji) disaster management committee in an exercise.

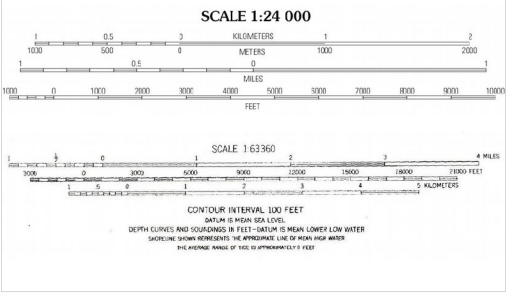
For technical rescue, we think of high angle terrain – where you are dangling off a rope, and low angle terrain, where the ground is supporting your weight (but you may still be using ropes, particularly in rough ground).

More that about 35-40 degrees is high angle.

35 degrees is about 70% grade.

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

Map Scales and Distance



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

Use these to measure distance.

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

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

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

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

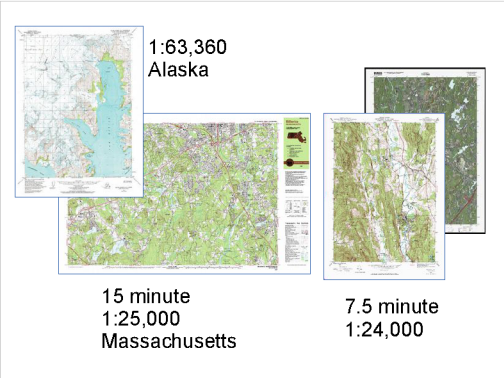
Measuring Distances on a Map

- Straight Line
- Curved Lines (lay out string on curve, pull straight and transfer to scale)

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

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

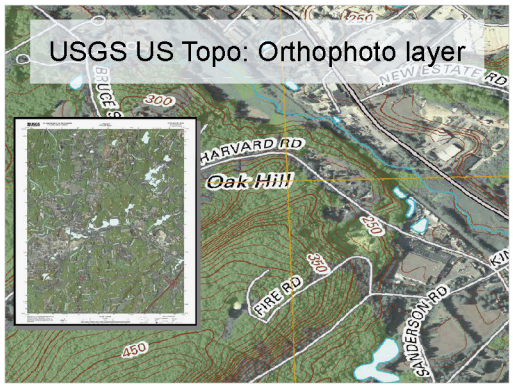
Practical Evolutions 1 + 2 here.



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

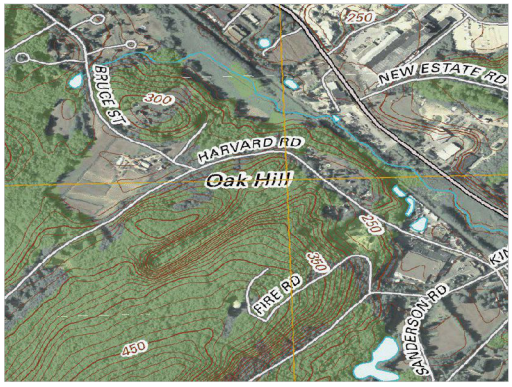
Alaska is covered by a 1:63,000 series (big state, larger number, less detail).

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



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

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

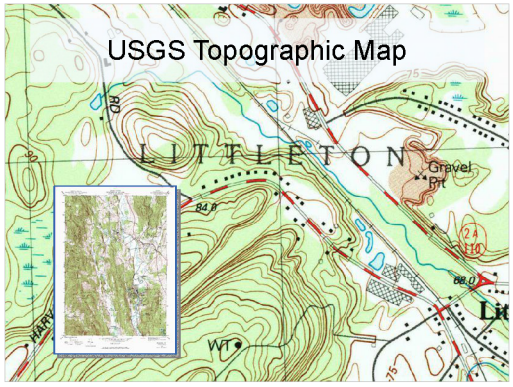


So let's walk through some differences.

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

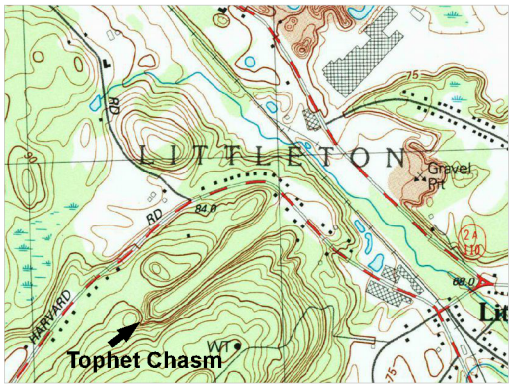
We can see oak hill, and in the center of the map, the long narrow valley cut into it (Tophet chasm, name isn't on the map).

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



Here's the same area on a topographic map.

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



Tophet chasm is still evident.

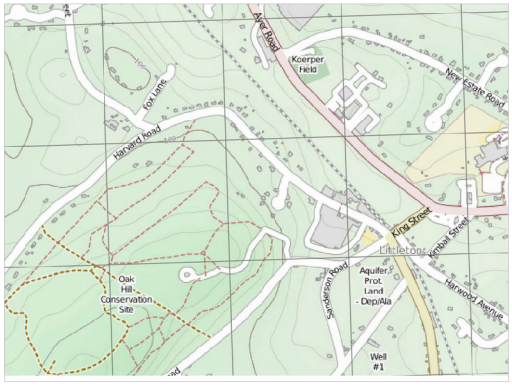


Here's an Open Street Map rendering of the same area.

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

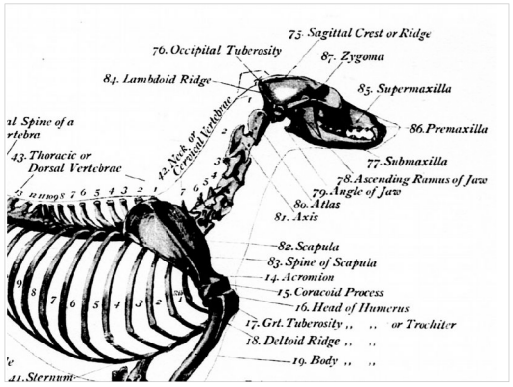
Oak hill is a conservation area – the trails have been mapped and contributed to Open Street Map.

Nice abstraction of roads, buildings, trails, railroads.



Where's Tophet chasm?

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



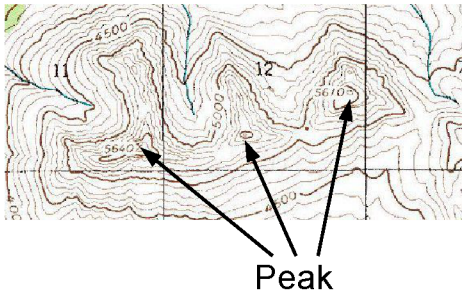
When we study anatomy, we put names on things to help us see, recognized, and observe them.

Terrain Features on Topographic Maps

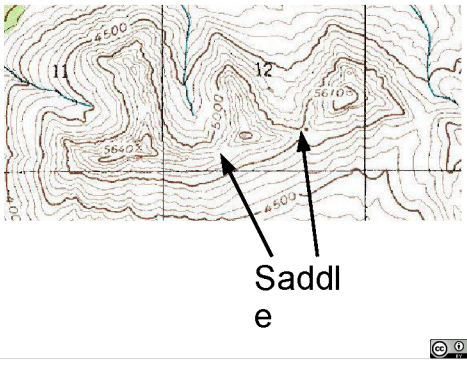
- Depression
- Cut
- Fill
- Hill
- Valley
- Ridge
- Saddle
- Draw
- Spur
- Cliff

Same thing with topography.

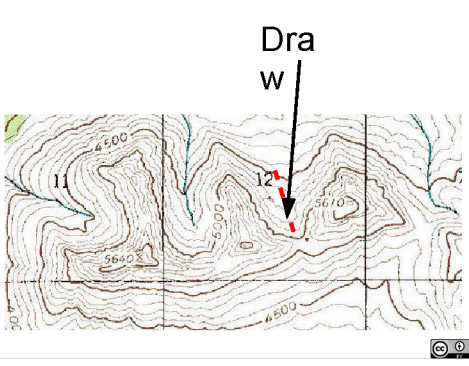
Putting names onto things can help us observe them. So, let's put some names to some terrain features.



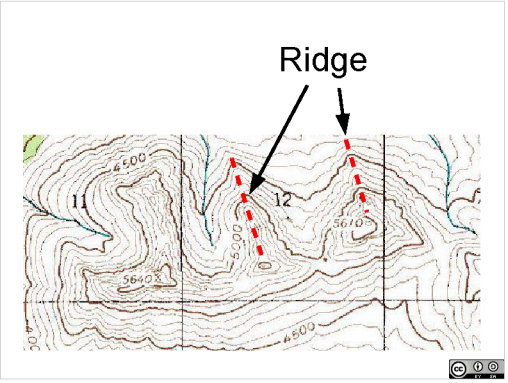
We've got peaks



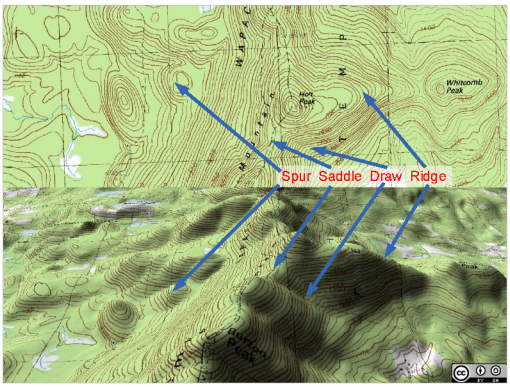
And saddles – things you could sit on with legs dangling down on each side and a high point infront and behind you.



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

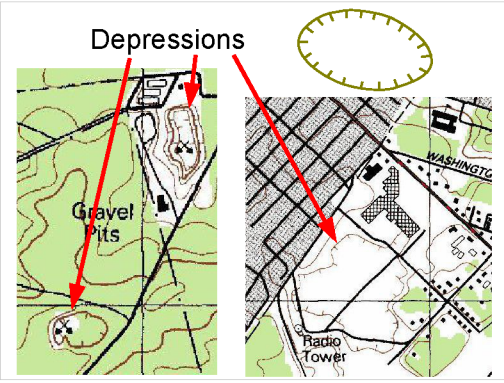


Between two ridges



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

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



Depressions are marked on topographic maps as contour lines with tic marks on the down hill side.

Usually just one, but sometimes several for a deep depression.



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

What do we see here?

