SAR Systems, Search Crucials

"Emperor Fraser hits reef and sinks near Dunraven"

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

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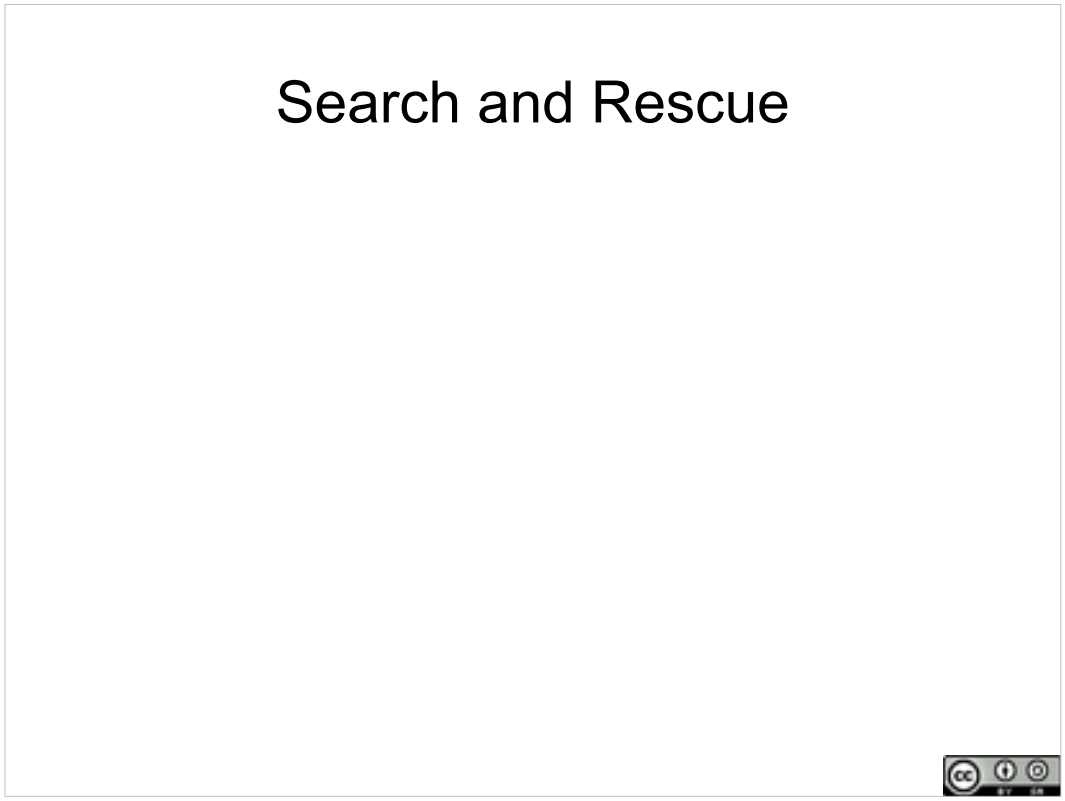


Search and Rescue

What's the difference? [Discuss]

Search and Rescue

- **Search**
  - **Locate Persons in Distress**
- **Rescue**
  - **Retrieve Persons in Distress**
    - **Access, Stabilize, and Transport persons in distress**

- LAST: **Locate**, **Access, Stabilize, Transport**

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).

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
- Implementation in the US: NSARC: National Search and Rescue Committee.

SAR can happen anywhere.

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)

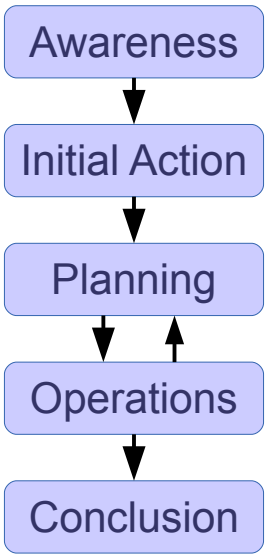
Land SAR is not governed by international agreements (except where planes are in distress on land).

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.

