

Geospatial Technologies in Wilderness Search and Rescue: Potential, Challenges and Opportunities

Loren Pfau
21 September 2012
GIS in the Rockies

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Wilderness SAR

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Selected References

Introduction

- Penn State MGIS Candidate
- 11 Years of Wilderness SAR Experience
- A strong belief in the potential of geospatial technologies to enhance and change SAR



“I have never been lost, but I will admit to being confused for several weeks.” – Daniel Boone

Search and Rescue

Locating/retrieving people/objects in:

- Urban settings (e.g. EMS, law enforcement, fire)
- Water (e.g. lost watercraft (USCG))
- Land (e.g. lost aircraft (Civil Air Patrol, DoD))
- Confined space (e.g. collapsed buildings, mines)
- Wilderness – focus of my study

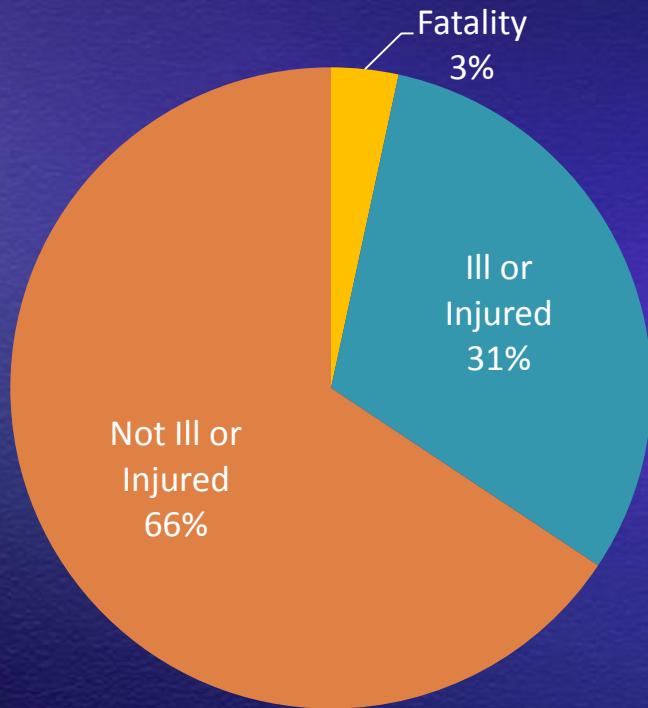


Wilderness SAR

- Remote locations; harsh weather; difficult terrain; long access and transport times
- Limited connectivity for communications purposes
- National Parks – paid professionals
- Most Everywhere Else - volunteers
 - In most Western States SAR is the responsibility of the County Sheriff
 - Many SAR teams are members of the Mountain Rescue Association and are funded by donations and fundraising



SAR Incidents in USA



USA National Parks – 1992 - 2007

- Approximately 65,439 SAR missions
- Approximately 4,090 per year

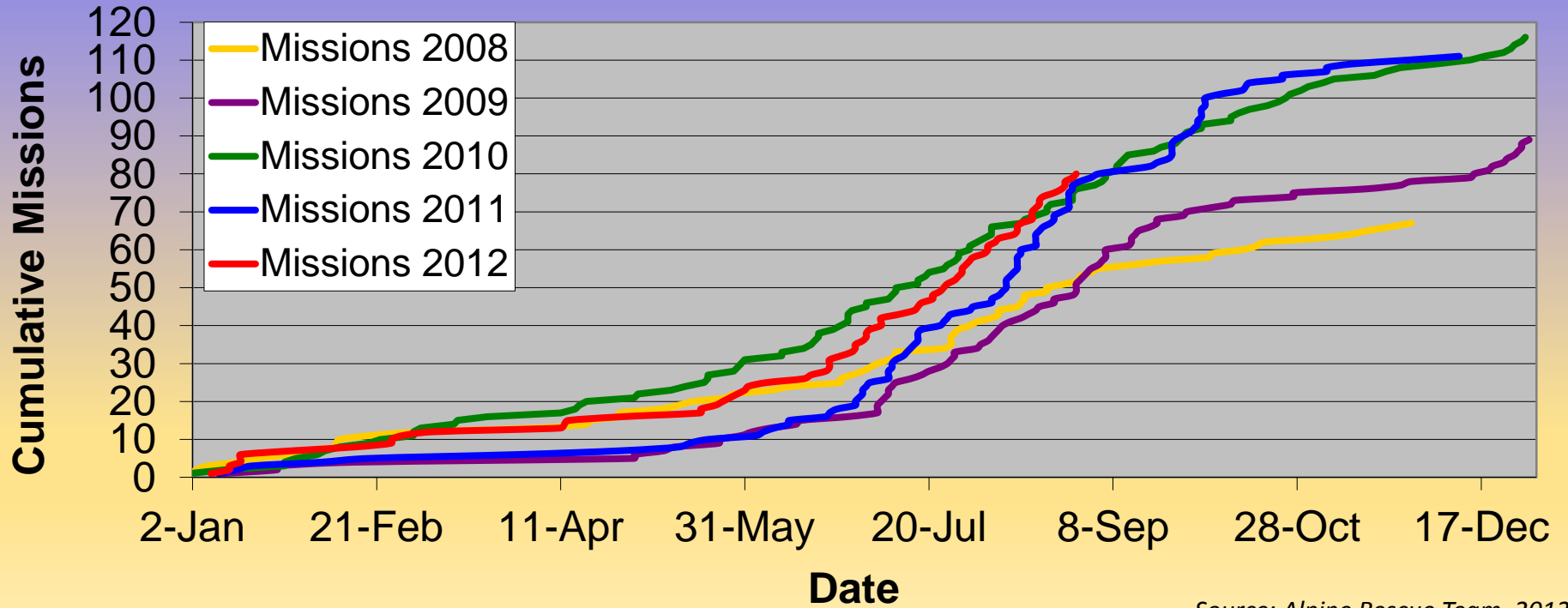
Source: Heggie, 2009

Colorado between 1995-2009

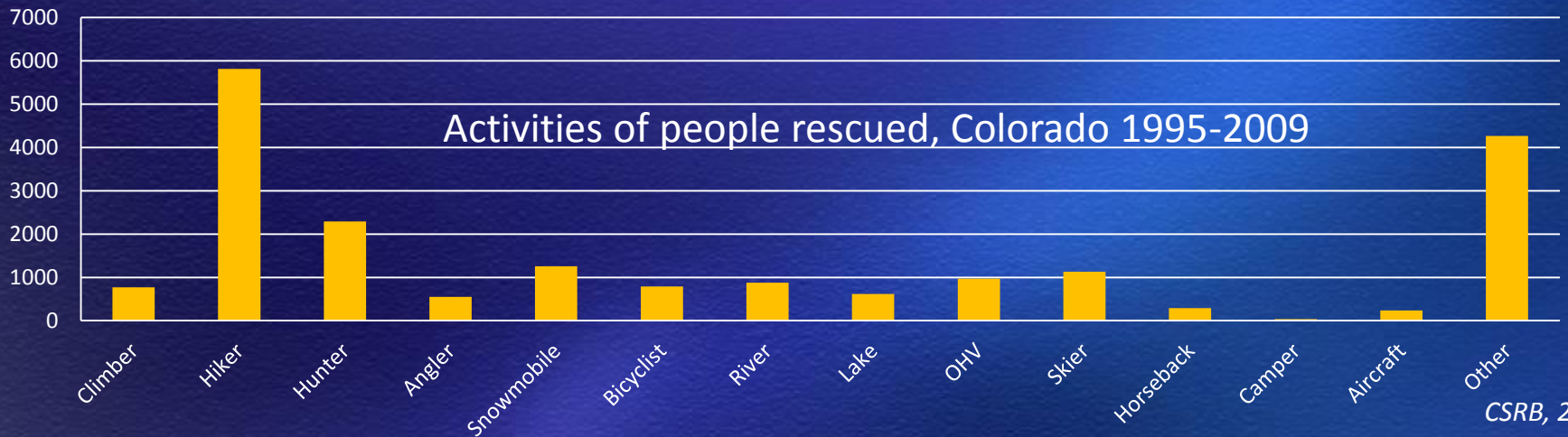
- Approximately 20,672 SAR Missions
- Approximately 1,378 per year

Source: CSRB, 2009

Alpine Rescue Team Mission Counts



Source: Alpine Rescue Team, 2012



CSRB, 2009

SAR Is Changing...

- Traditionally: a telephone call and a topo map
 - Now: e911 Phase II, social media, smartphone apps, mapping GPS units, GIS, etc.
 - A wealth of geospatial data becoming available but understanding of how to access and use this data is in early stages of development
- ▶ We are moving from a “Search For” to a “Go To” environment thanks to advances in geospatial technologies

... and so Must the SAR Mindset

- ▶ We have access to more and more location-based information on subjects
- ▶ But much of the data on location comes from sources and is in formats other than what the SAR community is accustomed to using
- ▶ We need to modify our thinking about how we conduct a search using this data
- ▶ And we need new tools and expertise to help us deal with it

Geospatial in SAR Survey

**Survey
Conducted 2 –
22 March, 2012**

- Announced via the MRA
- Conducted under the auspices of Penn State
- 122 started the survey; 74 completed the survey