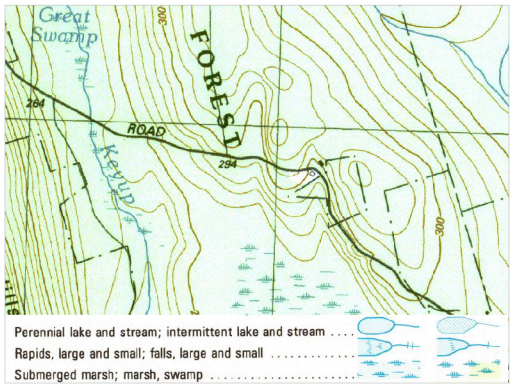
Wetlands.

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



Here's an air photo of an area.

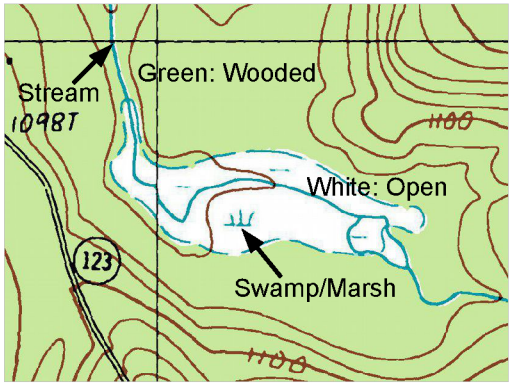
What jumps out at us?



Topographic map of the same area.

What can we see here?

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



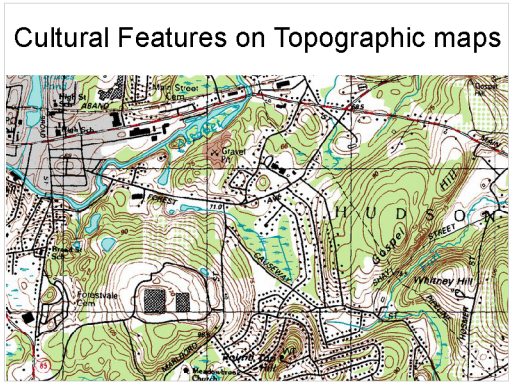
Wetlands indicated by blue horizontal line with three vertical strokes – wet ground with plants growing out of it.

Which way is the stream flowing?



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

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



Lots of human features also on topographic maps.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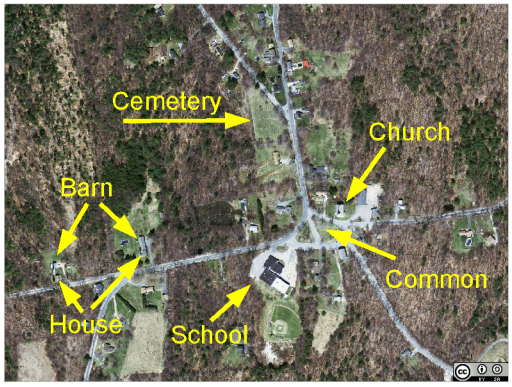
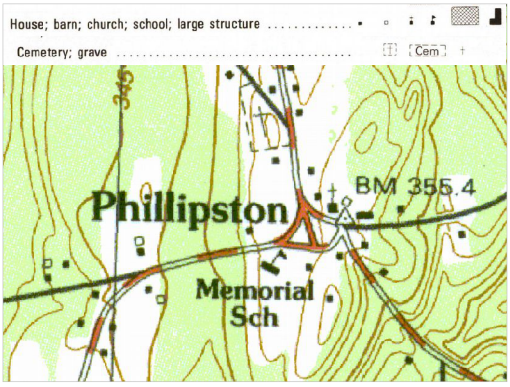
Let's look at a typical small New England town.



What can we identify?

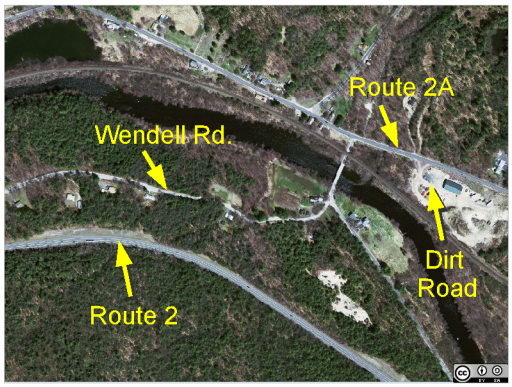
Knowing something about small New England towns, a lot.

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



Here's the topographic map of the same area.

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

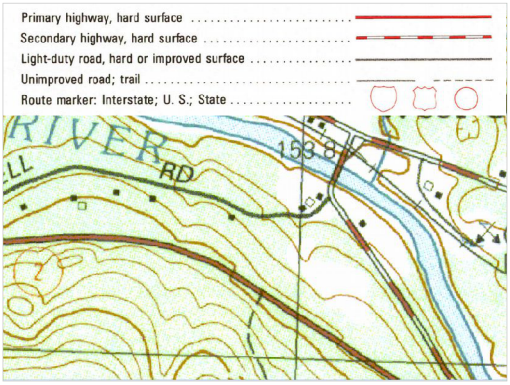


Here;s an air photo.

What do we see?

There are roads of different types.

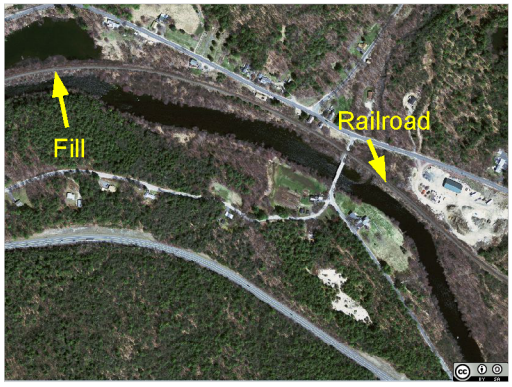
What else do we see?



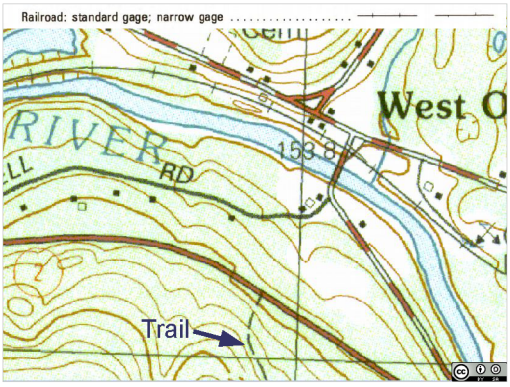
Roads of different types are evident on the map.

What else can we see on the map?

.



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



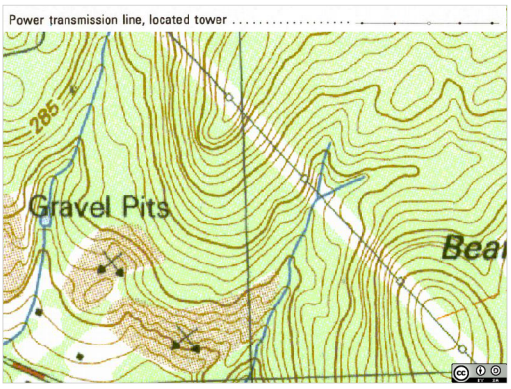
Railroad and fill evident on the map.

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



Another air photo.

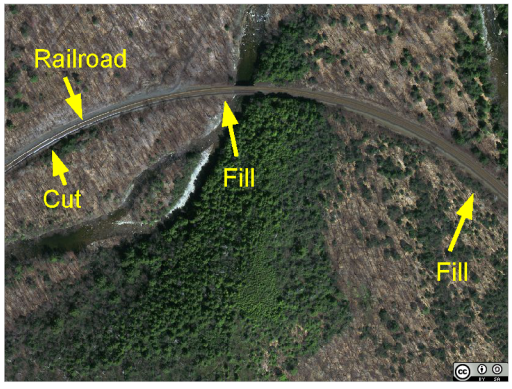
What do we see?



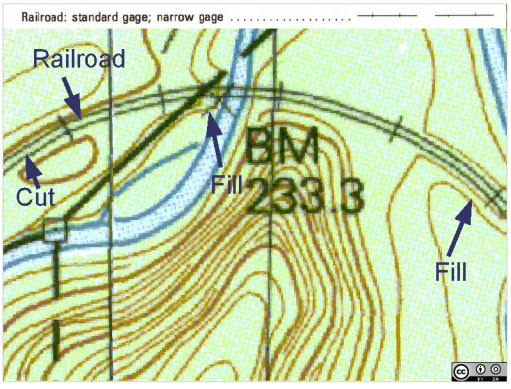
Where's the golf course?

What is the linear cleared feature?

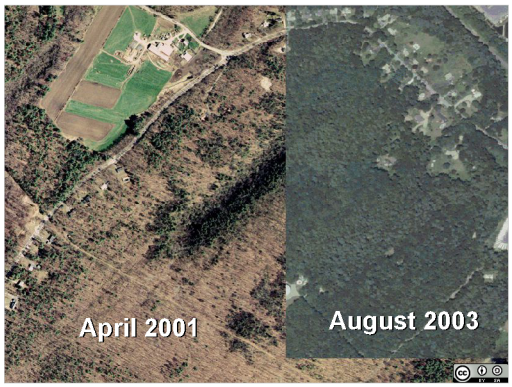
Are the gravel pits still there?



What can we see here?



Same area on a topographic map



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

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

Some Search Related Symbols

PLS/LKP/IPP

Clue

SARSAT Location (ELT, PLB hit)

Behaviors on Terrain

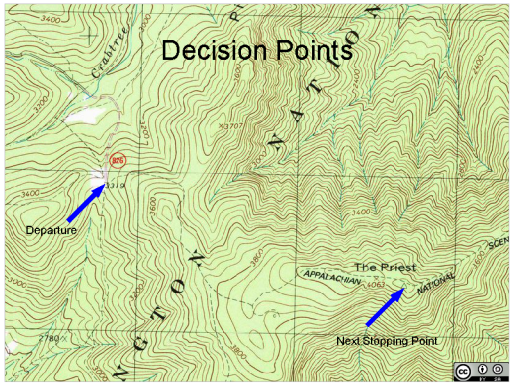
- Decision Points
- Paths of least resistance
  - Ridgelines
  - Remain in same watershed
- Goal directed behaviors
  - Route traveling to reorient (trails, roads, streams).
  - View enhancing: Going uphill in search of cell phone signal or view of landmarks.