Lets look briefly at systems for maritime and aeronautical SAR

IAMSAR Manual: SAR Stages

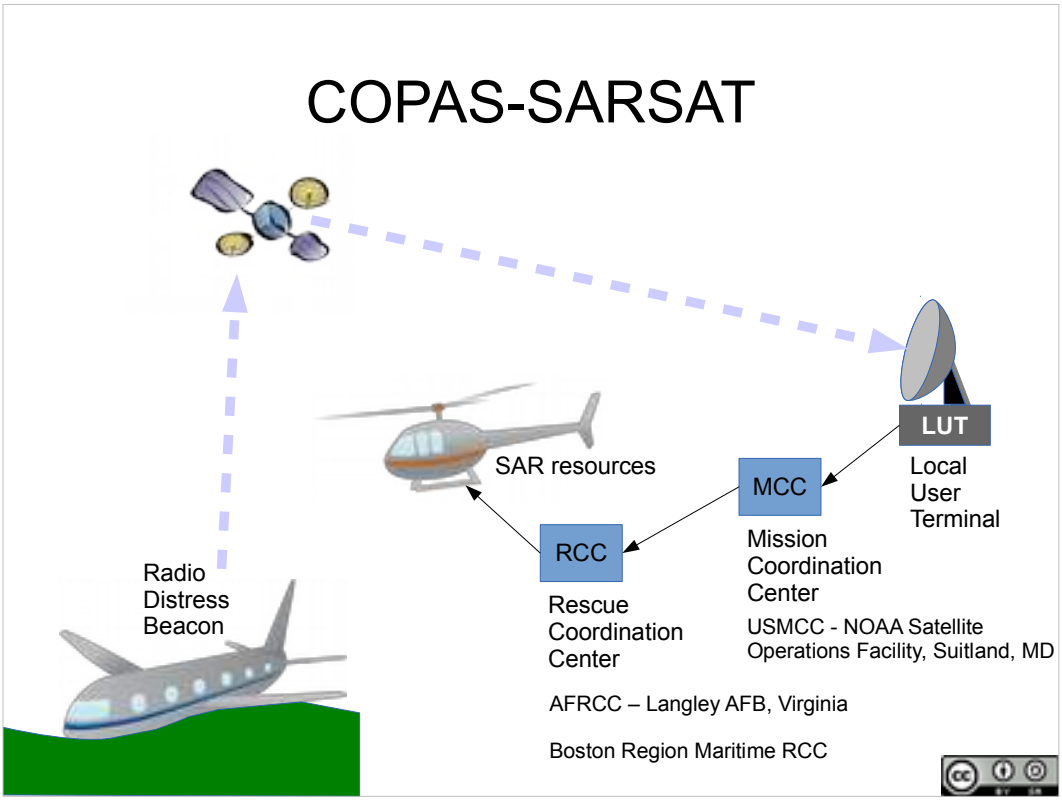


IAMSAR provides a broad picture of the process of SAR operations – dividing into Awareness, Initial Action, cyclical phases of planning and operations, and finally, conclusion.

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

Awareness of SAR incidents can come from distress beacons.