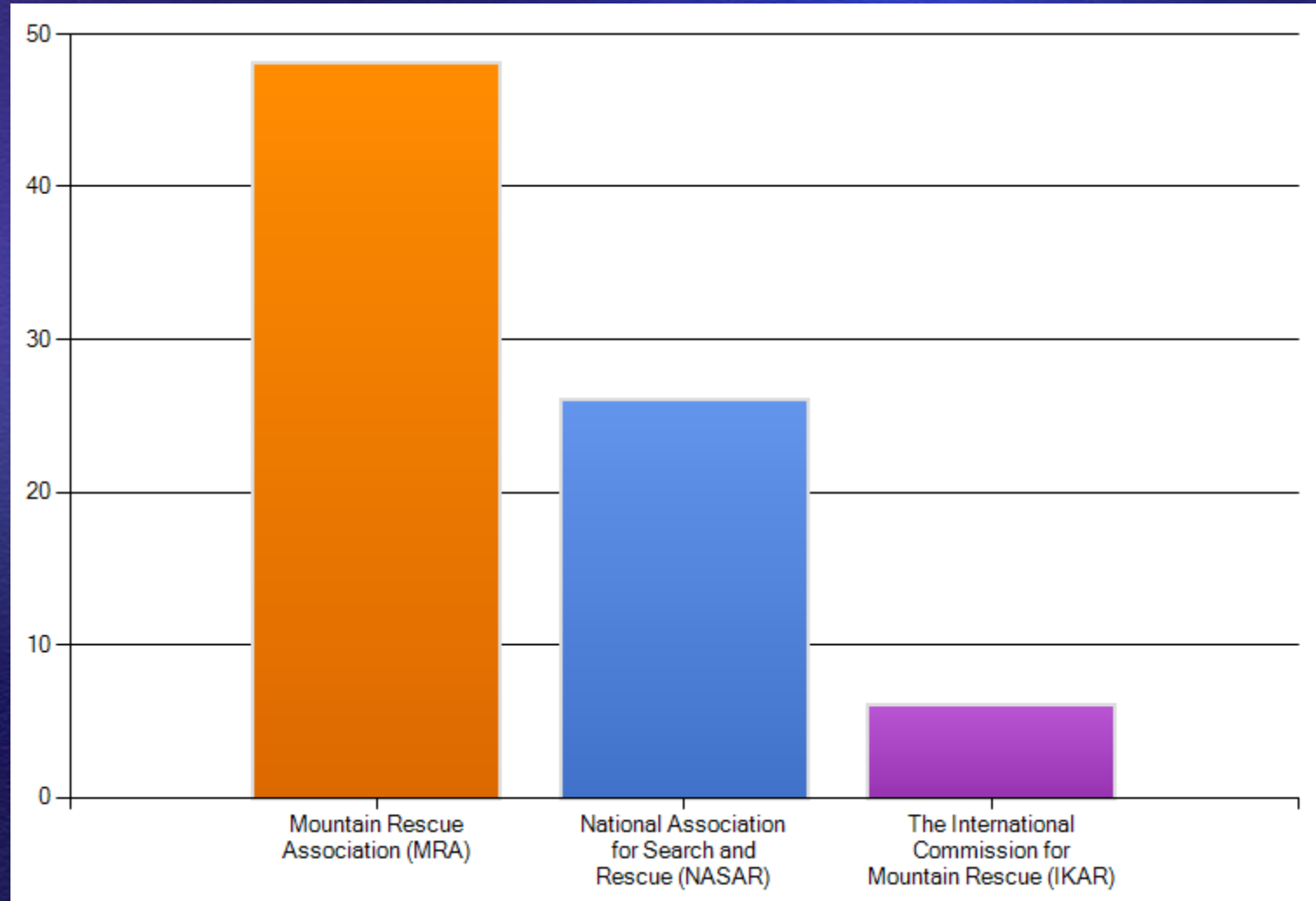
Goals

- Ascertain what geospatial data and tools are being employed in wilderness SAR
- Identify why some tools are used and others are not
- Use information to determine ways to integrate GIS technology to improve SAR

Country	Responses
USA	67
Canada	3
Australia	1
UK	1
South Africa	1

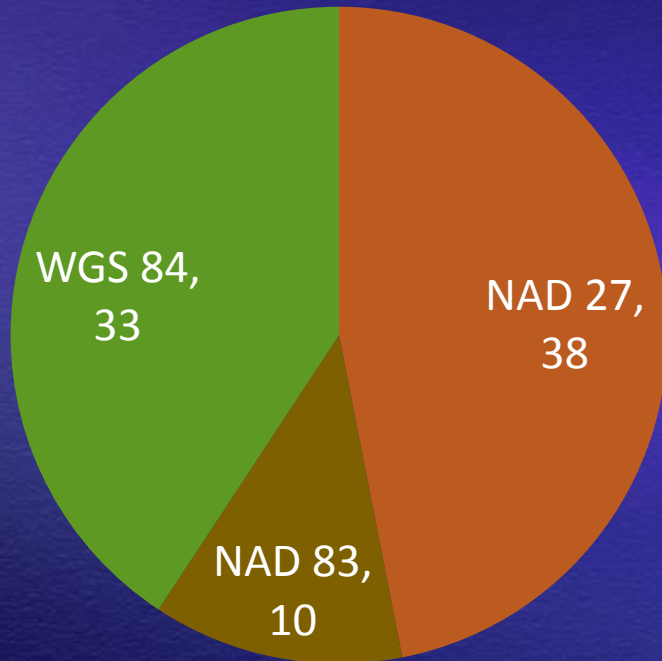
State	Responses
CO	13
CA	7
AZ	3
MN	3
OR	3
WV	2
Georgia	2