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

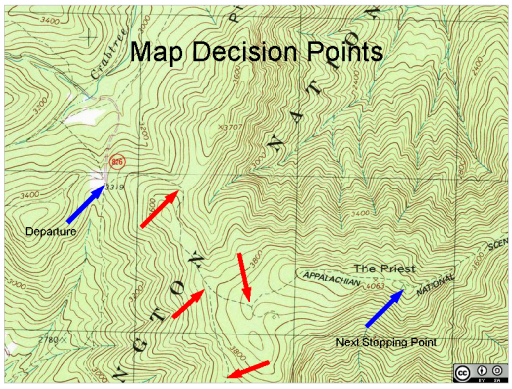
Key concept from Robert Koester and the study of lost person behavior is decision points – places on the terrain where a person may make a decision about navigation, and where they may make the wrong decision.

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

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



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



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

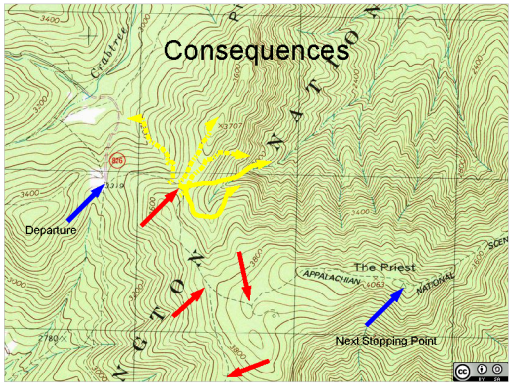
These are map decision points – we can see them on the map.



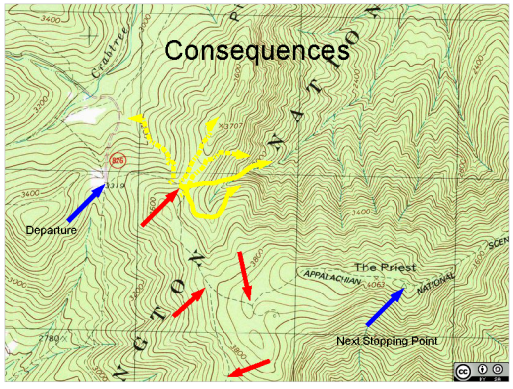
There are also field decision points – places on the ground where the route may not be evident – where a trail becomes faint, where it diverges into a set of herd paths, where it is cut by game trails, where it is overgrown, etc.

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

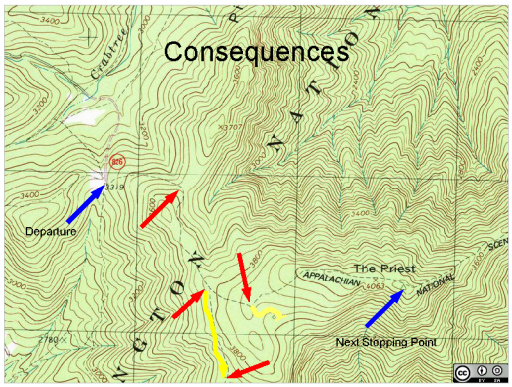
Very important to signcut field decision points, plot their location on the map, and report them in debriefing.



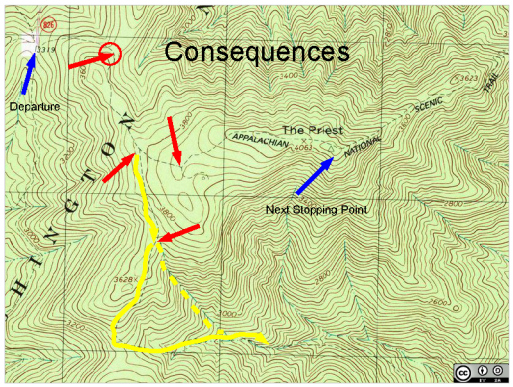
Now, what's the consequence of an incorrect decision at each decision point?



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

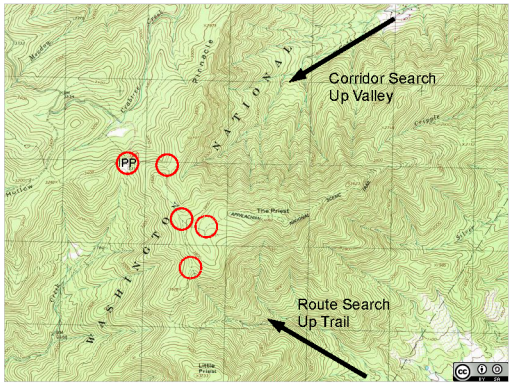


Points in the bottom center lead down into trails to the south. Point right center leads to a short spur trail. Consequence of taking a wrong turn there? Probably realizing it was a wrong turn and turning right around again.



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

Where do you want to put resources?



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

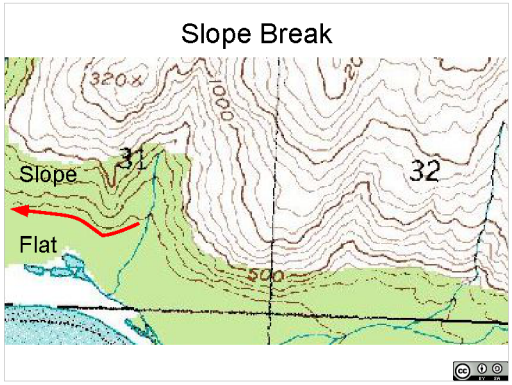
Implication for some high priority assignments – put a corridor search up the valley to the NE and a route search up the trail from the SE.

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

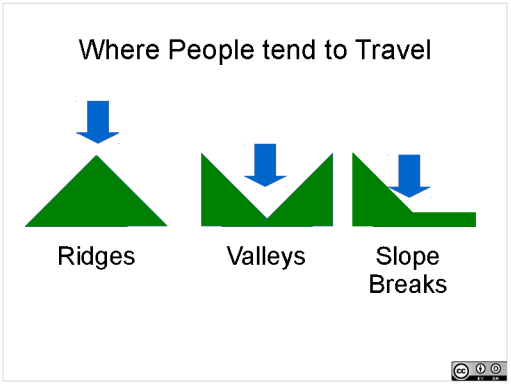
Yosemite Watershed data

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

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



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



People tend to travel:

Along ridges.

Along valleys.

Along slope breaks.

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Search Sensors and Tactics



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Unit 5, Search sensors and Search tactics.

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Search Crucials

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

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



Search Sensors and Tactics

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

What can you see?



Looking beneath the bush.



How about here?

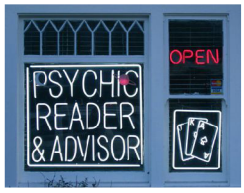
Footprint: Transfer on the leaf, pattern (straight lines from the pattern on the sole, color change, impressed pine needles, etc...

Subject Finders and Clue Finders (and technical resources)

- Clue aware searchers
  - Human searchers
  - Signcutters
  - Dogs
  - Horses
- Public safety personnel (fire, police, EMS)
- Spontaneous Volunteers
- Technical rescue
  - High angle, Confined Space, Snow, Cave, Water
  - Mountain Rescue Teams

Broadly distinguish between resources that are subject finders and those that are both clue finders and subject finders.

External Influences



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There are also external influences to be managed.

Other Resources

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

Other resources that can be brought in to the search.

Fire Service Resources

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

Plenty of important resources in the fire service.

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



Resources for transport and search.

Ground Searchers

- Clue Aware Searchers
  - Volunteer SAR organizations
  - Civil Air Patrol
  - SAR trained Police, Fire, CERT personnel
- Subject Finders
  - Firefighters (without SAR training)
  - CERT teams (without SAR training)
  - Spontaneous volunteers

Ground searchers clue aware and subject finders.

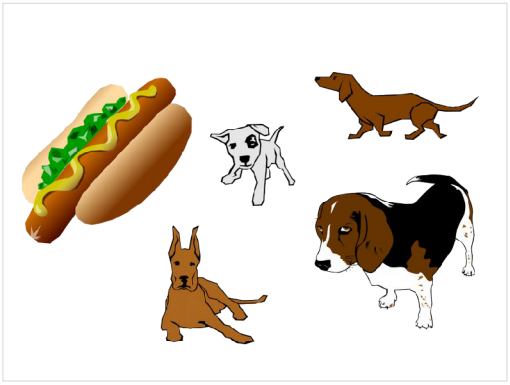


Search dogs

Typed Resources

- Call out the dogs....

Ask for searchers, need to be more specific.



What sort of dogs?

FEMA Typed Canine SAR Resources

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

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

Need to understand the general capabilities.

Canines

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

Some canine disciplines relevant to search.

Dogs may be cross trained or single discipline.



The bloodhound.

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

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



Trailing dog at work.

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

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

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

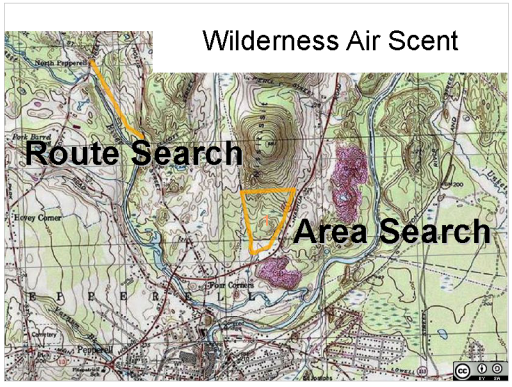


Air scent

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



Typically with a trained indication behavior – stay and bark at the subject, or return to the handler, perform a trained behavior and bring the handler back to the subject.



Can search areas or routes (trails, drainages, travel corridors).

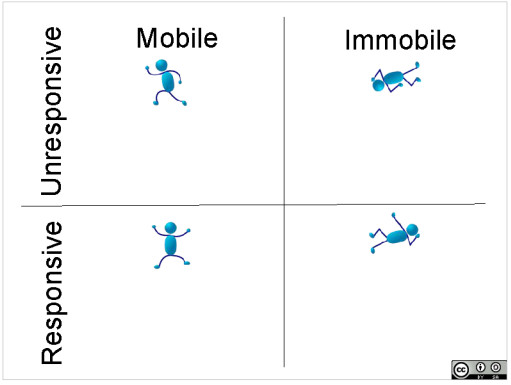


Then we have humans that track humans.