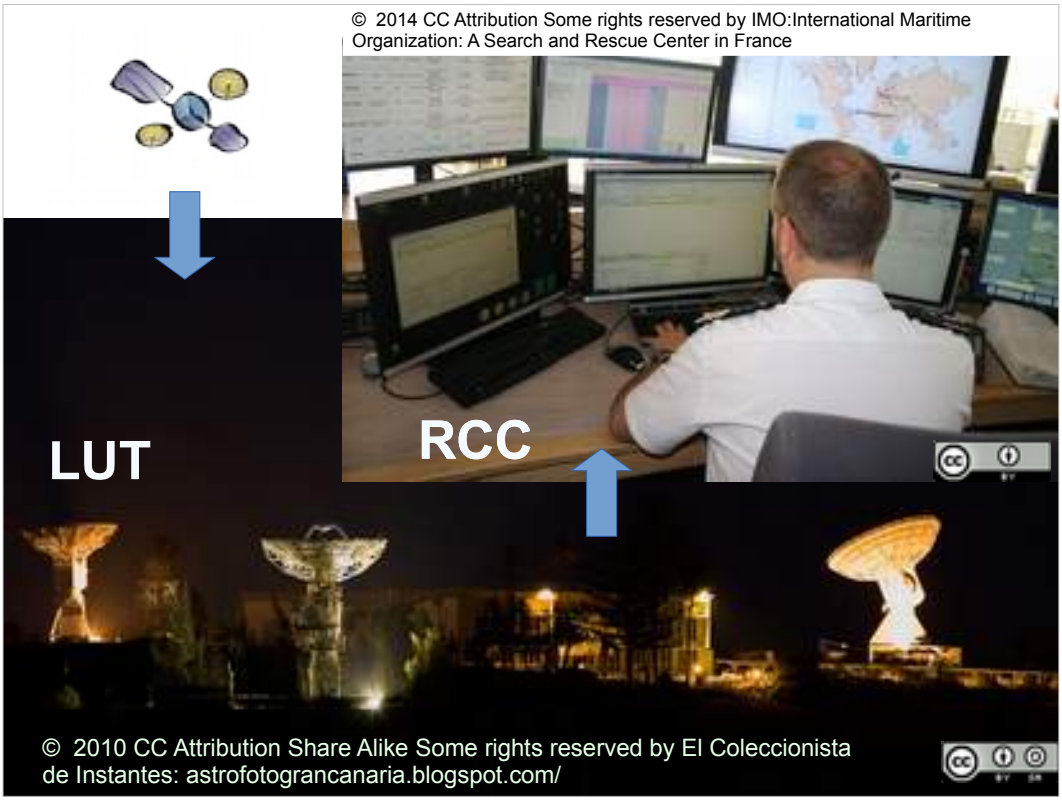
These are supported by a global network of satellites and grounds stations known as COPAS/SARSAT.



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.

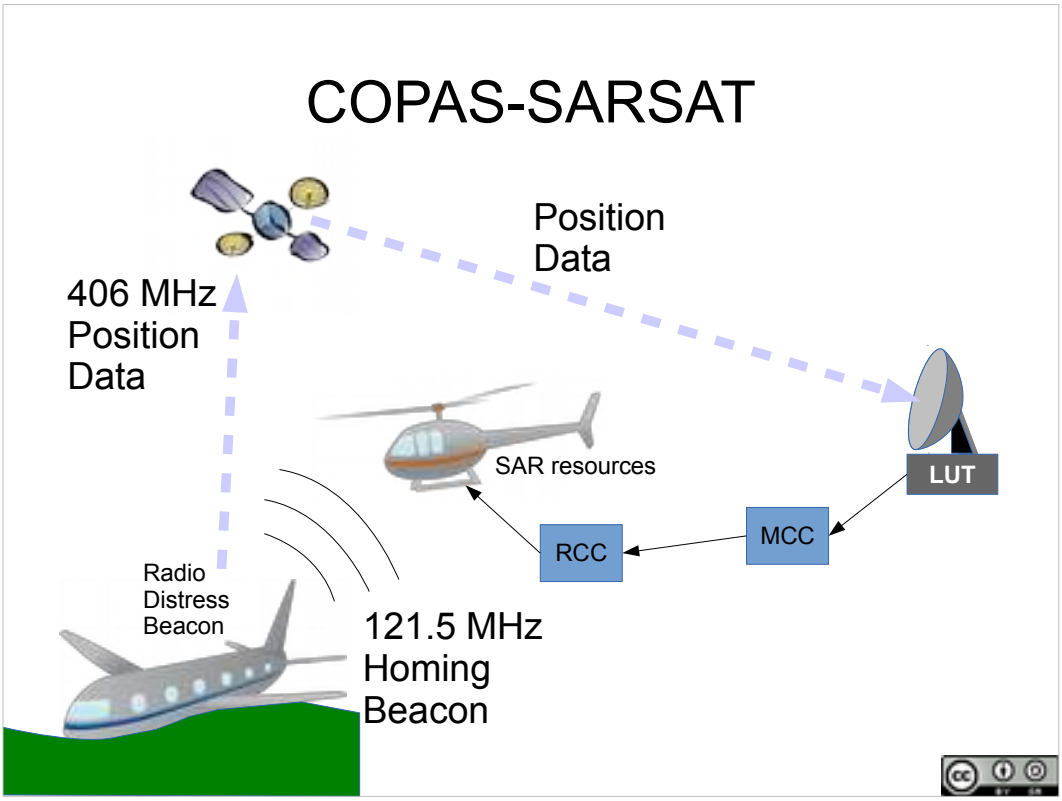
The radio distress beacon may not provide position data, and may need to be triangulated with several satellite passes.