Affiliations

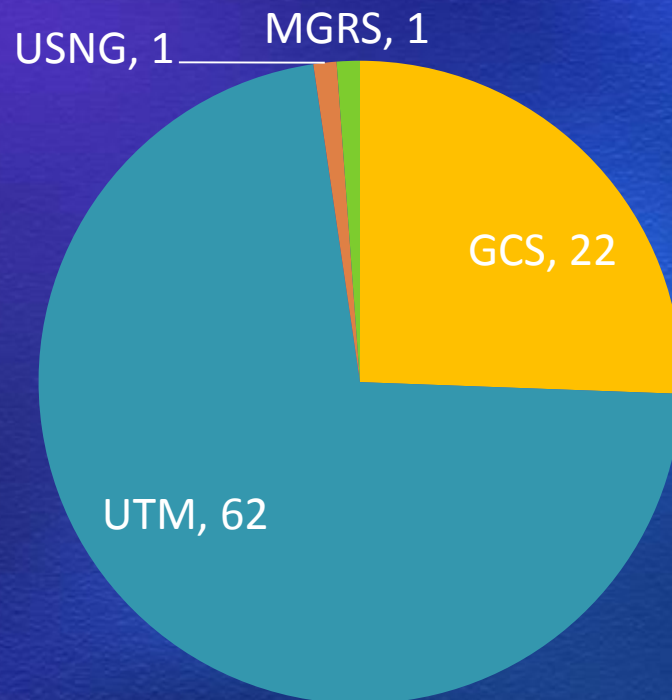


Geospatial Data Standards

Standard Datum



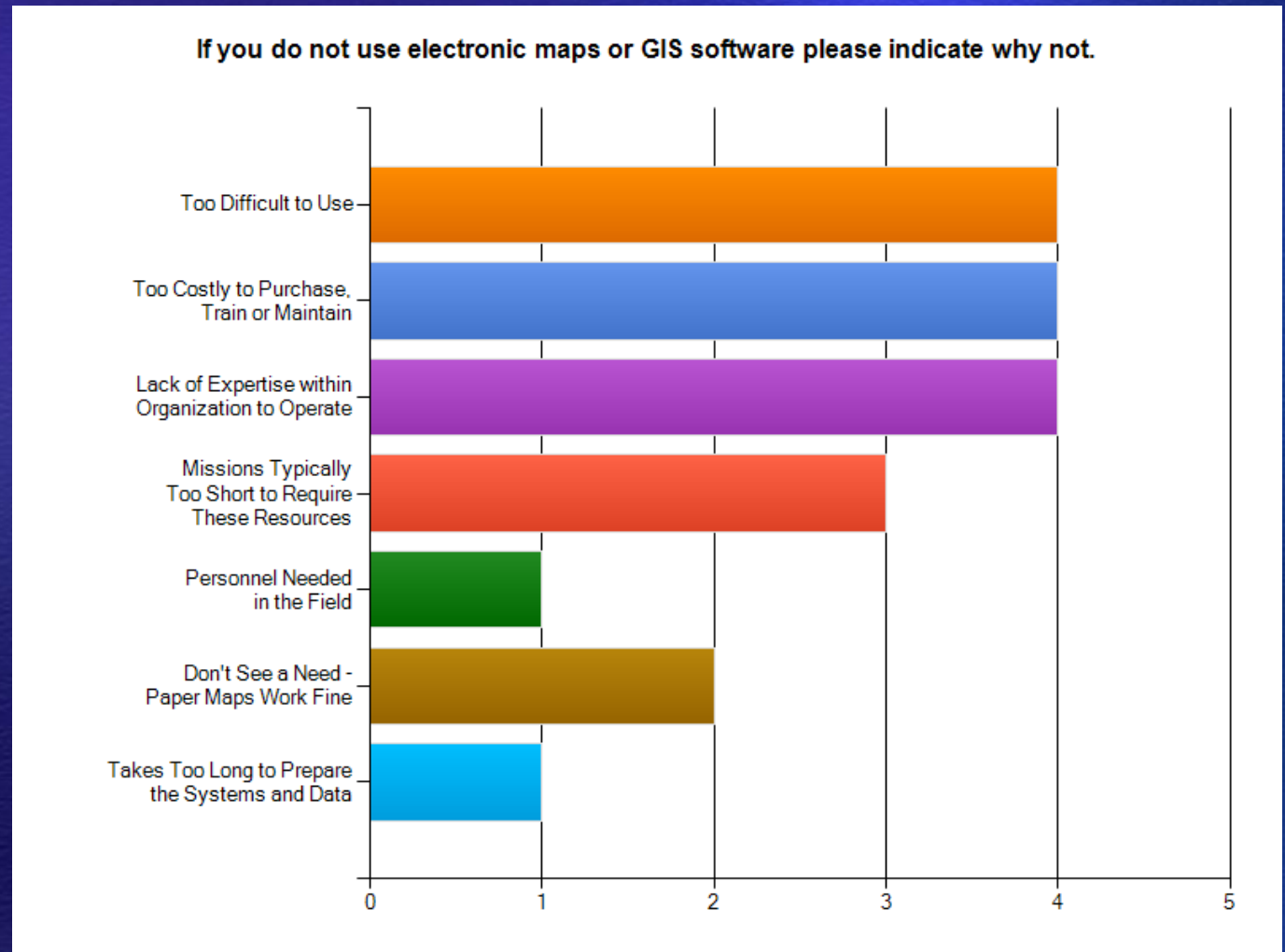
Coordinate System



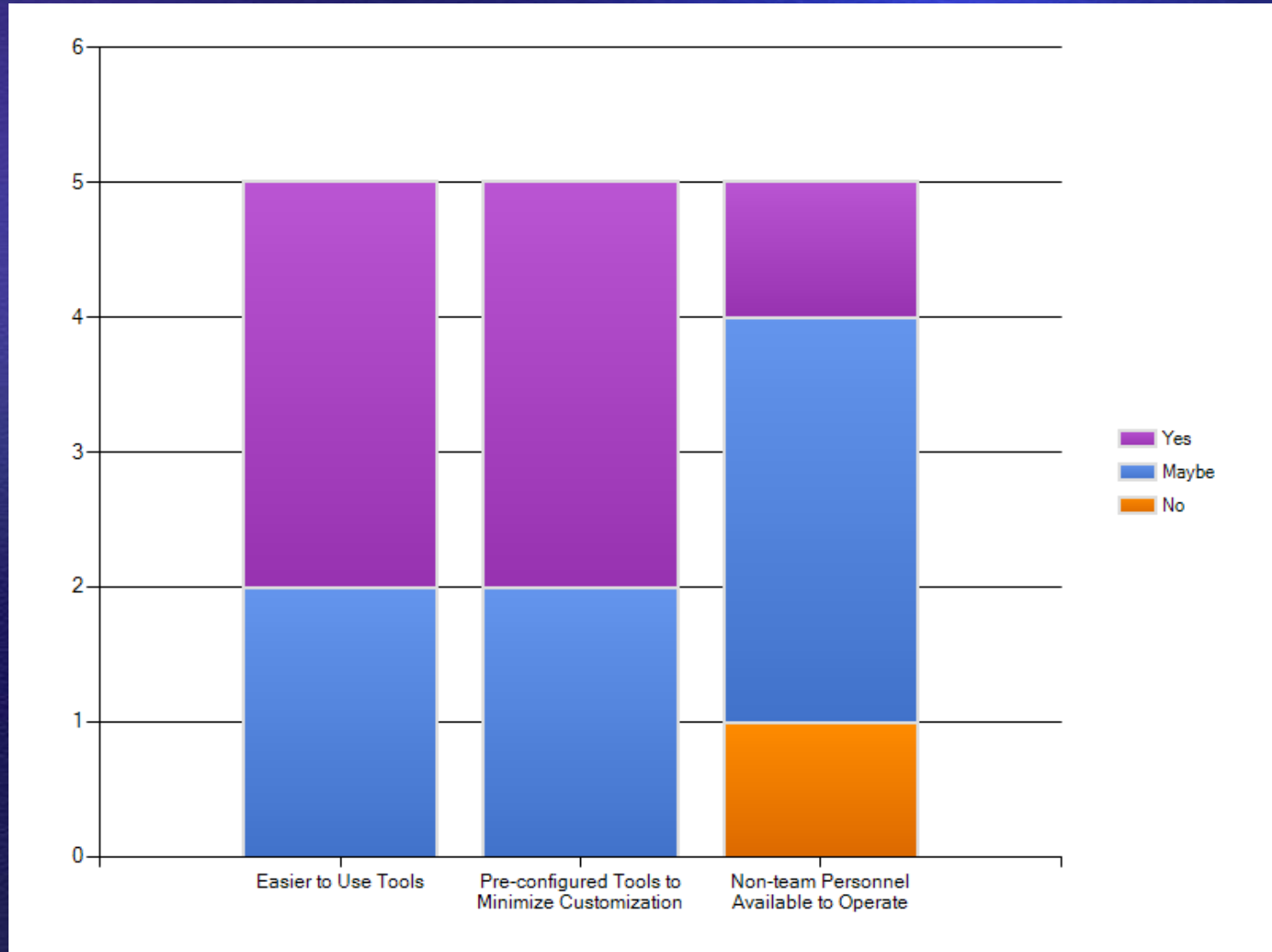
Use of Software

Does Your Team Use Electronic Maps or GIS?

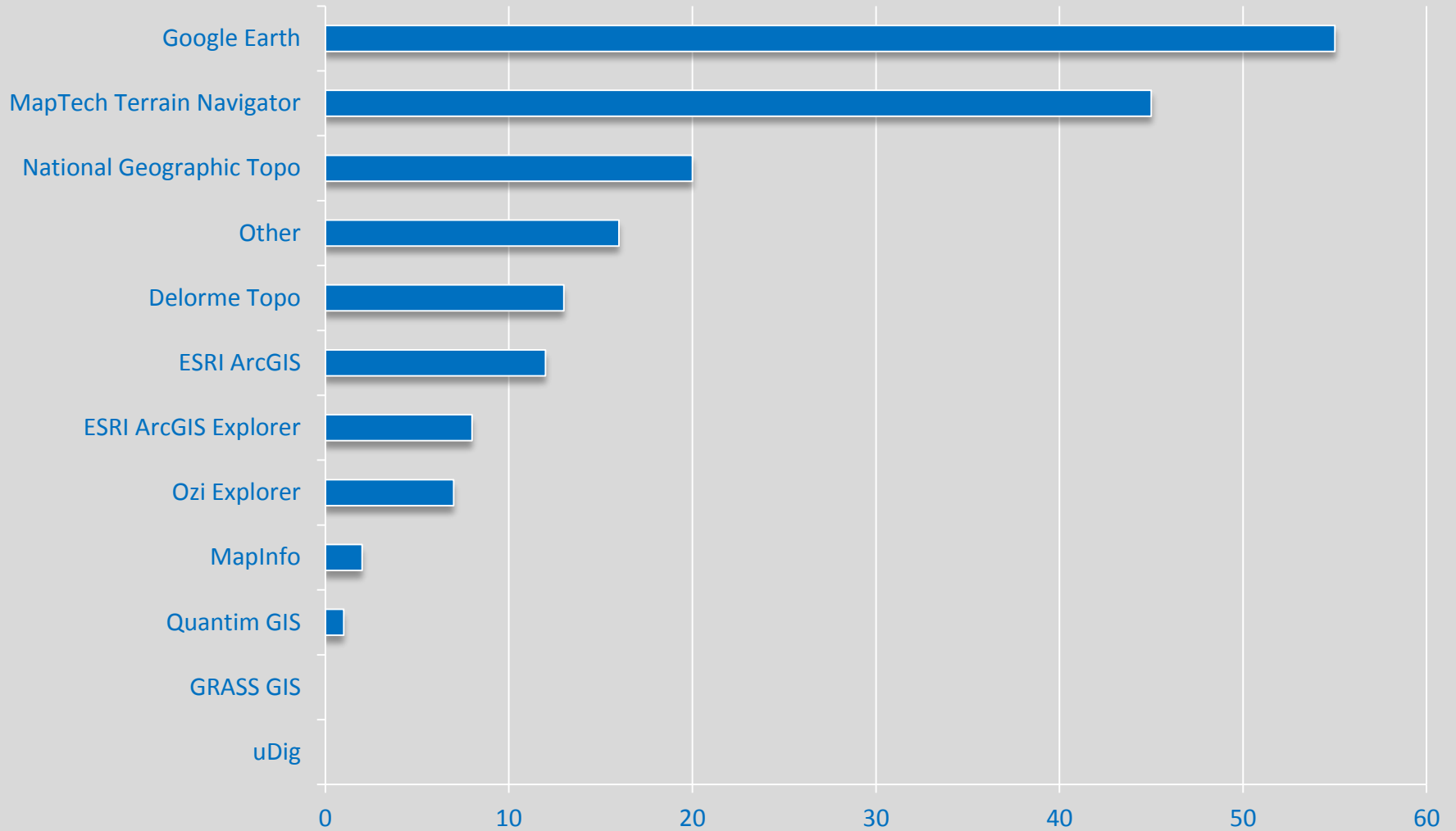
- 91% Use
- 9% Don't Use



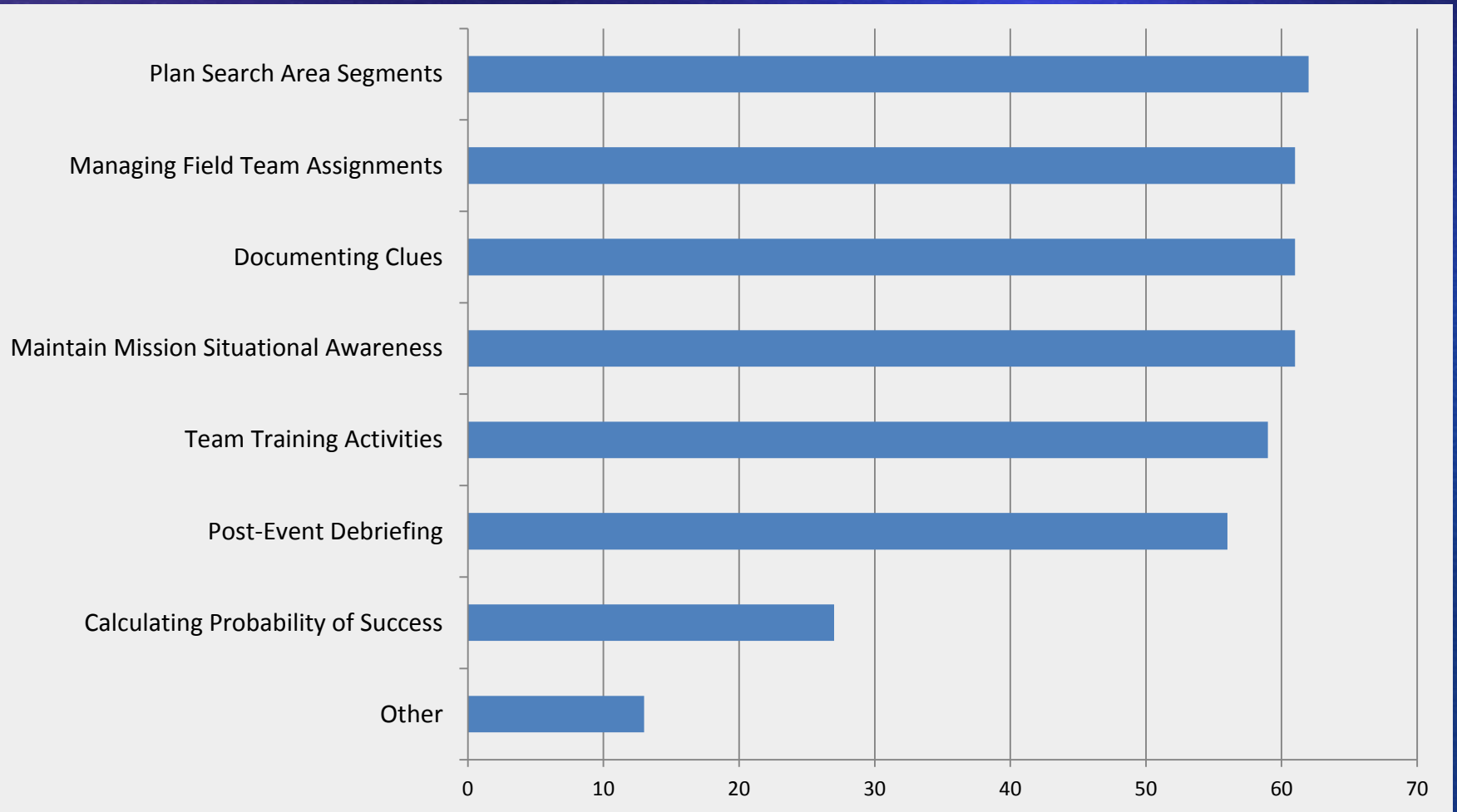
Would You Consider Using If:



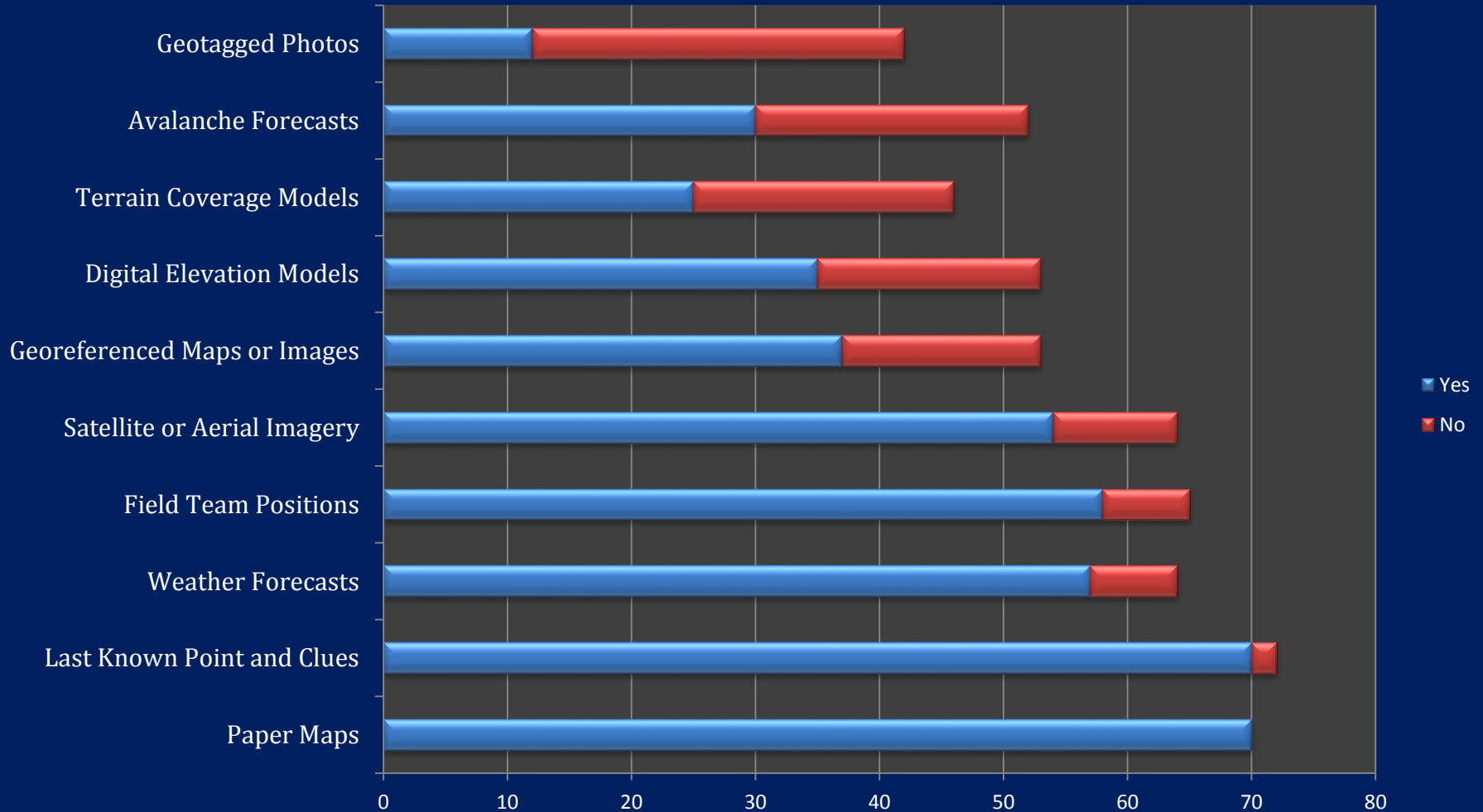
Software Packages



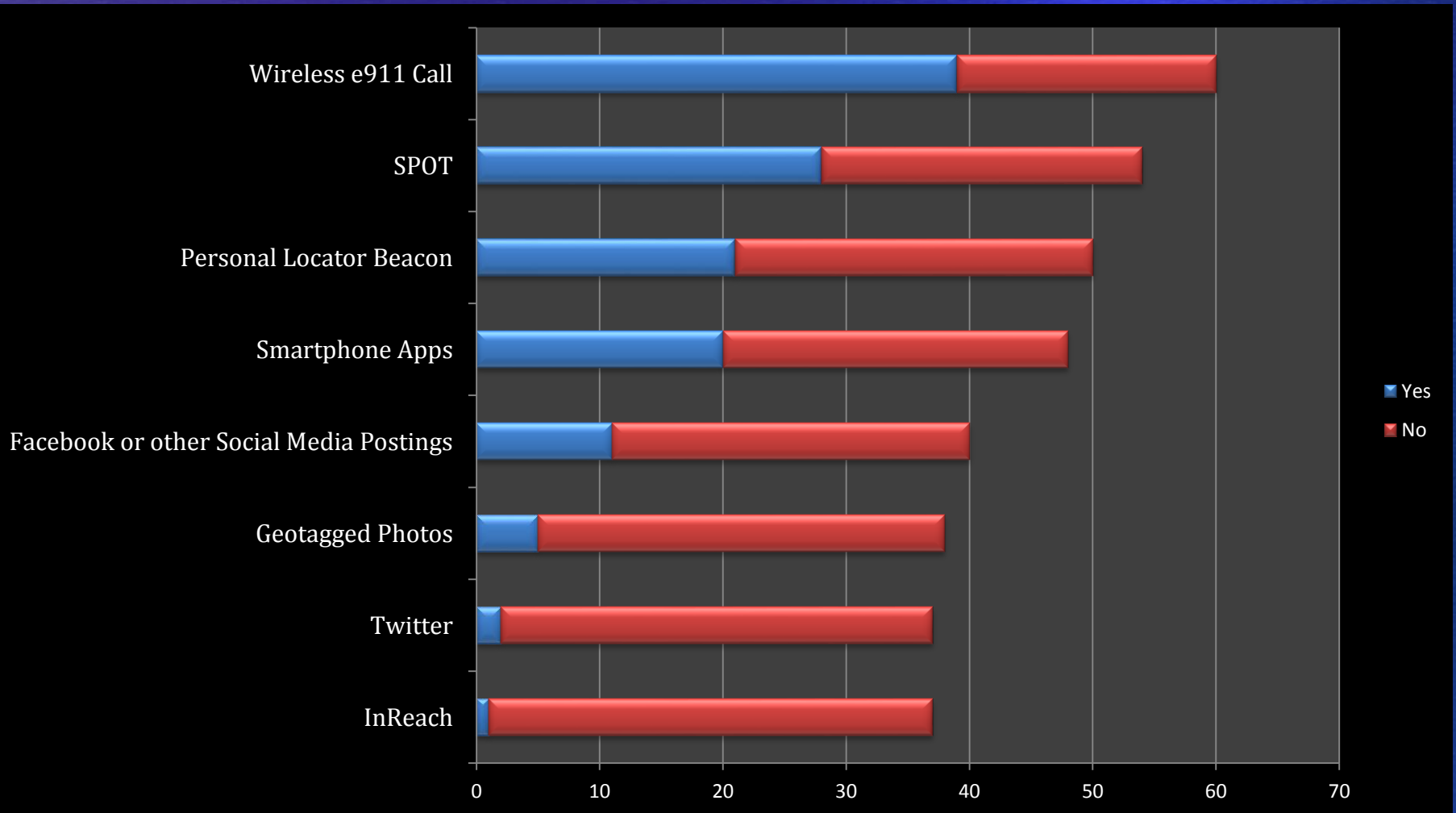
Use of GIS / Electronic Maps



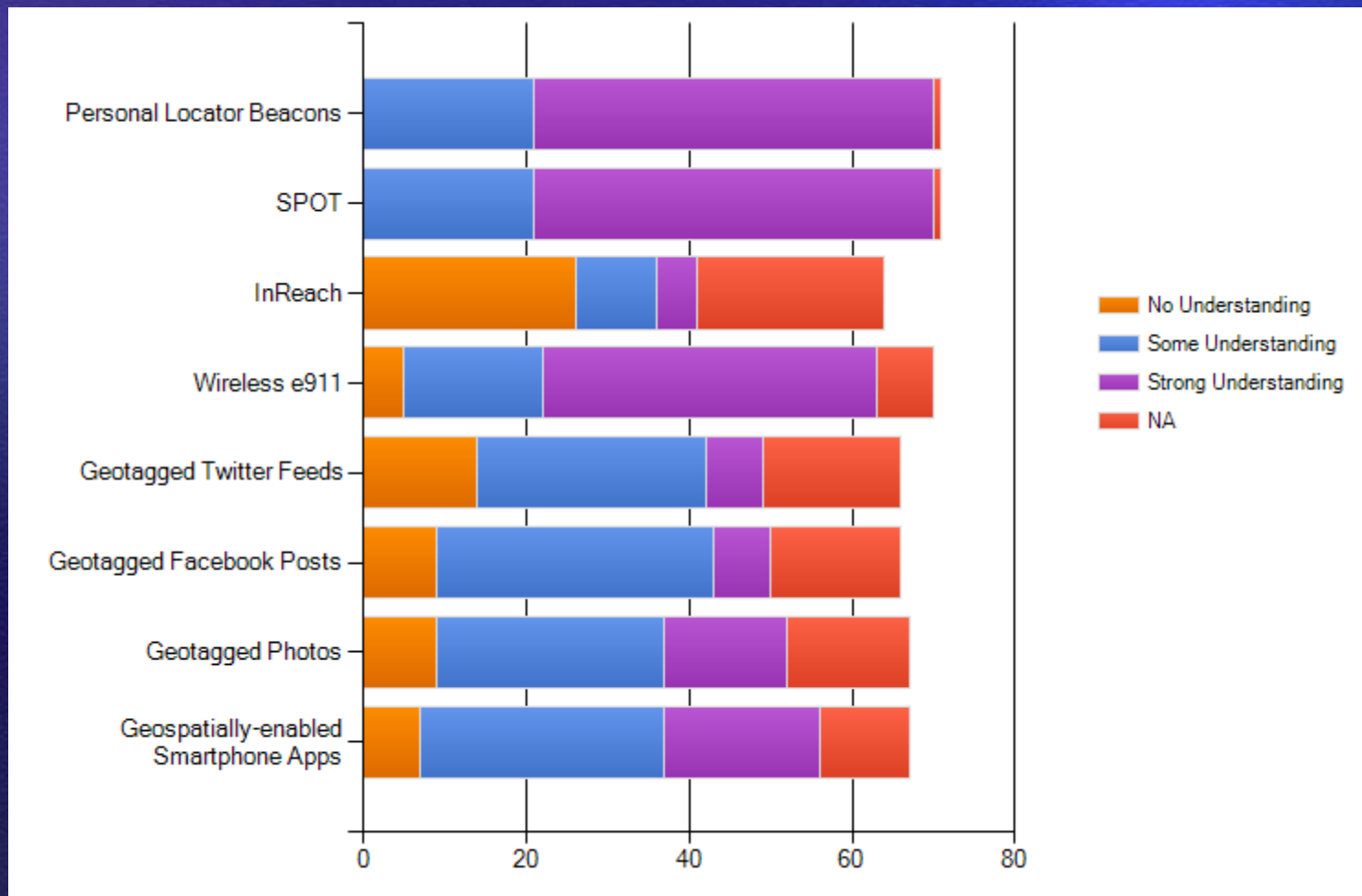
What Types of Data Typically Used



Have you used geospatial data from any of the following sources?