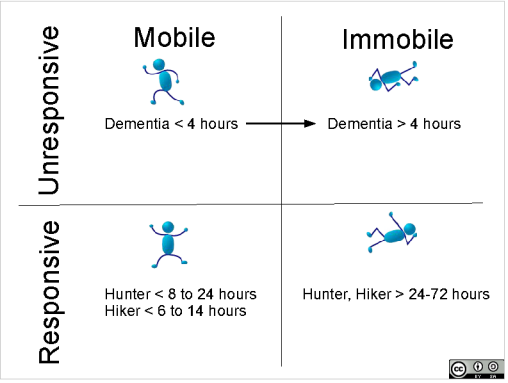
Tactics

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

Tactics in a search – direct or indirect.



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



Where a subject falls in this matrix changes over time.

General motion towards immobility.

Responsive?
Sound Sweep

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

Sound Sweep:

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

Not: "Johnny, Johnny, Johnny, Johnny...."

Tactics

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

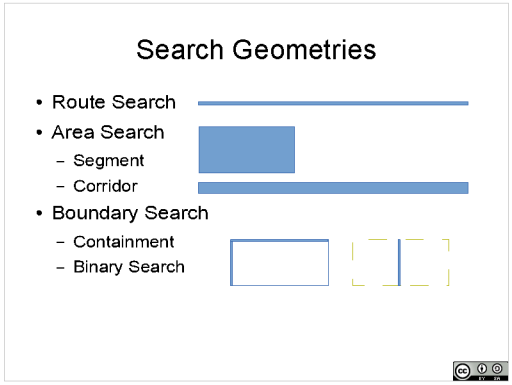
Some direct and indirect tactics.

Not mutually exclusive. Investigation key in all searches.

Determining Direction of Travel

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

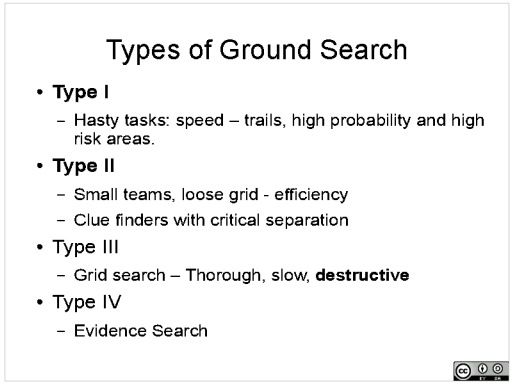
Some resources are able to identify the subject's direction of travel. For some subject categories, this is very predictive.



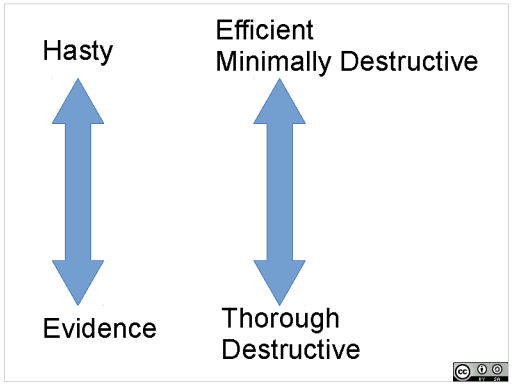
Search areas get divided into search segments. That isn't the only approach.

Trail/route searches, corridor searches on likely travel routes.

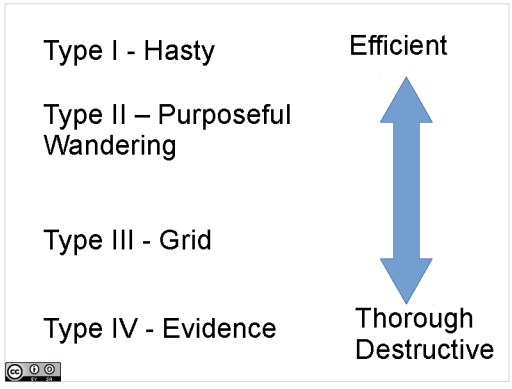
Searches along boundaries of segments – typically with signcutters.



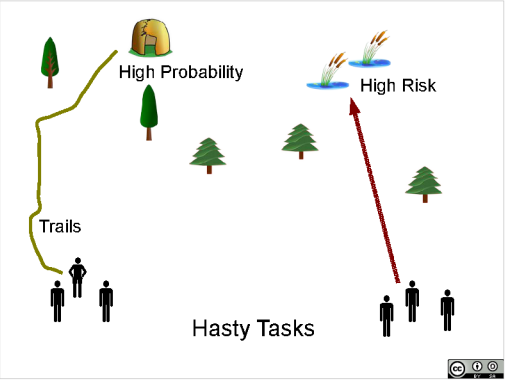
We can divide ground search into 4 types.



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



Hasty – efficient
Evidence search – thorough and destructive.



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

High probability is also often trails and travel corridors.

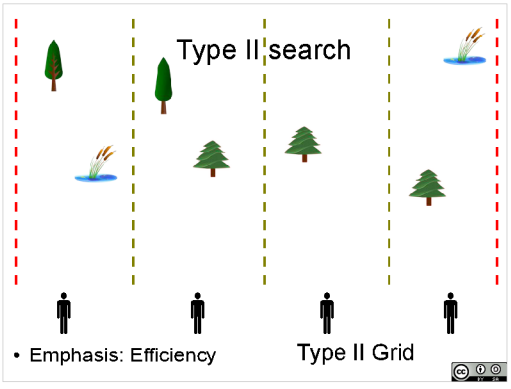
Special attention should be paid to enclosures like refrigerators, freezers, and the interior of parked vehicles where limited breathing are may place the child at even greater risk.

NCMEC Model Missing Children's Policy

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

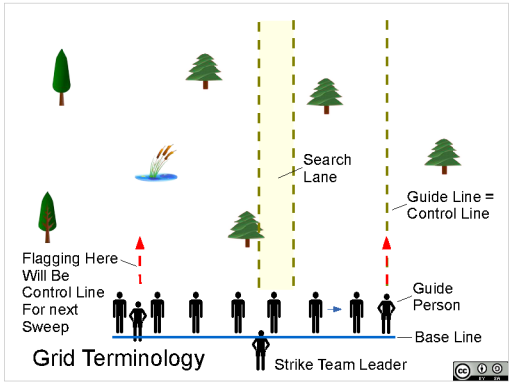


Here's a hasty task searching along a shoreline.



Open grid search with clue aware searchers.

Everyone has a search lane.



Maintain span of control.

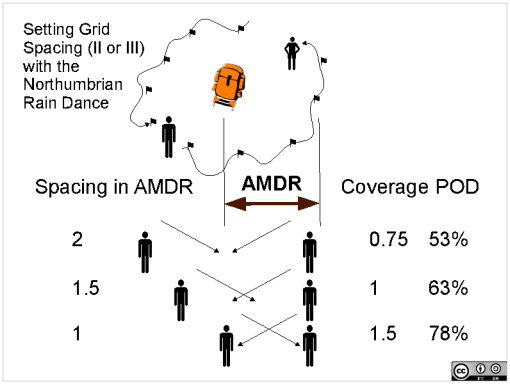
Each searcher has a search line.

Each searcher starts on the base line.

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

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

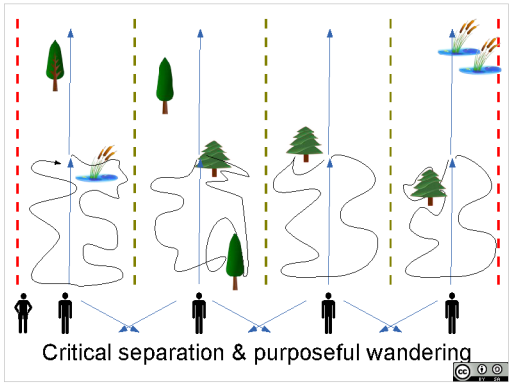
(For type III searches use relatively small numbers of untrained searchers mixed with and under the leadership of trained searchers.)



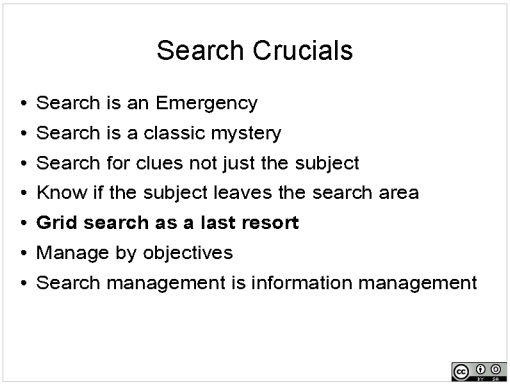
Reminder on the Northumbrian Rain Dance as a means for setting the grid spacing for either Type II or Type III grids.

Covered in the NEWSAR POD/POD Factoring class.

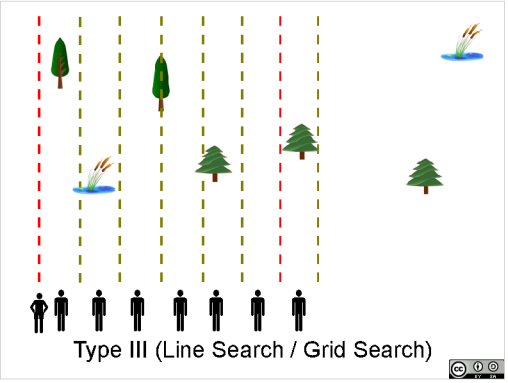
Use an object the size of a person to determine POD (the POD reported will be that of finding the subject).



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



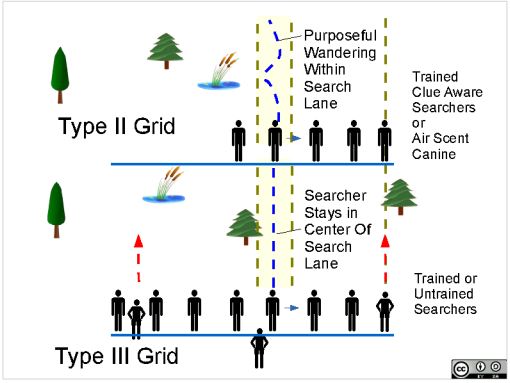
General principle – close grid search as a last resort.



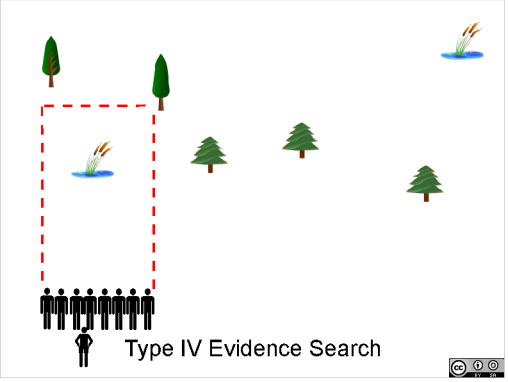
Type III grid search with subject finders.