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.

Examples of EPIRB, ELT, and PLB.

PLB

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

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."

An example of a SEND

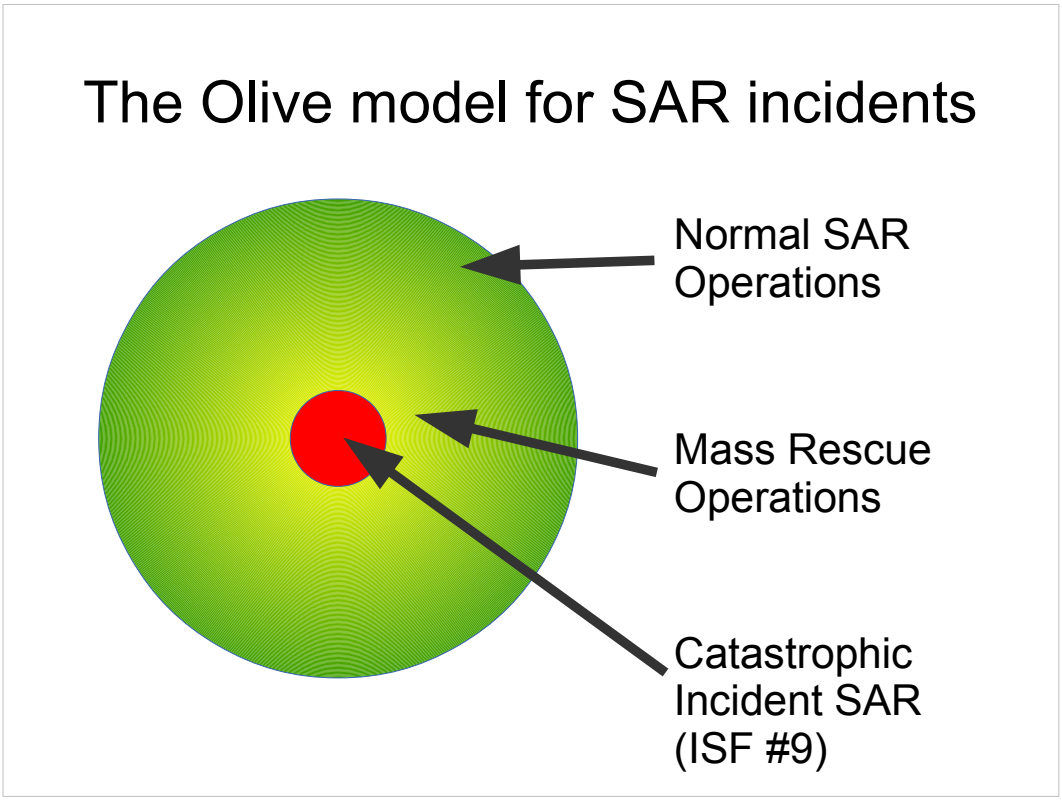
Land SAR

- 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

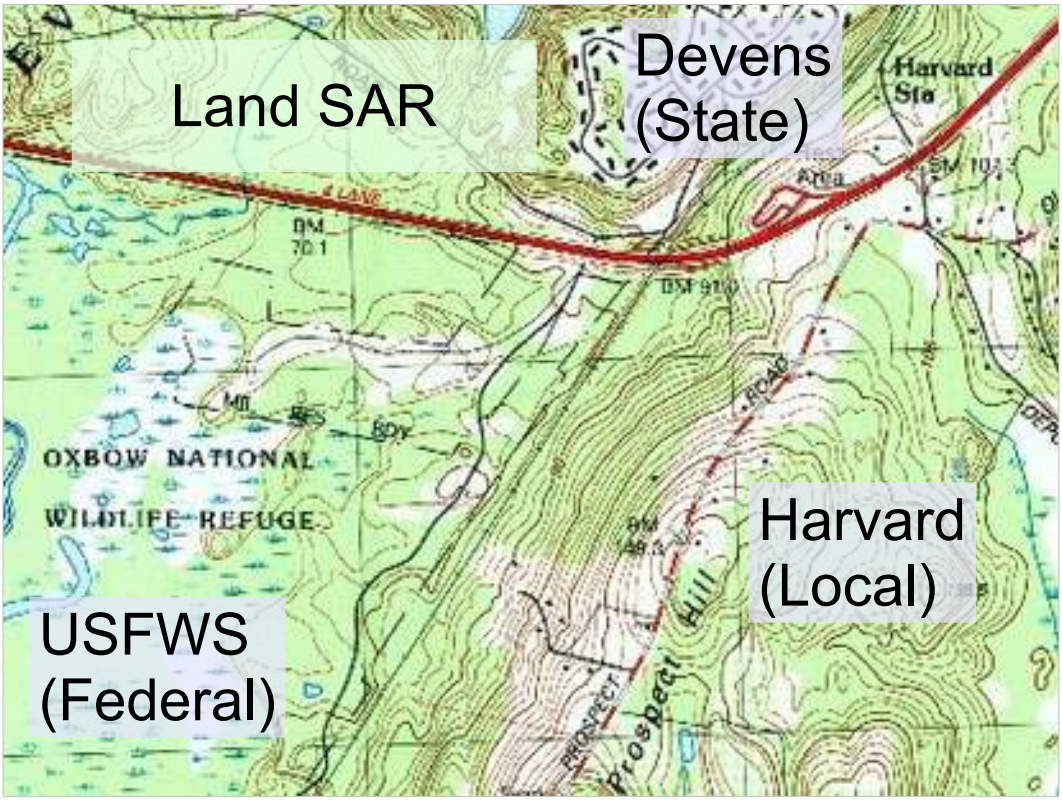