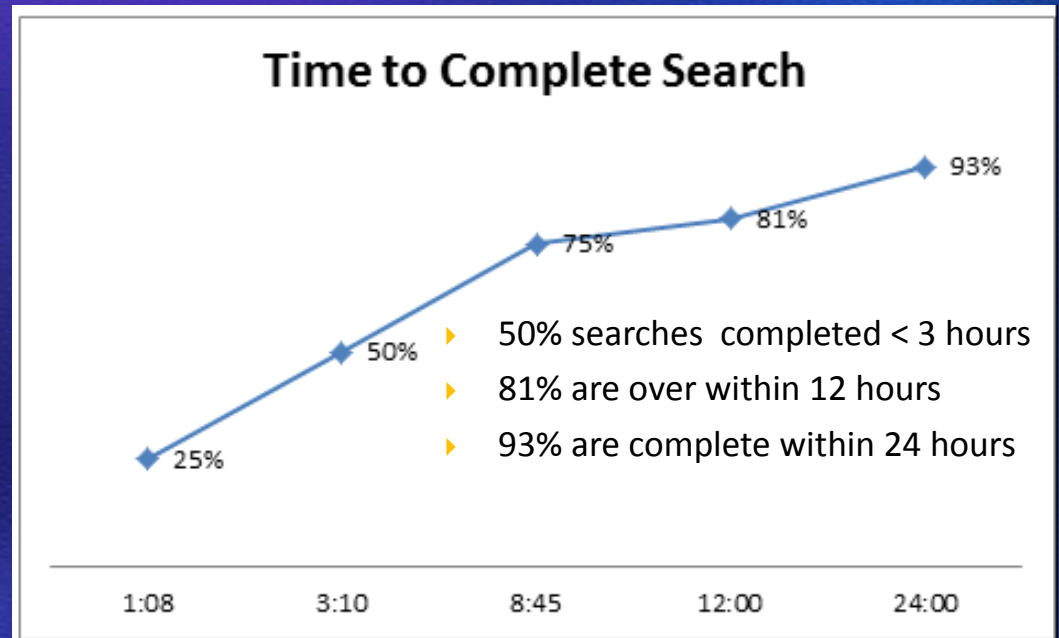


How well do you understand the following technologies?



Summary of SAR

- Fundamentally a Geospatial Activity
- Need to Visualize, Analyze, Model, Manage and Document mission activities
- Time-sensitive



Examples

- Cell Phones
- Locators
- Mission Management Tools
- Analysis and Training

Cell Phones

- Wireless e911
- Pings and Tower hits
- Smartphone Apps
 - Twitter and other Social Media
 - Geotagged photo's
 - Latitude, etc.

More than 234M Mobile Phones in Use in the US

- More than 104M of these are smartphones

And What Do They Do?

Source: comScore Reports
February 2012 U.S. Mobile
Subscriber Market Share, 4March
2012

Top Smartphone Platforms

3 Month Avg. Ending Feb. 2012 vs. 3 Month Avg. Ending Nov. 2011

Total U.S. Smartphone Subscribers Ages 13+

Source: comScore MobiLens

	Share (%) of Smartphone Subscribers		
	Nov-11	Feb-12	Point Change
<i>Total Smartphone Subscribers</i>	100.0%	100.0%	N/A
Google	46.9%	50.1%	3.2
Apple	28.7%	30.2%	1.5
RIM	16.6%	13.4%	-3.2
Microsoft	5.2%	3.9%	-1.3
Symbian	1.5%	1.5%	0.0

Mobile Content Usage

3 Month Avg. Ending Feb. 2012 vs. 3 Month Avg. Ending Nov. 2011

Total U.S. Mobile Subscribers (Smartphone & Non-Smartphone) Ages 13+

Source: comScore MobiLens

	Share (%) of Mobile Subscribers		
	Nov-11	Feb-12	Point Change
<i>Total Mobile Subscribers</i>	100.0%	100.0%	N/A
Sent text message to another phone	72.6%	74.8%	2.2
Used downloaded apps	44.9%	49.5%	4.6
Used browser	44.4%	49.2%	4.8
Accessed social networking site or blog	33.0%	36.1%	3.1
Played Games	29.7%	32.3%	2.6
Listened to music on mobile phone	21.7%	24.8%	3.1

Wireless e911

- Phase I

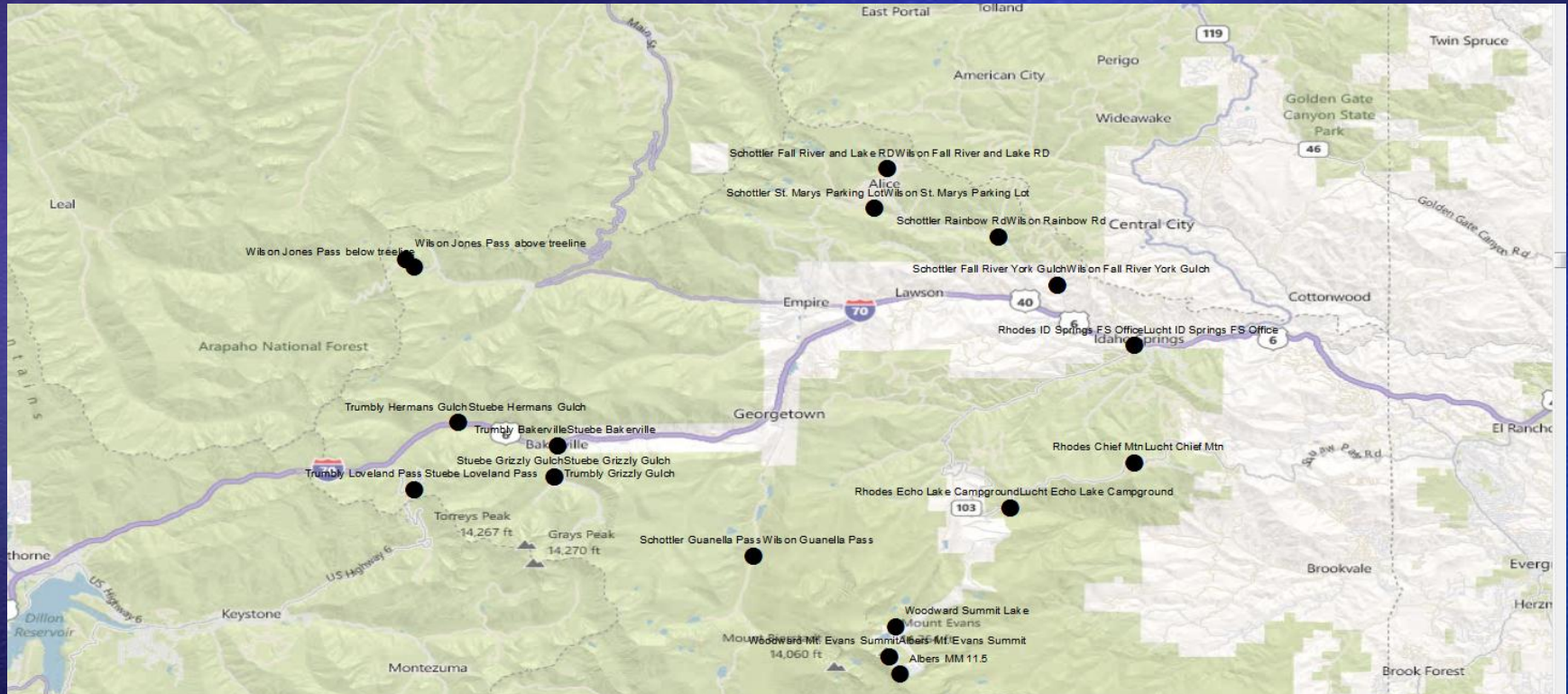
- Calling number, name and tower information

- Phase II

- Adds latitude and longitude information

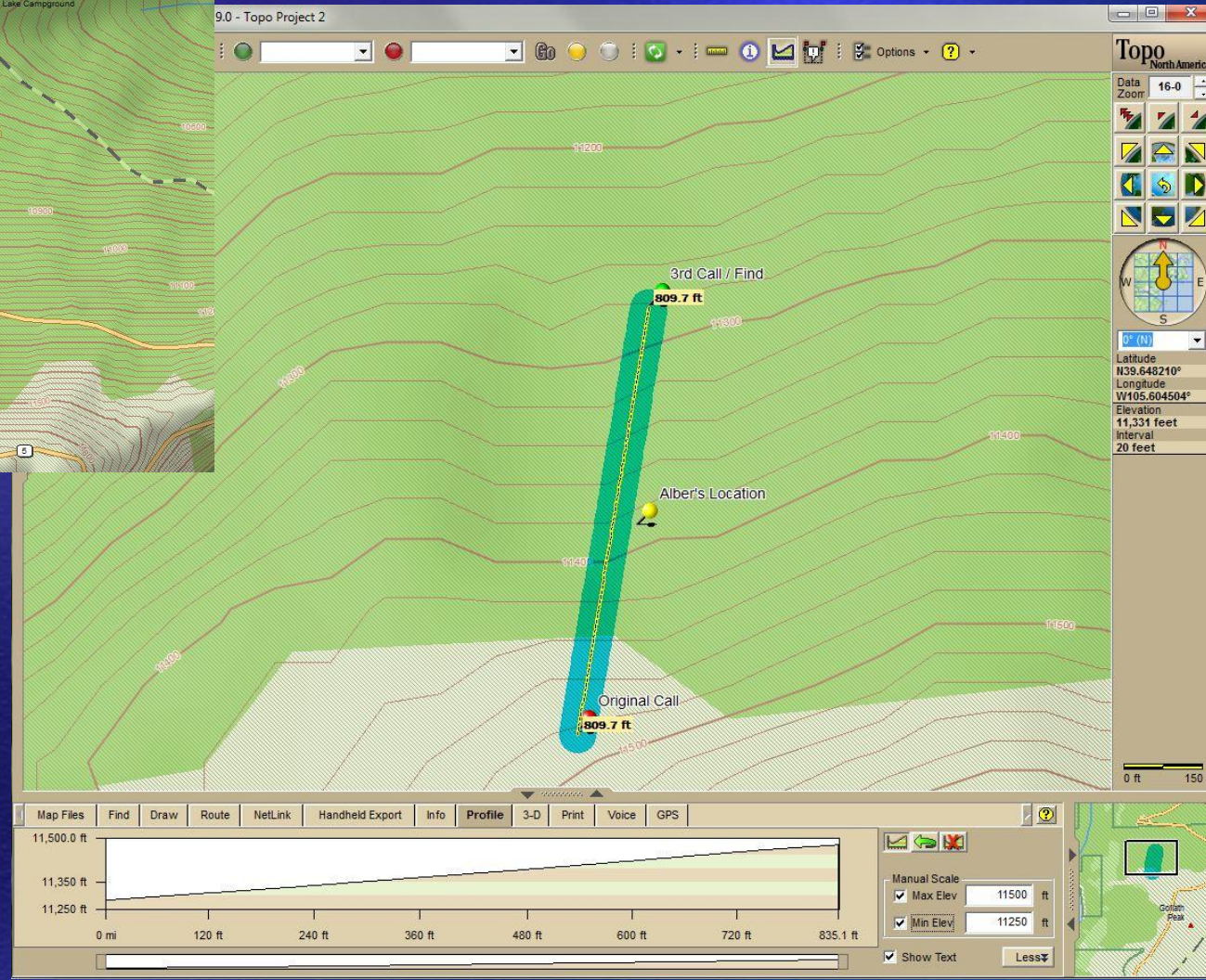
- “Wireless phones relying on network-based technology must provide Public Safety Answering Points (PSAP) with reports on their locations within 100 meters of accuracy for 67 percent of calls, and within 300 meters for 95 percent of calls, by Sept. 11, 2012, according to the order. Phones installed with GPS chips, meanwhile, must provide PSAPs with reports on their locations within 50 meters of accuracy for 67 percent of calls, and within 100 meters for 95 percent of calls, by the same date. The FCC also specified certain benchmarks to measure the carriers' progress, such as meeting the location accuracy requirements in at least 75 percent of PSAPs a carrier serves by 2010.” - *FCC E911 Location Accuracy Second Report and Order* in PS Docket No. 07-114