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

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



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



Type IV search – evidence search.

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

Takes lots of people and lots of time.



Type IV searches tend to be a line of police academy cadets.



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

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

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

Task Force/Strike Team Member Functions

- Leadership
- Navigation
  - Bearing
  - Distance (Tally)
  - Flagging
- Communications
- Record Keeping (time keeper)
- Medical

Lots of responsibilities in a resource that is searching. Divide those responsibilities up.

Individual Responsibilities

- Own Gear
  - Navigation, Flagging, Lights, PPE, Survival
- Dressed appropriately for terrain and weather
- Physically and mentally prepared

Some key responsibilities of each individual searcher.

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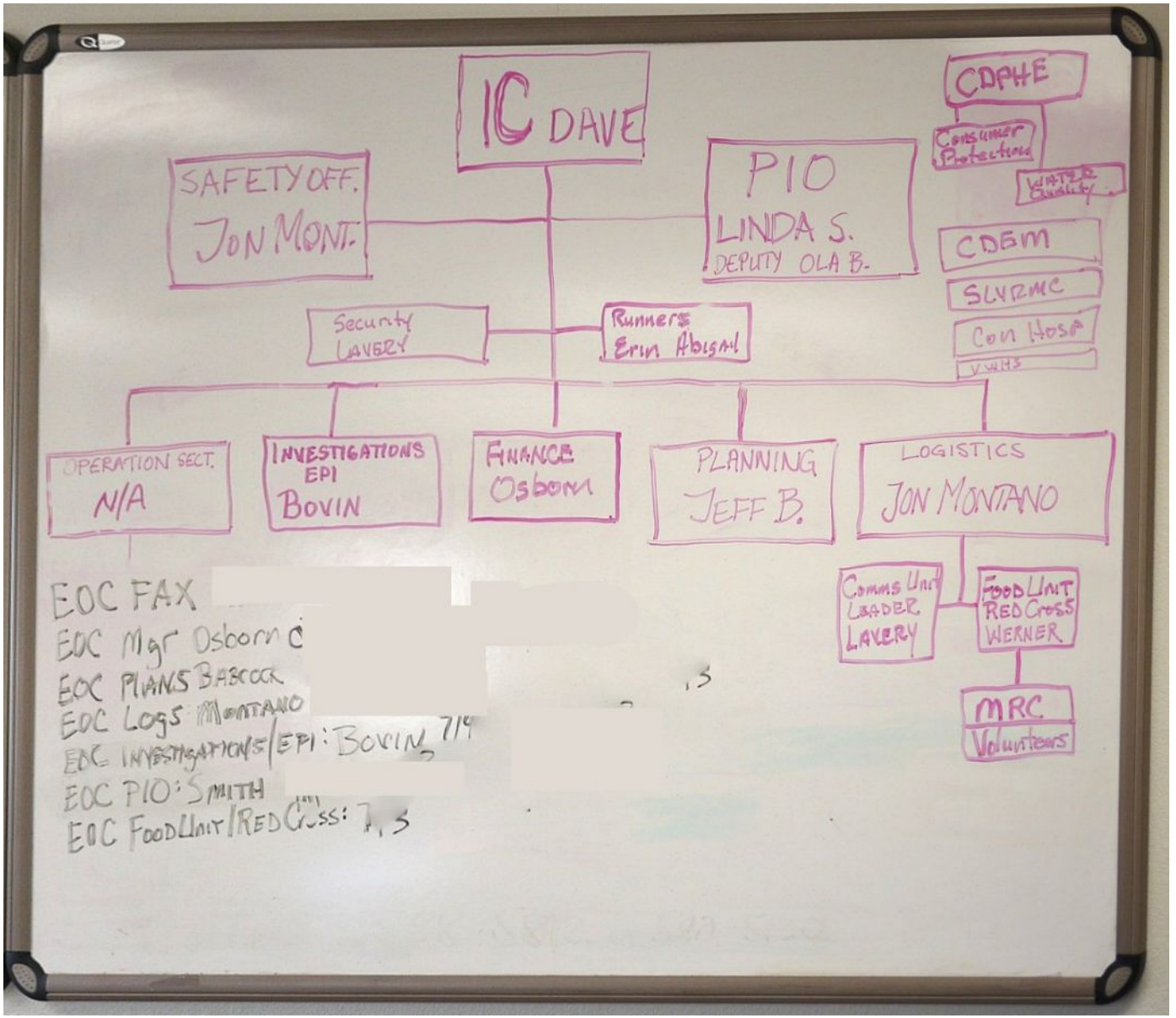
Incident Command System



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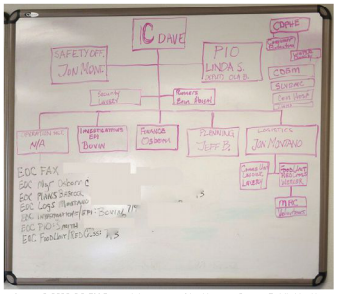
Incident Command System



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Unit 6: ICS
What is present in any incident?
[Chaos (uncertainty, misinformation, etc..)]
The Incident Command System is a means for reducing chaos.

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- **Search management is information management**

Two of the search crucials highlight the importance of ICS

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

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



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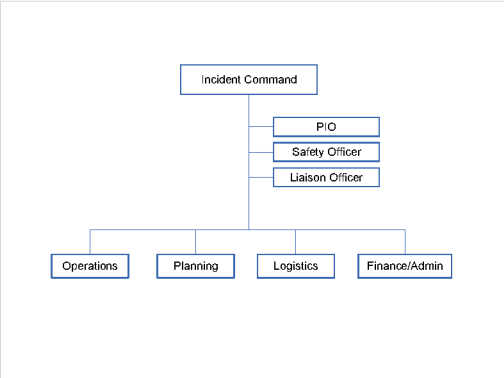
(U.S. Navy photo by Mass Communication Specialist 1st Class Matthew M. Bradley/Released)

The nature of an incident is chaos.

ICS lets us organize, manage, reduce the chaos.



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



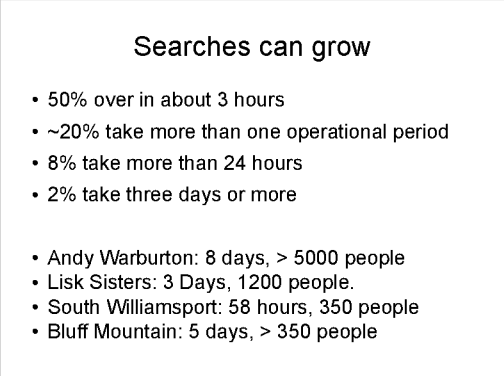
So, let's look at ICS, and how it can function to assist in reducing chaos in a search (or a SAR training event, or any incident).



Incidents Scale

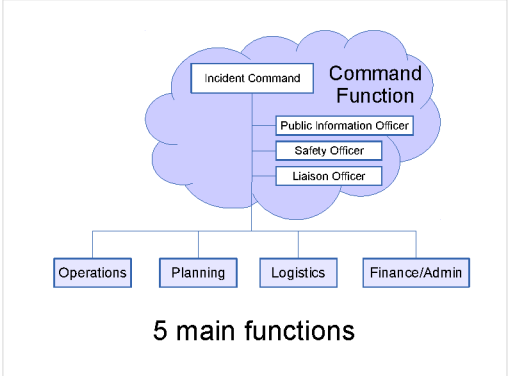
ICS is designed to scale

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



Most searches are over fairly quickly and involve few agencies.

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



ICS defines five functions that are performed at most incidents.

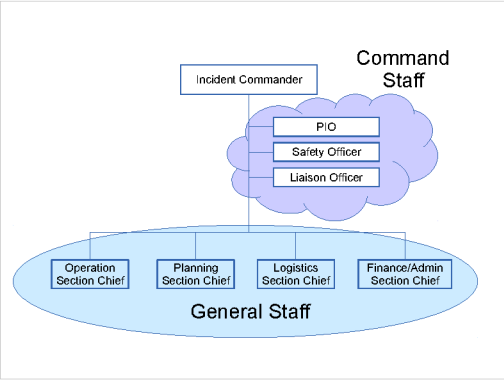
Command – overall management

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

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

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

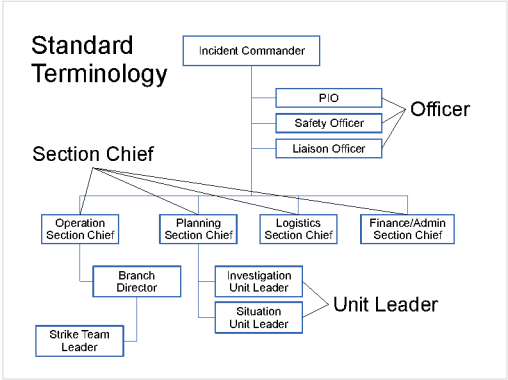
Finance/Administration – on site financial activities to support the incident (tracking hours, maintiaining purchasing records, injury and damage claims, etc). Key in large searches and in disasters where there may be reimbursement from FEMA.



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

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

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



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

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

Standard terminology includes titles for positions.

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

Standard Titles

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

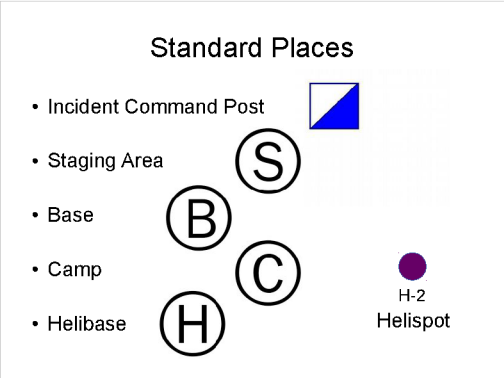
Some of the key titles.



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

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

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



Management of the incident at the ICP – separated from distractions (e.g. keep the family out).

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

Base – Logistics section – primary service and support activities.