In the US, Land SAR (other than aeronautical), is governed, at the federal level, by documents produced by NSARC: The US National Search and Rescue Plan, and the National SAR Supplement to the IAMSAR manual. These designate the AFRCC as the national land SAR coordinator, and the national park service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



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.



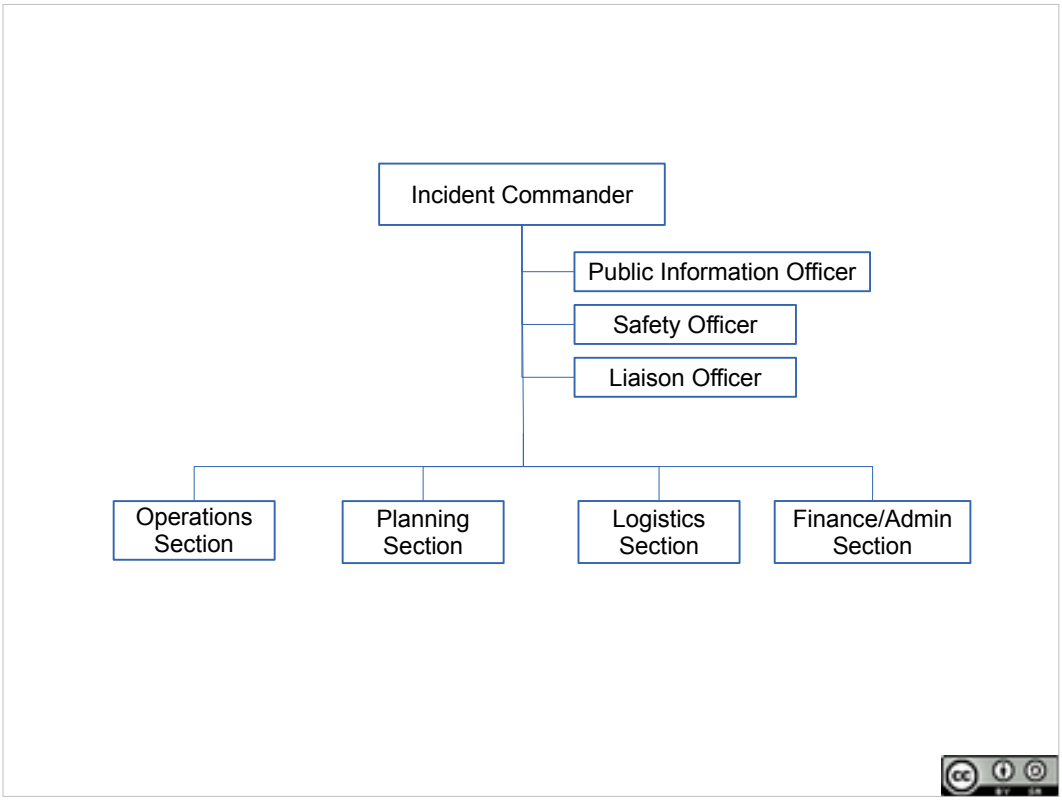
Even simple day to day SAR operations are complex.