e911 Tests – Clear Creek County



Time	Location (Description)	Team Member Placing Call	Carrier	Tel. #	Known Lat	Known Lon	Lat-initial	Lon-initial	Lat-rebid	Lon-rebid	Notes	DeltaLat - Known to initial	DeltaLong - Known to Initial	Total Error - KM
10:00:00 AM	Chief Mtn		ATT		39.6828	-105.5220	39.7636	-105.5417			Bellview Tower only on initial call and rebid	-8.9731	1.0830	9.0382
10:04:00 AM	Chief Mtn		Tmobile		39.6828	-105.5220	39.6826	-105.5220			Squaw Pass RD per Dispatch	0.0194	0.0042	0.0198
10:08:00 AM	Loveland Pass		VZ		39.6697	-105.8751	39.6696	-105.8752				0.0077	0.0027	0.0081
10:09:00 AM	Loveland Pass		Sprint		39.6697	-105.8751	39.6696	-105.8751				0.0063	-0.0031	0.0071
10:15:00 AM	Guanella Pass		ATT		39.6372	-105.7091	39.7231	-105.6719			Saxon Mtn. Tower	-9.5252	-2.0462	9.7425
10:17:00 AM	Guanella Pass		VZ		39.6372	-105.7091	39.6375	-105.7092				-0.0319	0.0036	0.0321
10:27:00 AM	Hermans Gulch		VZ		39.7025	-105.8537	39.7025	-105.8537	39.7026	-105.8539		-0.0031	0.0008	0.0032
10:29:00 AM	Hermans Gulch		Sprint		39.7025	-105.8537	39.7025	-105.8537				0.0027	-0.0017	0.0032
10:50:00 AM	Mt. Evans Summit		Tmobile		39.5878	-105.6422	39.4867	-105.6306			Call went to JeffCo Yankee Tower	11.2249	-0.6382	11.2430
10:50:00 AM	Mt. Evans Summit		VZ		39.5878	-105.6422					Call went to JeffCo Beaver Tower; JeffCo unable to transfer			
11:09:00 AM	Grizzly Gulch		VZ		39.6759	-105.8065	39.6914	-105.8036			Tower Only	-1.7130	-0.1585	1.7203

Real Life Results

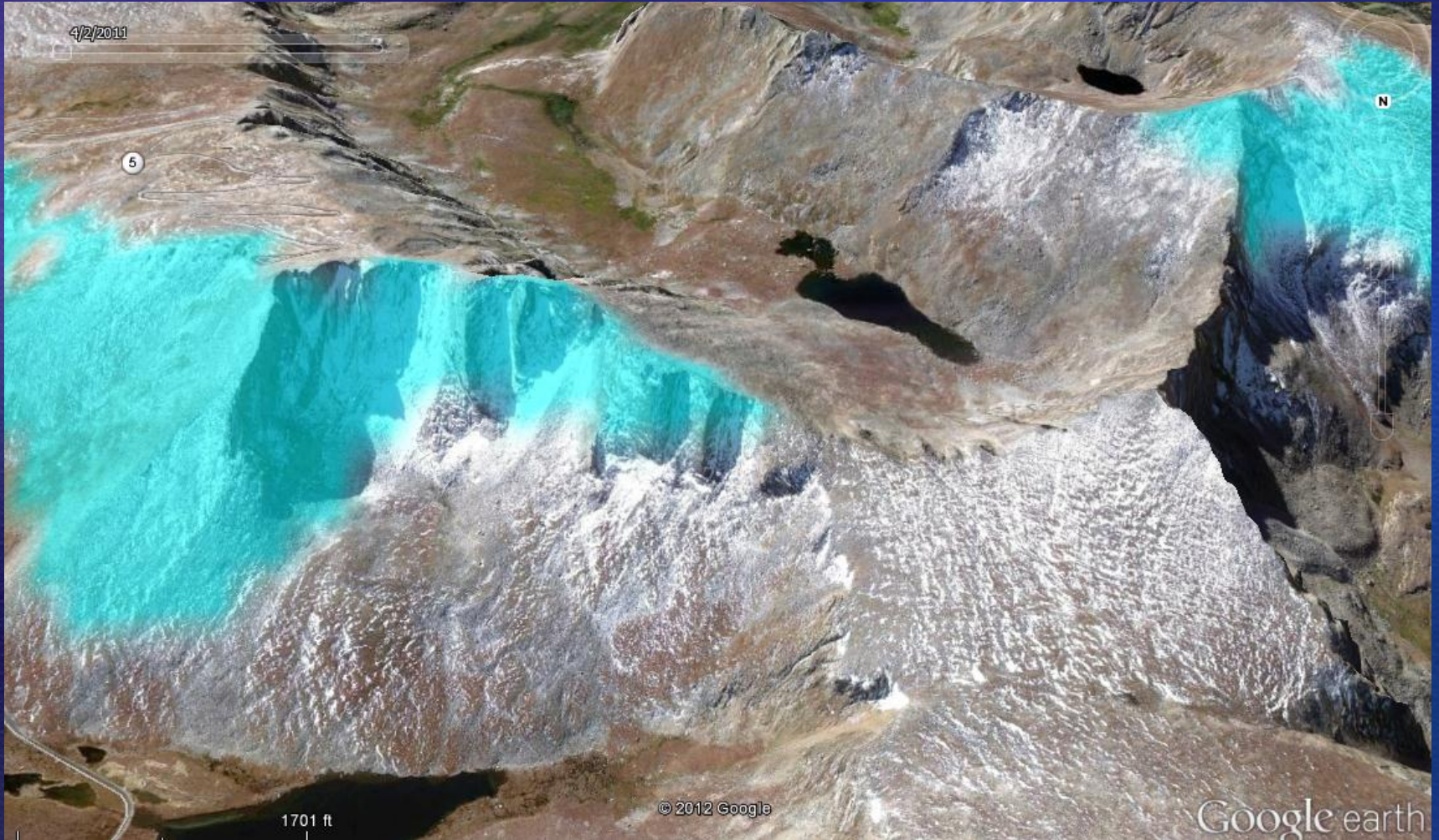


What can you do if you only know the tower?



Source: Civil Air Patrol Briefing on Alpine Search for missing hiker 18 July 2012

Evans-Bierstadt Viewshed



Source: Civil Air Patrol Briefing on Alpine Search for missing hiker 18 July 2012

SPOT, InReach and PLB's



Call +1 866 651 7768 or [Buy Now](#)

SPOT

Messages

Map Legend **FAQ**

Type	Time	Messenger
Messenger: Messenger1 (23 Messages)		
Track Pro...	3 Hours ago (12:06 PM)	Messenger1
Track Pro...	3 Hours ago (11:54 AM)	Messenger1
Track Pro...	3 Hours ago (11:43 AM)	Messenger1
Track Pro...	3 Hours ago (11:34 AM)	Messenger1
Track Pro...	4 Hours ago (11:24 AM)	Messenger1
Track Pro...	4 Hours ago (11:14 AM)	Messenger1
Track Pro...	4 Hours ago (11:03 AM)	Messenger1
Track Pro...	4 Hours ago (10:54 AM)	Messenger1
Track Pro...	4 Hours ago (10:44 AM)	Messenger1
Track Pro...	4 Hours ago (10:33 AM)	Messenger1
Track Pro...	5 Hours ago (10:23 AM)	Messenger1
Your Local Time: Sat Apr 14 2012 10:23:04 GMT-0600 (Mountain Daylight Time)		
Coordinates: (WGS84) 39.72563 , -105.32826		
Message Detail:		
Track Pro...	5 Hours ago (10:13 AM)	Messenger1
Track Pro...	5 Hours ago (10:03 AM)	Messenger1
Track Pro...	5 Hours ago (9:53 AM)	Messenger1
Track Pro...	5 Hours ago (9:43 AM)	Messenger1
Track Pro...	5 Hours ago (9:33 AM)	Messenger1

Page 1 of 1

1 - 23 of 23

Map

Map | Satellite | Hybrid | Terrain

Messenger1

ESN : 0-8171812

Type : Track Progress

Latitude : 39.71589

Longitude : -105.30968

Time : Sat Apr 14 2012 09:53:15 GMT-0600 (Mountain Daylight Time)

Map data ©2012 Google

Alpha Rescue Team - SPOT Response

Version 1.0 - 10 April 2012

Purpose: Guidance in handling responses to SAR missions initiated by or involving SPOT satellite messenger devices.

Background: SPOT is a family of personal devices designed to share position information in non-emergency situations and to activate a response similar to a 911 call in emergency situations. Unlike the global positioning technology in which the hardware is produced by commercial firms and the service provided by the US Government, SPOT hardware and service are both provided by a commercial firm using the Globalstar LEO satellite constellation. SPOT requires the purchase of annual subscriptions to activate various types and levels of services. The basic service provides for emergency activation.

There are several versions of SPOT hardware in the field. One type is completely standalone unit. Another is a piece of equipment that connects to Android and iPhone smartphones via Bluetooth and is controlled via an installed app. Under ideal circumstances the SPOT units have accuracy comparable to consumer grade GPS units, or about 3 meters.

In non-emergency situations positions and messages can be sent to designated individuals via email and text messages, and to public and private websites. An emergency message which SPOT filters to as an SOS is sent to their GEOC Rescue Coordination Center which in turn requests local law enforcement to notify them of an activation, provide location, and information on the user of the SPOT unit. Position information is delivered to local authorities if a local degree controller using the SOS is detected.

If activated positions are transmitted every 20 minutes in non-emergency situations, and can also be sent on demand. If the SOS function is activated the unit attempts to transmit position every 5 minutes. Battery life on fresh lithium batteries when transmitting SOS locations is claimed to be 3 - 6 days for SPOT messenger and 4-5 days for SPOT Connect.

Procedures:

- A SPOT SOS notification will be received by a County PSAP. In our case the Clear Creek or Jeffco Dispatch facilities from the SOC; during an activation they will provide location of the unit and information on the unit's owner.
 - An SOS should be treated in the same manner as a 911 call.
 - NEC should determine that the information transmitted is near the true position of the subject and should dispatch search teams to that location.
 - Dispatched position locations should help determine if the subject is stationary or mobile, and if the latter direction of travel.
- GEOC Response Coordination Center: 336-943-3131.
- Since the coordinates are in decimal degrees, UTM, and UTM standard is UTM, NAD 27 either convert the locations to UTM at 2m for the field team or have a single field team member enter the geographic coordinates and datum into a handheld GPS which outputs UTM format. If at all possible do not ask field teams to convert the coordinates themselves while enroute to the subject.

If a subject who is known to have a SPOT unit is missing but there has been no SOS it may still be possible to use SPOT information to aid a search.

- Check if reporting parties or friends are aware of the subject's use of SPOT and most importantly if the subject had checked a SPOT website that allows them to monitor location on a near-real time basis. If such a website exists obtain the URL and password (if required).