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

Helispot – landing zone

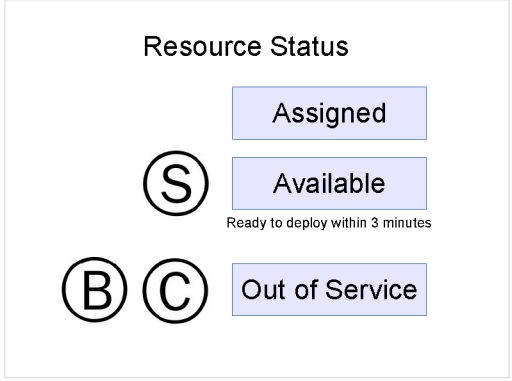
Helibase – fuel, maintenance, etc.



Out of service resources, resting, rehabilitating, servicing.



Available resources ready (within three minutes) for assignment



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

Assigned – performing some assigned task.

Available – ready for assignment within 3 minutes

Out of service



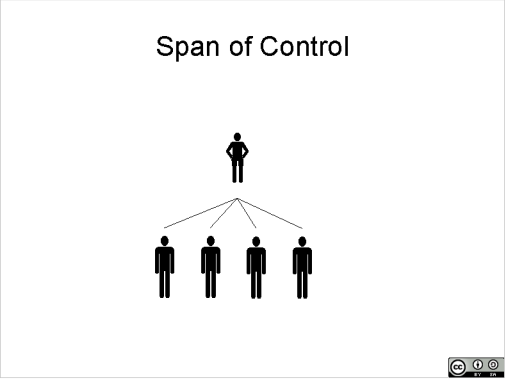
Everyone has exactly one supervisor.

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



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

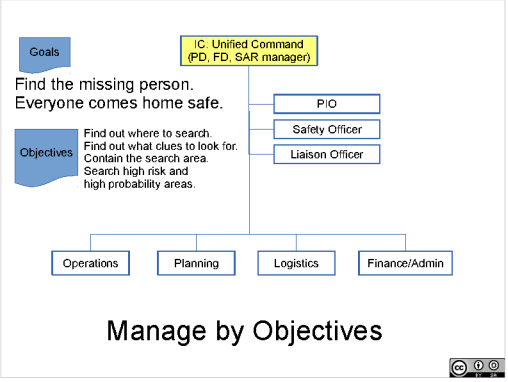
Operating as part of a task force in ICS, the yellow relationship applies – everyone in the task force reports to the unit leader (the canine handler).



How many people can you manage in an incident?

3-7, optimum 5.

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



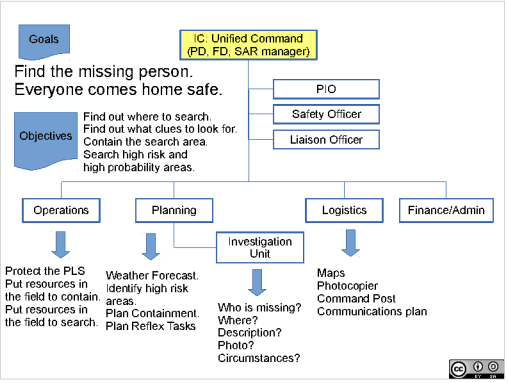
In the chaos of a search, there will be things you can control, and things you can't control. Focus on the things you can control, and set SMART objectives.

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

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

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

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



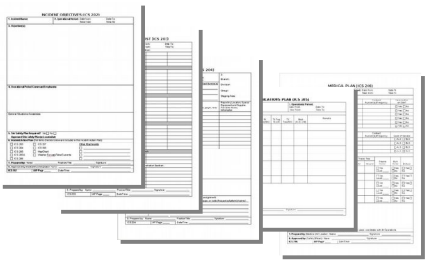
Incident objectives then drive the activities of the search – focusing them on actions on things that can be changed.

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

Goal: Everyone goes home safe.

SMART Objective...

Incident Action Plan

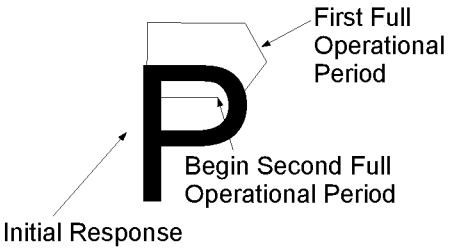


Searches run on paper. However:

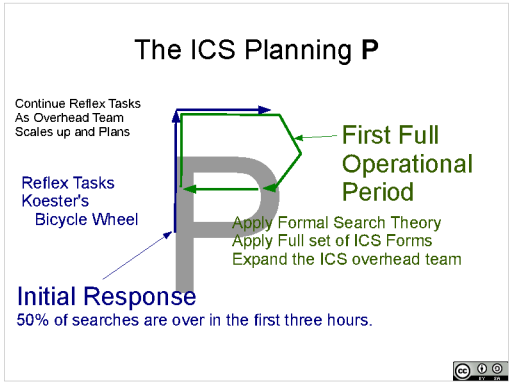
Don't get bogged down in paperwork and planning.

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

The ICS Planning **P**



Remember the ICS planning P.



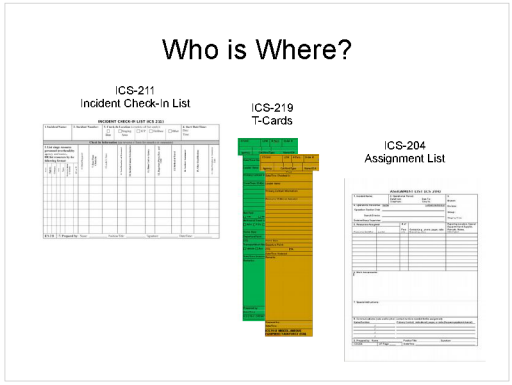
Very important not to get bogged down in paperwork during the initial response.

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

Record who is going on what task.

Get boots on the ground.

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



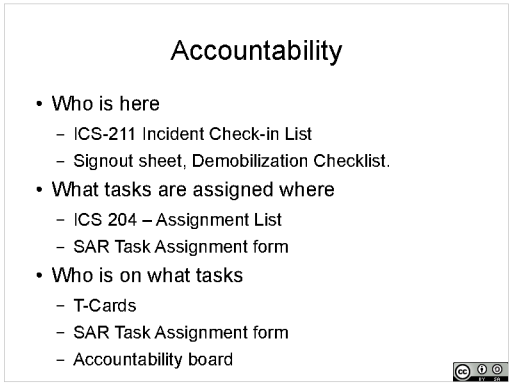
Accountability

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

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

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

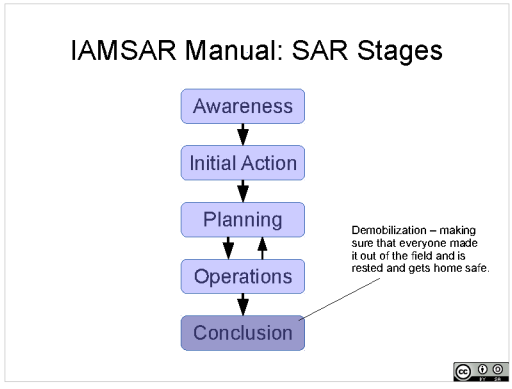
ICS has forms designed to manage this information.
Always sign everyone in.
The search isn't over until everyone is home.
Starting out, write it down on a blank piece of paper, and assign someone to keep an activity log.



Can also use:

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

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



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

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

Usually a signout sheet for a search.

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



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You have a lot of tools in your bag.

ICS isn't one of them.

ICS is the bag.

Legal and Ethical Framework



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Legal and Ethical Framework



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Unit 7: Legal and Ethical Framework for SAR

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

A cascade for decision making.

Legal to Ethical to Moral.

NEWSAR Code of Ethics (selected points)

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

Handout the NEWSAR code of ethics.

Highlighting some elements of the NEWSAR code of ethics.



Authority Having Jurisdiction

Volunteer searchers work for an authority having jurisdiction.

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

Highly variable in NE US.

Searches run under **Need to Know**

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



Need to know – you won't know everything.

Don't share information about the search.

Absolutely nothing to the press.

The public does not Need to Know

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

Or public.

Do not publicly criticize any Emergency Services Department.



Constructive criticism in mission critique.

No Freelancing

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



We work as emergency service organizations.

Scope of Practice



Are you trained to do this?

No? Then don't.

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

Standard of Care

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

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

Negligence

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

Need to prove chain of elements for negligence.

Consent (to medical care)

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

Obtain consent before providing medical care.

Evaluating Capacity to Consent

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

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

Entry onto private property

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

There is variation from state to state.



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Some people object.

Trespass

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



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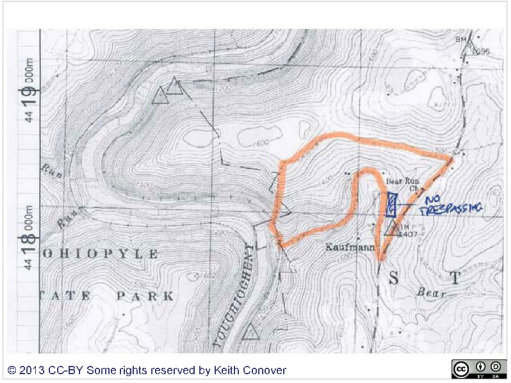
Trespass occurs when you enter somewhere you've been told not to (in person or through posting).

Except

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

Some exceptions.

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



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

Report it in debriefing.

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

Good Samaritan Laws

- Medical
- SAR

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

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

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

Details are Important

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

Details state to state are important.

Confidentiality

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

As said earlier – confidentiality is critical in a search.

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

HIPAA protects medical information.

Refer the press to the PIO.



No pictures.

Absolutely no pictures of someone injured.

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



Safety



Think.

Accountability

3 Cases in ISRID are of missing SAR Personnel

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

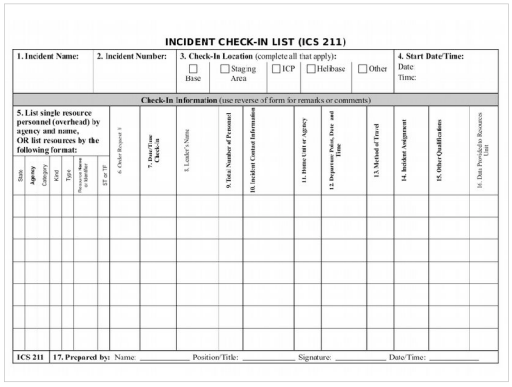
Important to know where everyone involved in the search is – and when they are out of contact.

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

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

Is everyone back from the field?

Getting home safely.