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.

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**

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?

[Discuss]

Lost

Missing

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

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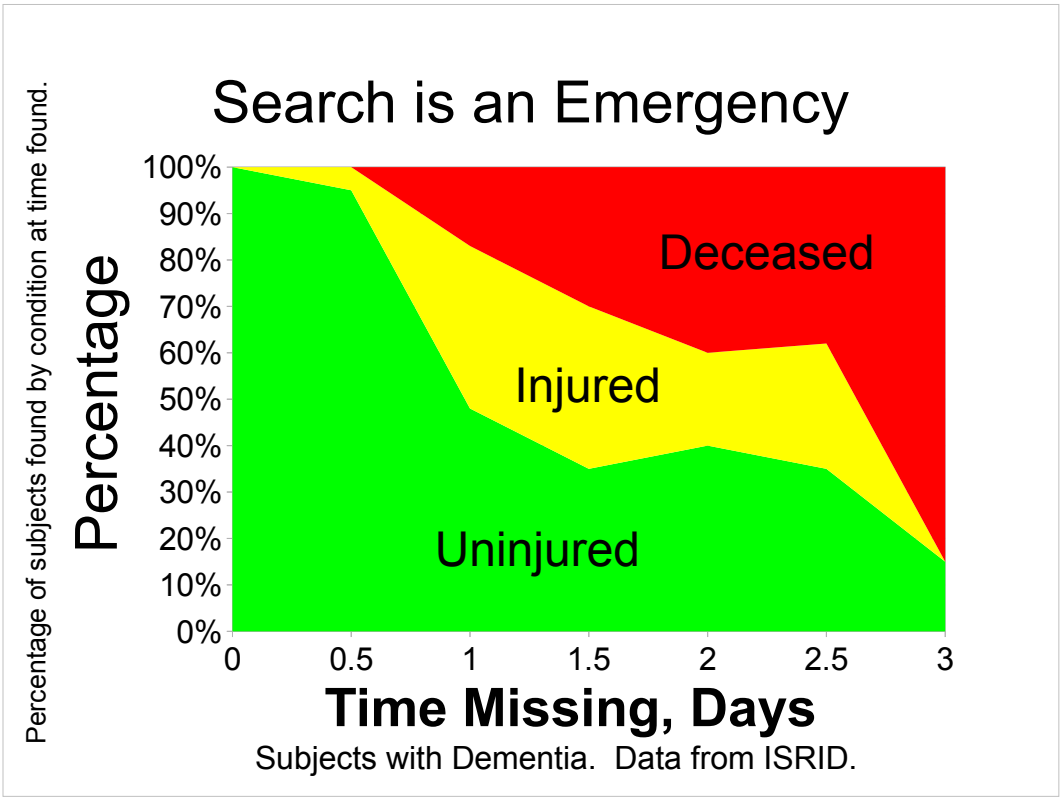
A search is always an emergency.