Copyrights

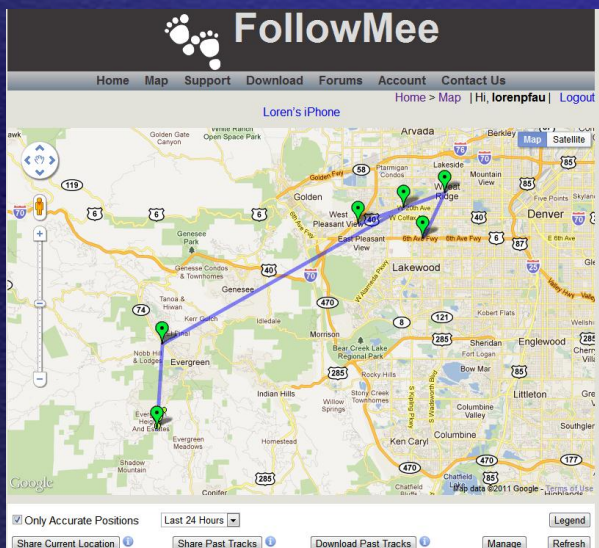
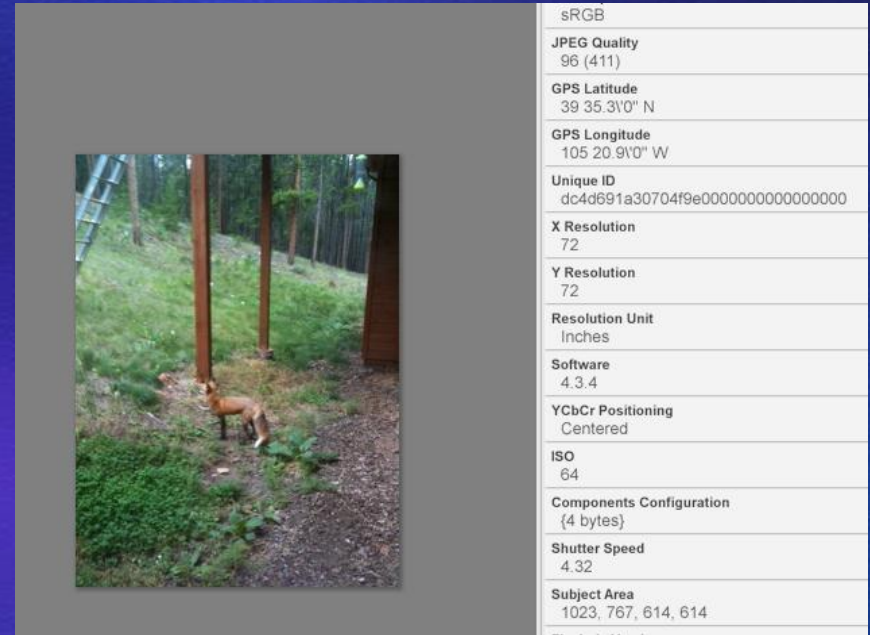
Apps and Geotagging

Smartphone activities

% of adult smartphone owners who use their phones to do the following social activities

	% of smartphone owners who do this
Send or receive text messages	92%
Take a picture	92
Send a photo or video to someone	80
Send or receive email	76
Access a social networking site	59
Get location-based directions or recommendations	55
Post a photo or video online	45
Access Twitter	15
Participate in a video call or video chat	13
Use a geosocial service like Foursquare or Gowalla	12

Source: The Pew Research Center's Internet & American Life Project, April 26 – May 22, 2011 Spring Tracking Survey. n=688 adult smartphone users ages 18 and older. Interviews were conducted in English and Spanish, by landline and cell phone.



Virtual clues in the form of geospatial data can be as important a physical clues in a search

Mission Management

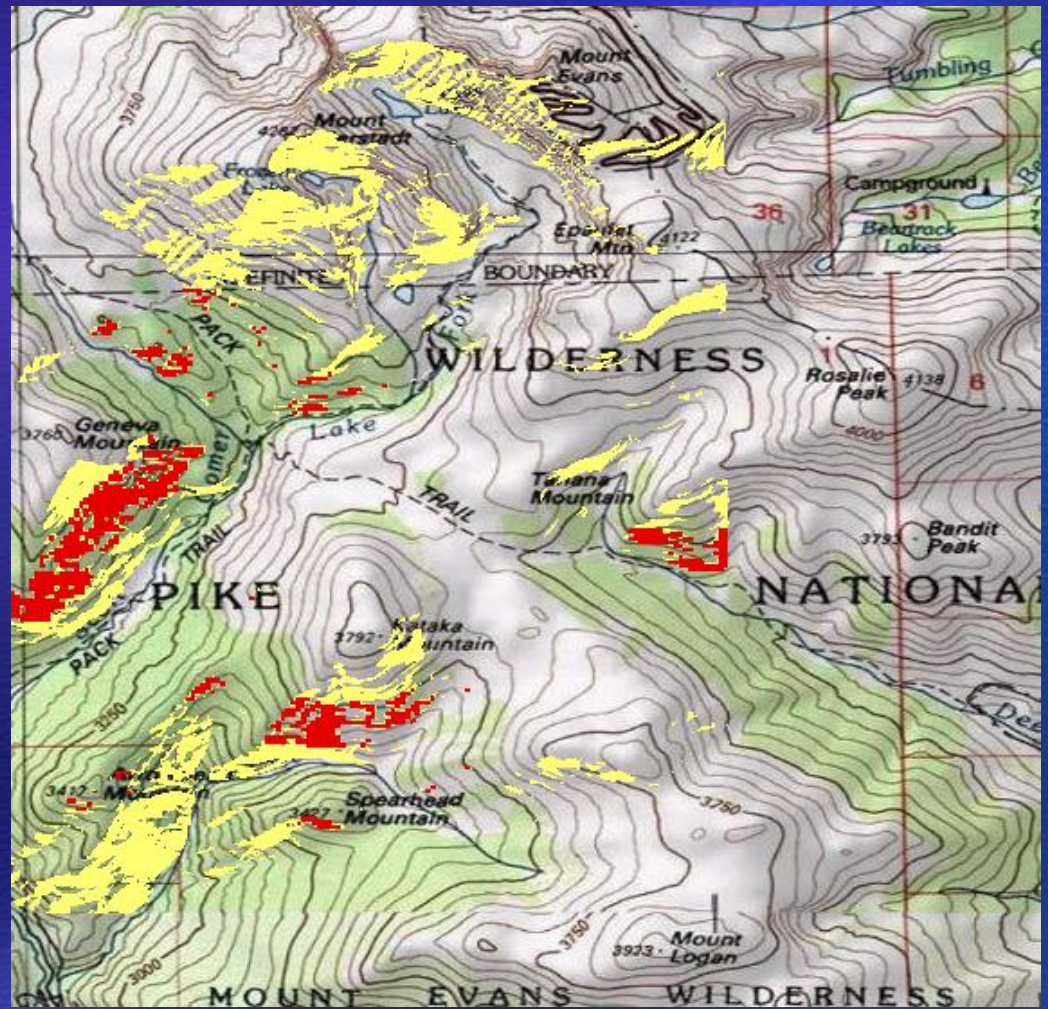
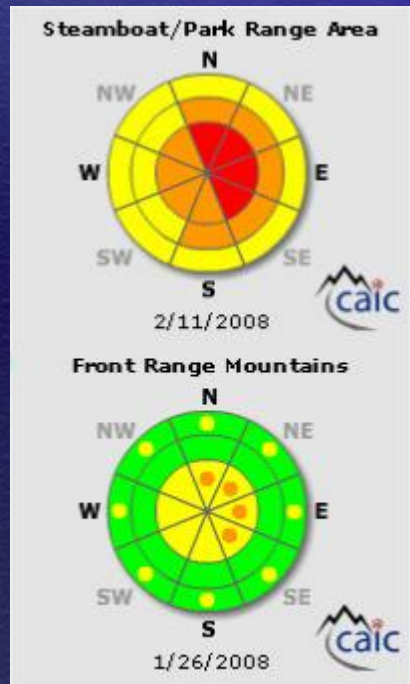
- MapSAR
- Ad hoc tools such as the avalanche danger predictor
- Online tools such as ArcGIS Explorer Desktop and Online
- Tablet apps and storage

MapSAR

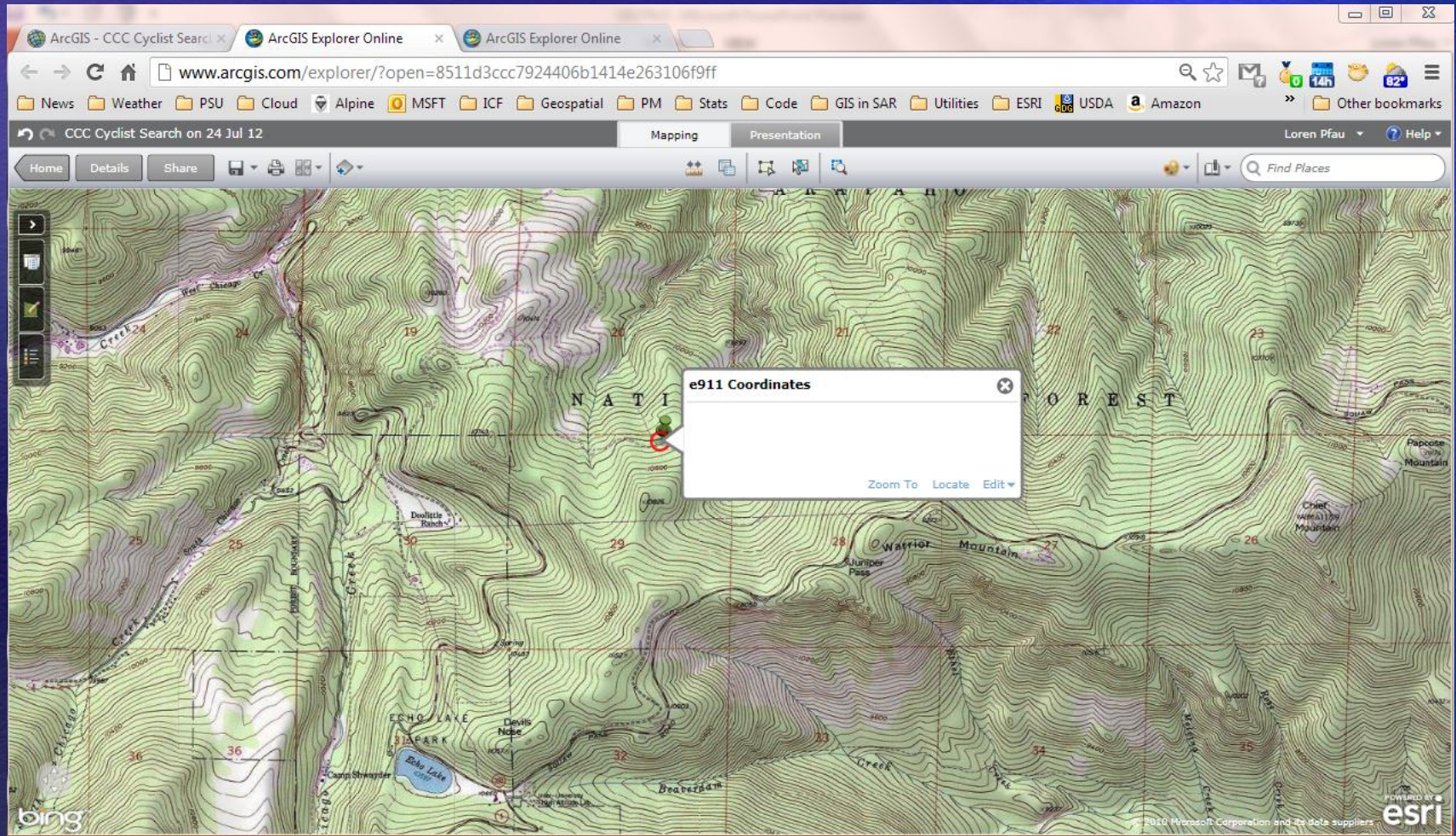
- Sophisticated, ArcGIS-based geospatial tool to aid wilderness SAR mission management
 - Developed by the SAR community and ESRI
 - National Parks
 - Several SAR Teams
 - Incorporates
 - Team / Asset Management
 - Documents Assignments and Clues
 - Search Theory
 - Lost Person Behavior