INCIDENT CHECK-IN LIST (ICS 211)

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

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

5. List single resource personnel (overhead) by agency and name, OR list resources by the following format: Strike / Agency / Kind / Type / Resource Name or Identifier	6. Order Request #	7. Date/Time Check-in	8. Leader's Name	9. Total Number of Personnel	10. Incident Contact Information	11. Home Unit or Agency	12. Departure Point, Date and Time	13. Method of Travel	14. Incident Assignment	15. Other Qualifications	16. Data Provided to Resource Unit

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

Tools for managing accountability – sign in on arrival.



T-Cards, task assignment forms, etc.

Radio status checks.

Nobody Leaves Last





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Clue Detection



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Unit 8: Clue Detection

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

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

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

What can we learn from this?

Search Crucials

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

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

Search for clues not just the subject.

Search for Clues not just the Subject

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

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

Clues can shift the focus of the search.

Clues may tell us that a crime has occurred.

Clues can be

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

Clues come in many types.

Examples?

Subject may:

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

Subject has behaviors that create clues.

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

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

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



Is this a clue?



How about this?

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

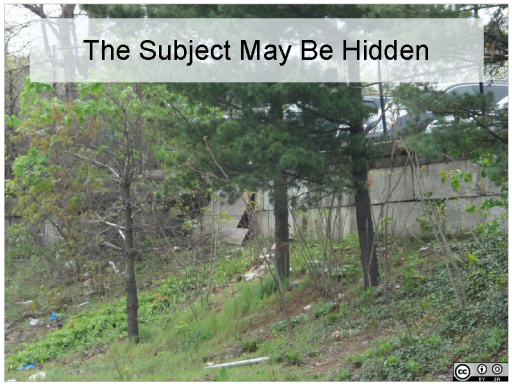
Information elicited in the investigation – lost person questionnaire.



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



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



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

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

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

Hug-a-Tree instructions

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

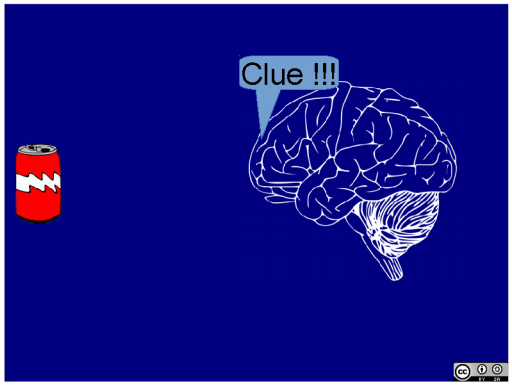
Subjects may be sheltering in a dark plastic bag – that's one of the preventative SAR messages, carry a plastic bag in your pocket or pack for expedient shelter.



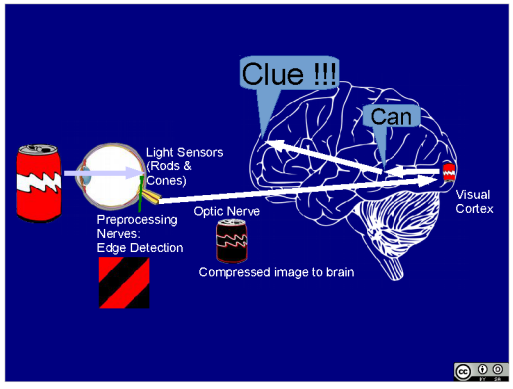
Subject in a plastic bag under a tree.



How does clue detection work?



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



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

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

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

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

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

Teach your Brain to Observe

You can teach your brain to observe clues.

Be attentive all the time.



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

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

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

Include clues in regular training evolutions

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

Regularly include clues in your training evolutions.

Use specific clue detection evolutions

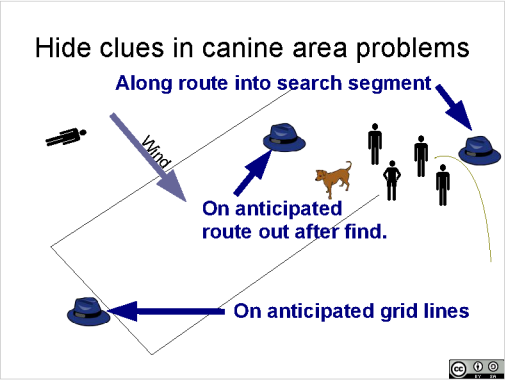
and

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

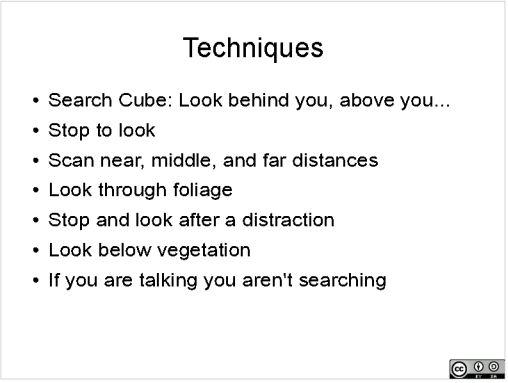


Canine route problems are ideal for adding clues – if the subject travels out on the route, have them leave some clues along the way.

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

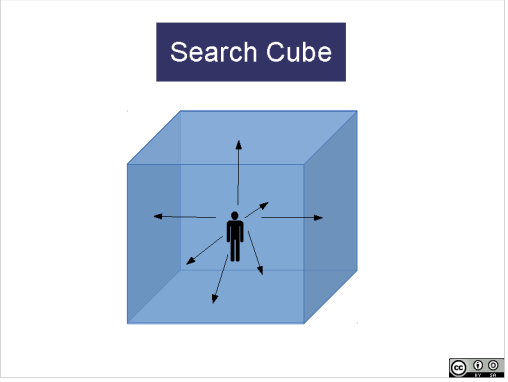


Canine area problems are a little more chancy for clue detection – the humans of the task force may not pass near a clue dropped in a random location in the search segment. Routes in to the search area, anticipated grid lines, and anticipated routes out of the area after the find are good places to consider.

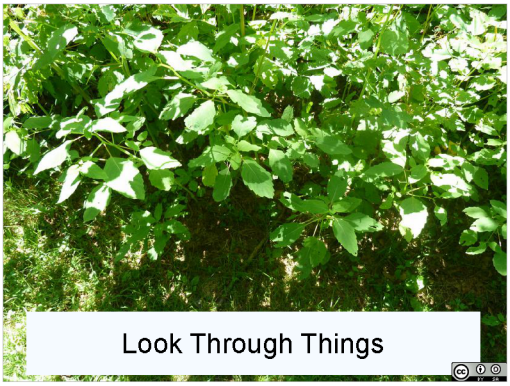


There are also strategies that you can follow to improve your ability to see and observe clues.

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



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



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

“It isn't the trees that are missing”



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



Take a Knee.

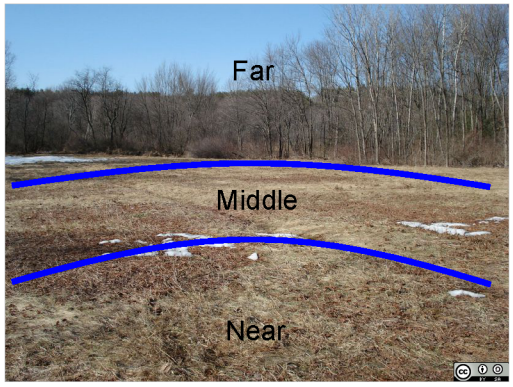
Kneel down and look beneath things.

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

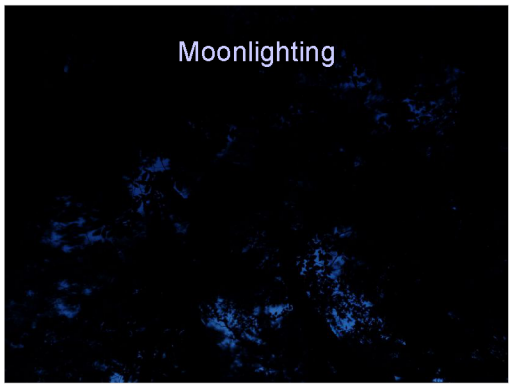


Clue hidden in a search segment in a MA SAR Exercise, and missed by a type II grid search team.

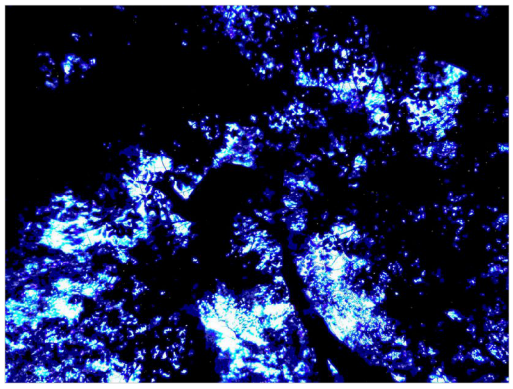
Clue was hidden low in an attractive pile of boulders – purposefully wander and Take a Knee.



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



At night, look up and move your head.



Silhouetting things in the trees against the lighter sky.



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

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



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



What do we see?

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



Behind, Behind, Behind

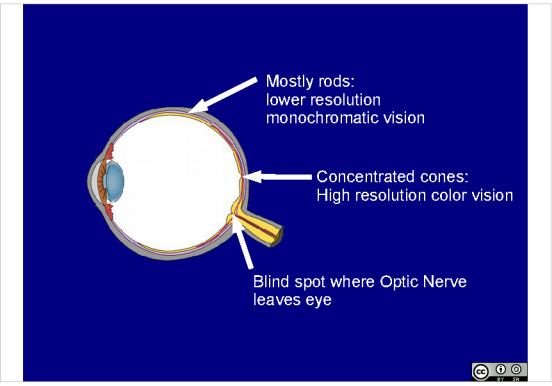
Look at all 6 faces of the search cube.

Look behind you.

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

What else is here?

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



Knowing something about the eye can help us observe things.

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

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



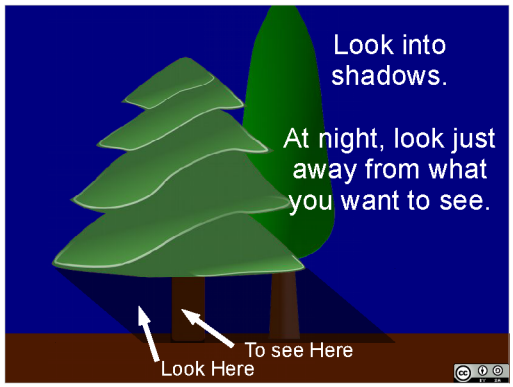
We think we see this.

Look at the puppy's nose.