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

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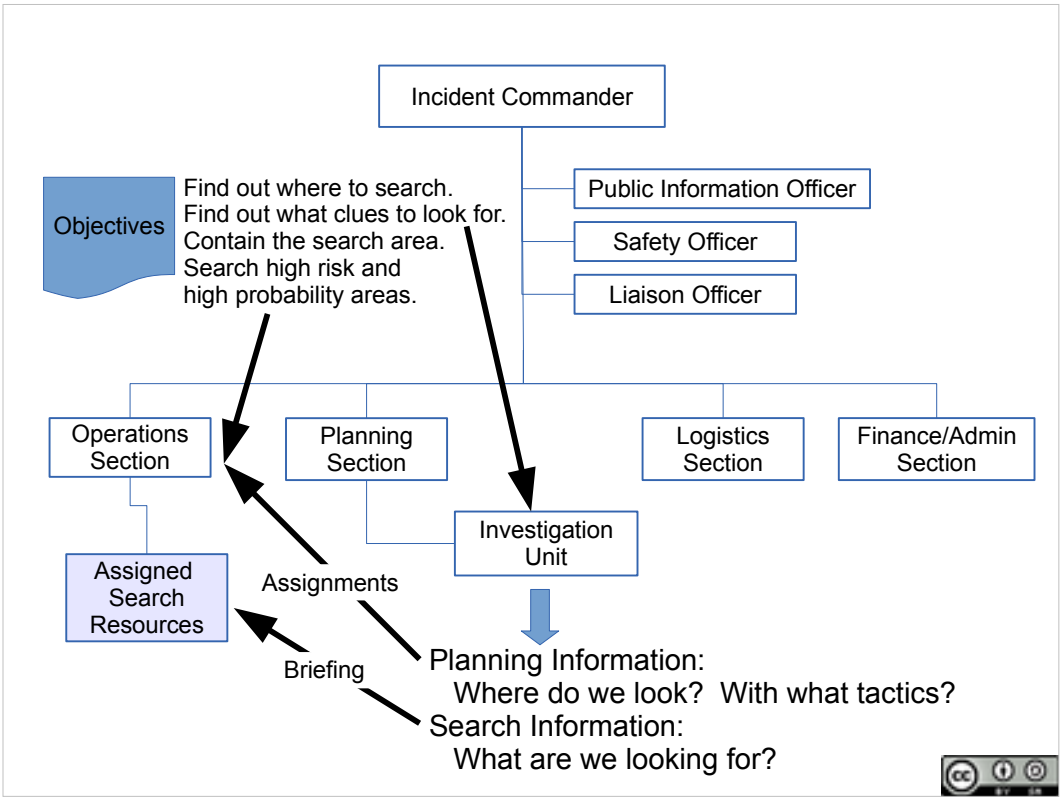
Search is a classic mystery – clues lead you to the subject, so you need to search for clues as well as the subject.

Thus, clue aware searcher.

What's this?

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.

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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.

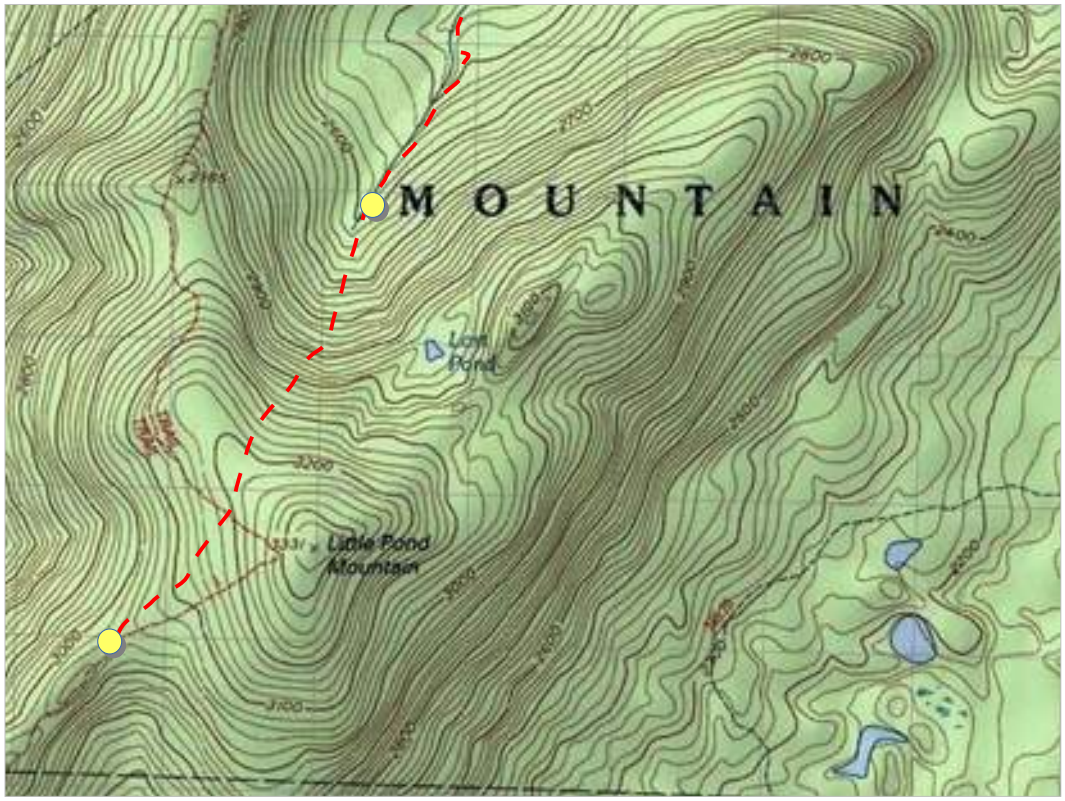
Probably behaving like a missing hiker. Hiker, may just keep moving – contain the search area.