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

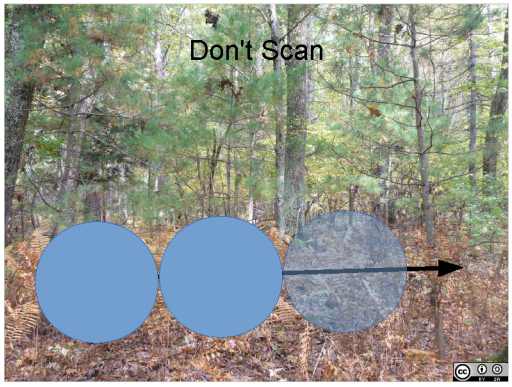
Your eyes are constantly moving (even when you think you have them focused on something), and your eye and brain are assembling what you think is a uniform colored sharp image.



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

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

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



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

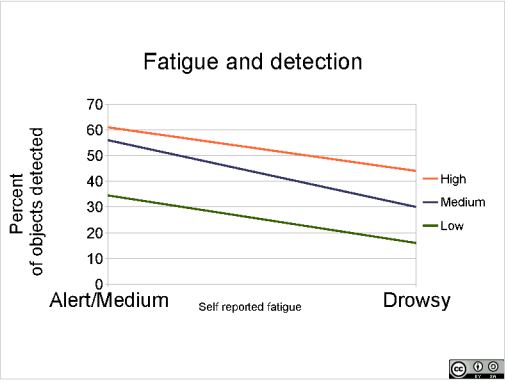
Instead of scanning your eye across the landscape, pause, move, pause, move, bringing attention systematically to bits of the landscape.

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



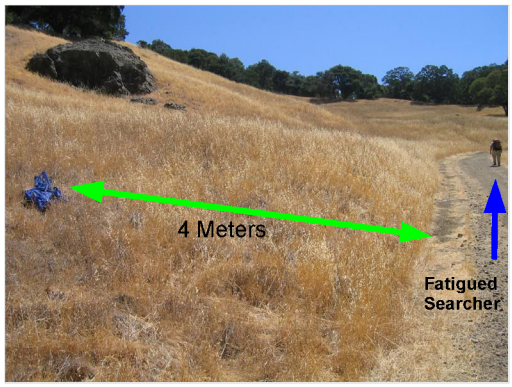
The behavior of a search dog provides clues.

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



Fatigue is well known to decrease performance.

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



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

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

Upon finding a clue

- Don't touch.
- Call it in.
- Record and flag the location.
- (More in Crime Scene Preservation)

What do you do when you find a potential clue?

Don't touch it.

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

Likely instructions are to record and flag the location.

Upon finding a clue

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

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



Good flagging method, three long streamers of flagging tape.

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

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

Clue Log

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

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

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

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

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Tracking



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Unit 9: Tracking/Mantracking/SignCutting

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Tracking

- Signcutting/Tracking/Mantracking
  - Signcutting = mantracking/tracking
  - Signcutting = trying to acquire a track
  - Signcutting = jump tracking
- Sign
  - Sign
  - Track
  - Print

Various names for a person following a track.

Signcutting is a good one – but more than one meaning.

Sign – what is it? Any evidence of passage.

What is a print? What is a track?



A print, observed in the early morning.

Notice the very clear impression of the lugs in the sole from the heel of the footwear.

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

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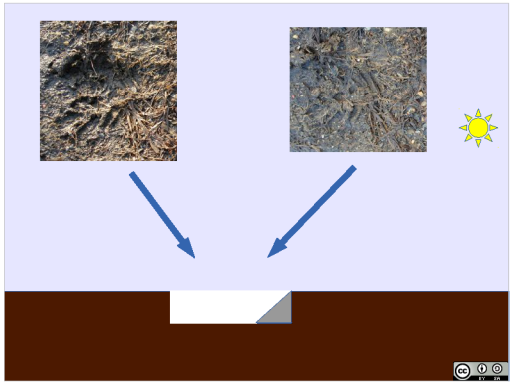
The same print, observed from the other side, the broken plastic is now at the top of the picture.

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



Lesson 1:

Angle of illumination is critical for observing sign.

Use Sun Angle

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

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

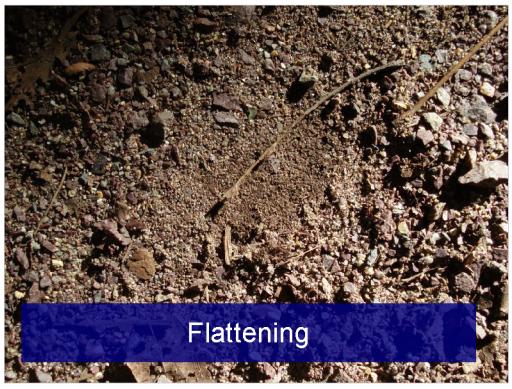
Sign

- Flattening
- Regularity
- Color Change
- Disturbance

Elements of sign that you can observe



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





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



An impressed twig. Again, a dark halo.



Regular wavy pattern from tread on the sole.



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

What sort of footwear is this?

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



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

Can be very durable tracks in urban environments.



Here we have a boundary between mud and asphalt pavement.

A tracklayer walked from the mud onto the asphalt.



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

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

Transfer.



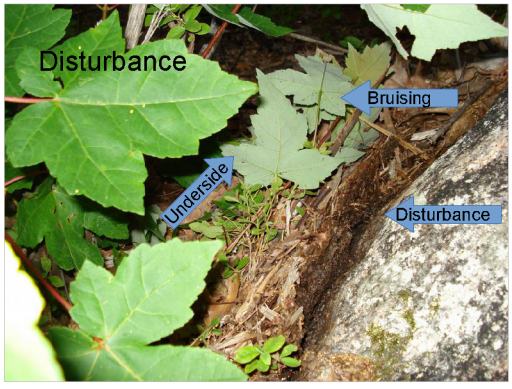
Transfer, later when the pavement is dry.



What can see here?

Scrape marks on the stick where frost was scraped off.

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



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

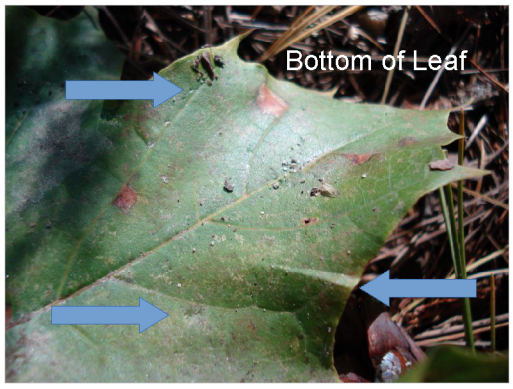
See also brusing on bottom of overturned leaves.



Dry leaves crack when stepped on.



Older cracks dry and spread apart.



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

What do you know about the sign?

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

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



What do we see?

What do we know about this sign?

Definitely human, may not be identifiable.

Look for sign in three dimensions

Sign isn't just on the ground.



Horse Trail crossing Evansburg Creek
Evansburg State Park, PA
Horse hair in branches over trail



Horsehair on leaves above horse crossing,
Evansburg Creek
Evansburg State Park, PA



Track in pine needles.



With a broken twig in the track.



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



Dry tall grass disturbed by passage
Penhurst State School, PA



Footprint in tall grass
Penhurst State School, PA

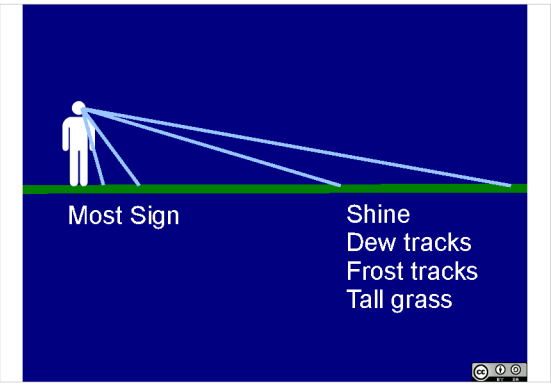


What do we see?

Tracks in dew.

Will these last?

Where can you see them best?



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

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



Track Traps: Natural or created.

You can create them.

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

Dirt time

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

Learning to track involves teaching your brain to observe sign.

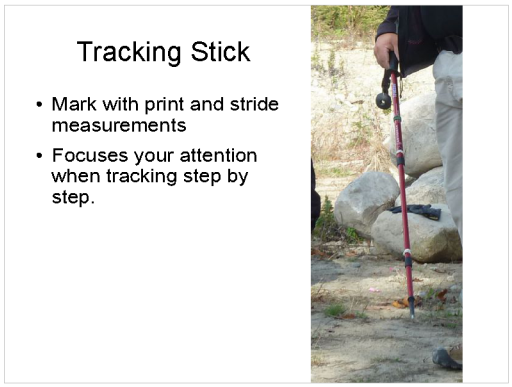
Very time intensive, needs lots of dirt time.

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

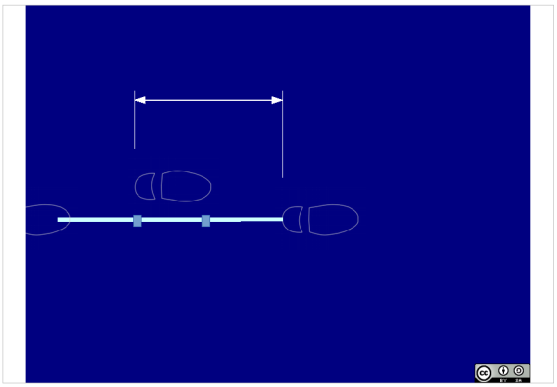
NEWSAR usually has tracking opportunities at the annual training.

NASAR has a tracking course.

VA Field Team Signcutter course is a week.

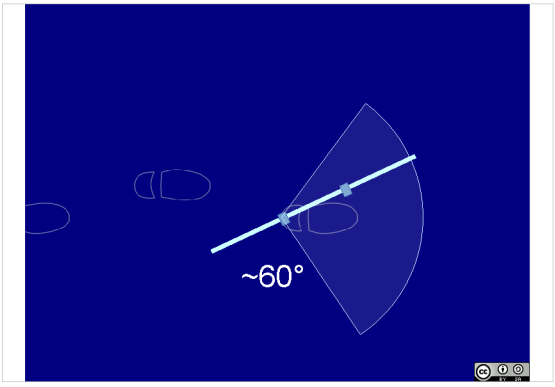


A tool that can help you track is a tracking stick.



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

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



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

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



What do we see?



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

What is going on here?