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.

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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.

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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

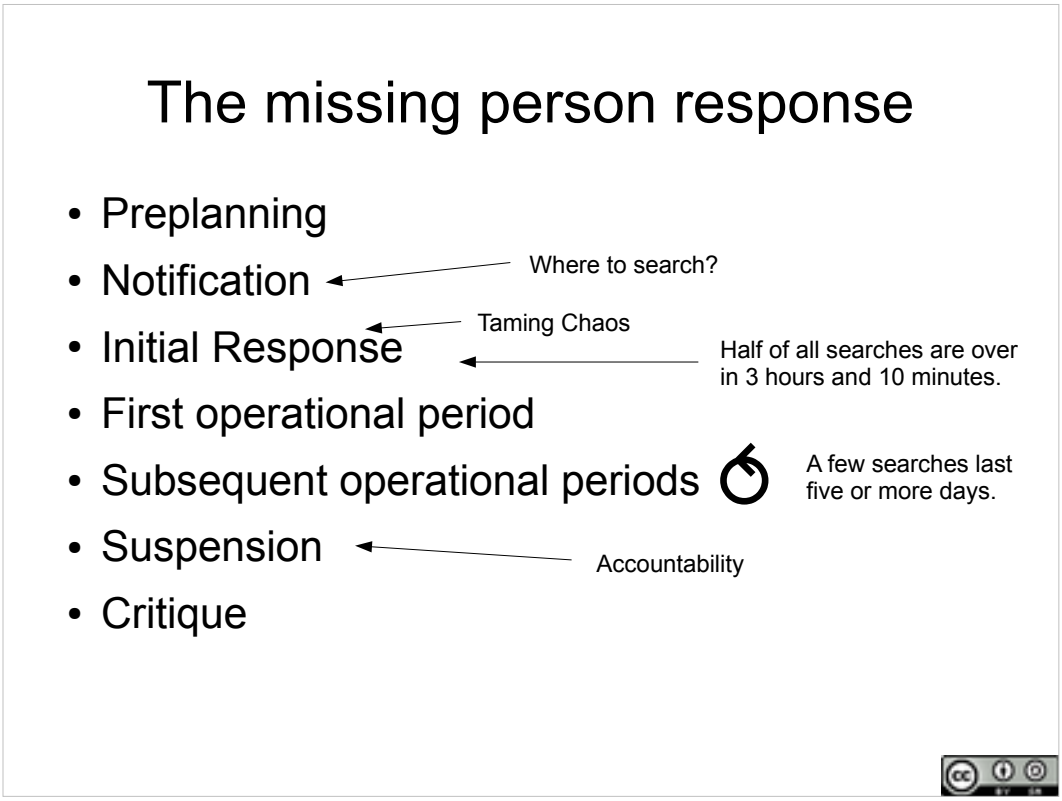
The alert student may note that this isn't quite the same as the IAMSAR Manual's scheme (Awareness, Initial Response, Planning, Operations, Conclusion).

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.



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.