Avy Danger Example – Risky areas based on Slope, Aspect and Elevation

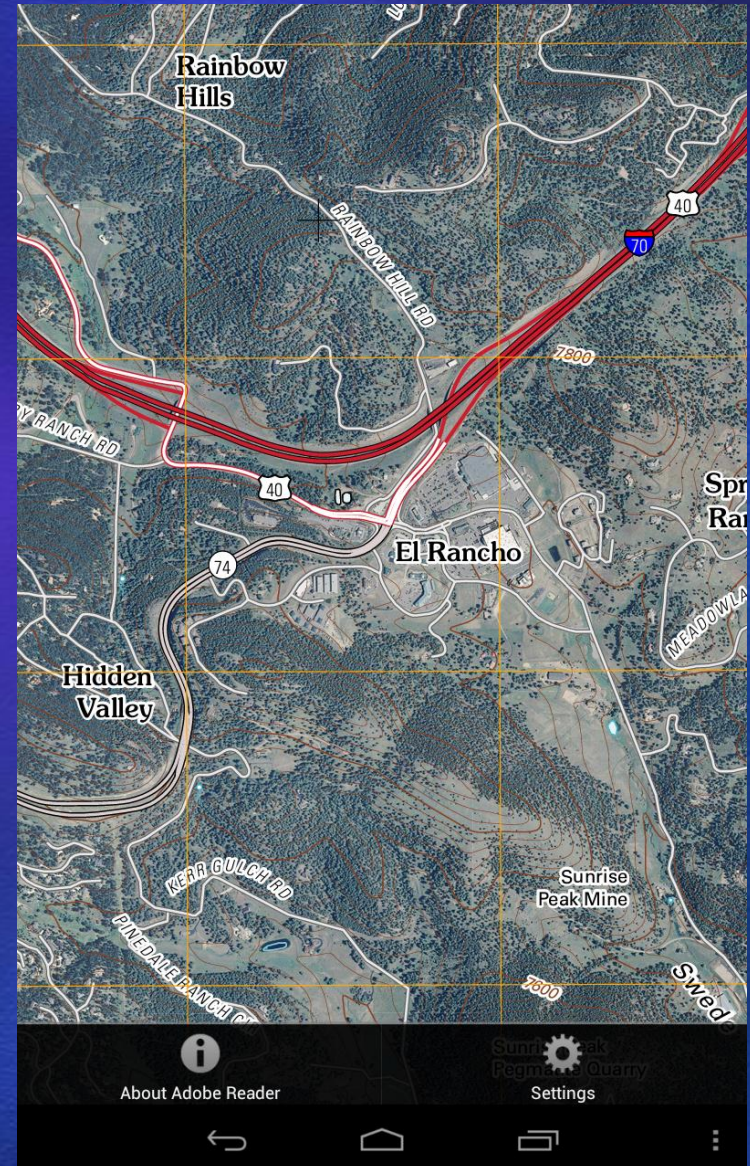
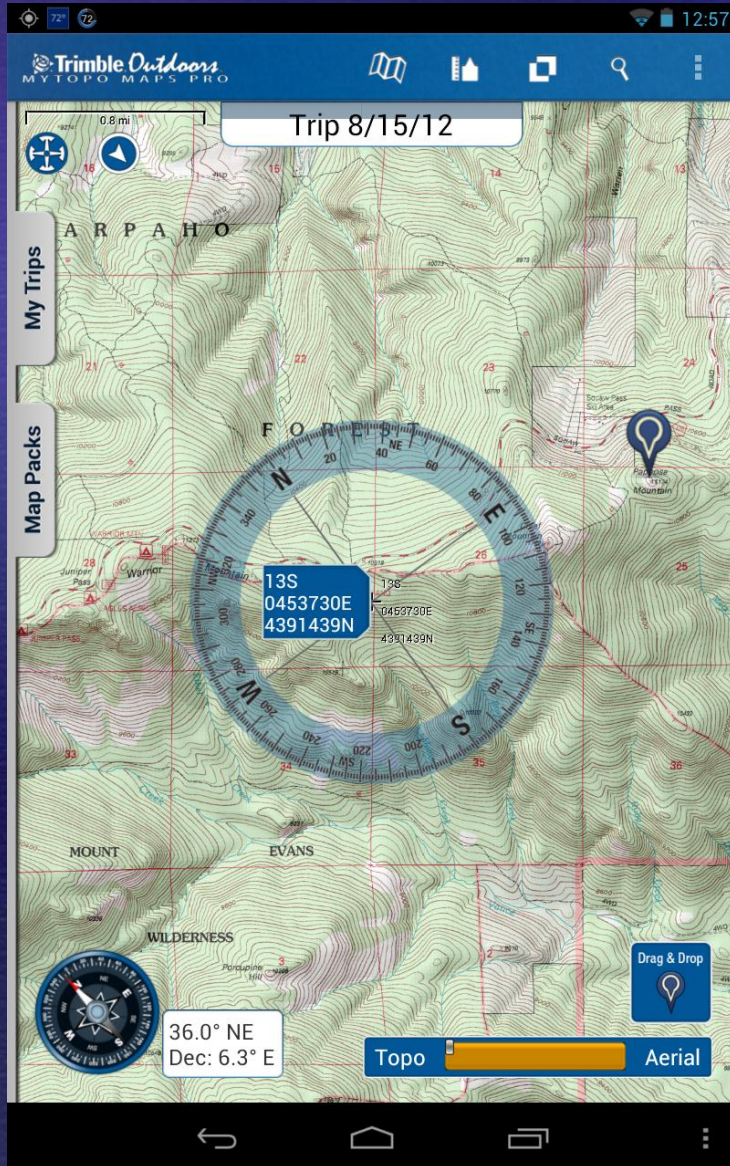
- CAIC Danger Rose
- DEM
- USGS Topo
- Custom Danger Map for Areas of Interest



ArcGIS Online Used to Share Mission Data – Lost Mountain Biker



Tablets...



Preparation, Analysis and Training

- Examples of the Alpine 4-year mission database
- Post-Mission Debriefing and Sharing
- Non-traditional Data Sources

Historical Mission Locations: 2008-2011

Density Lost Persons

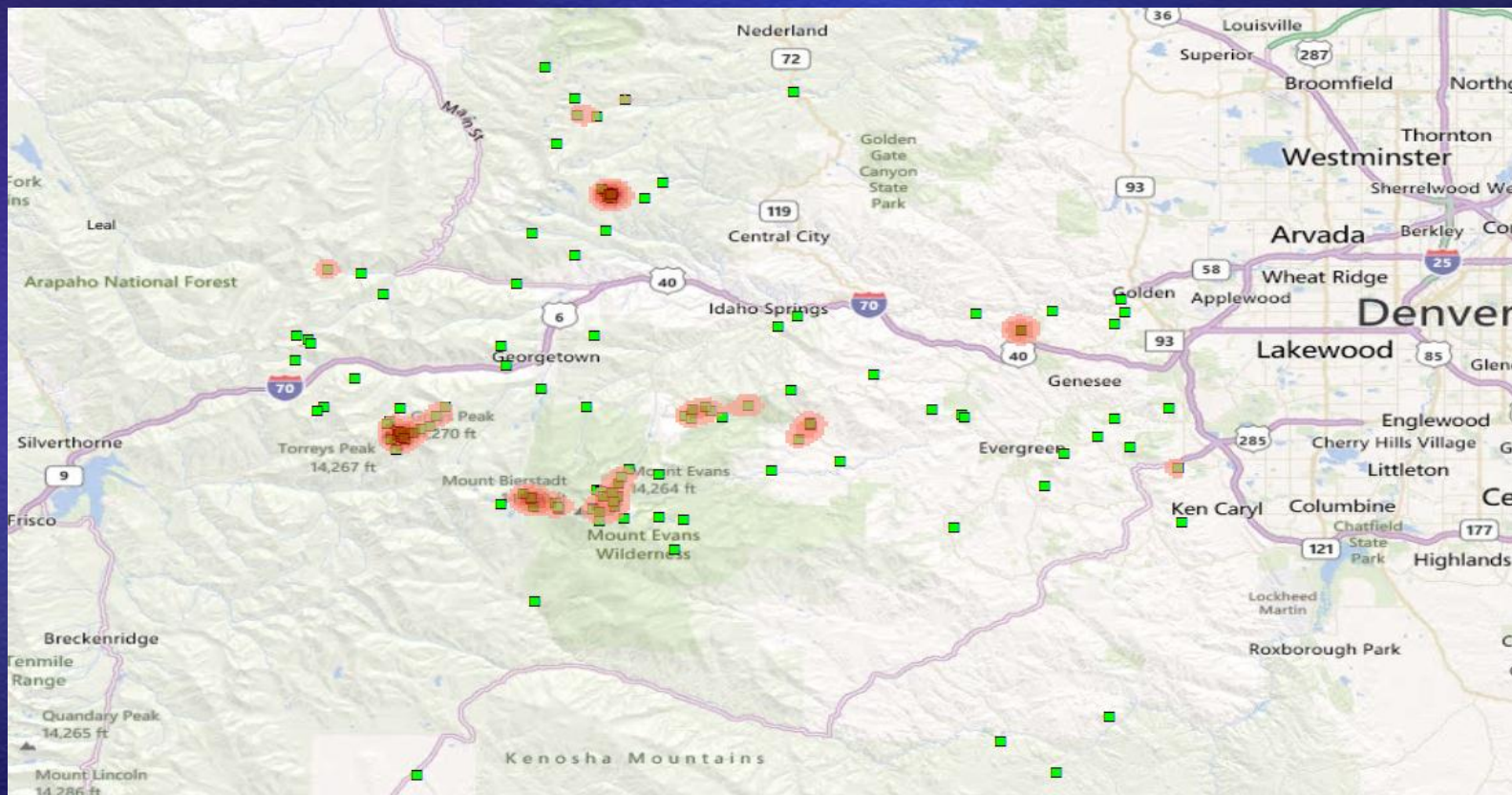
Low



High

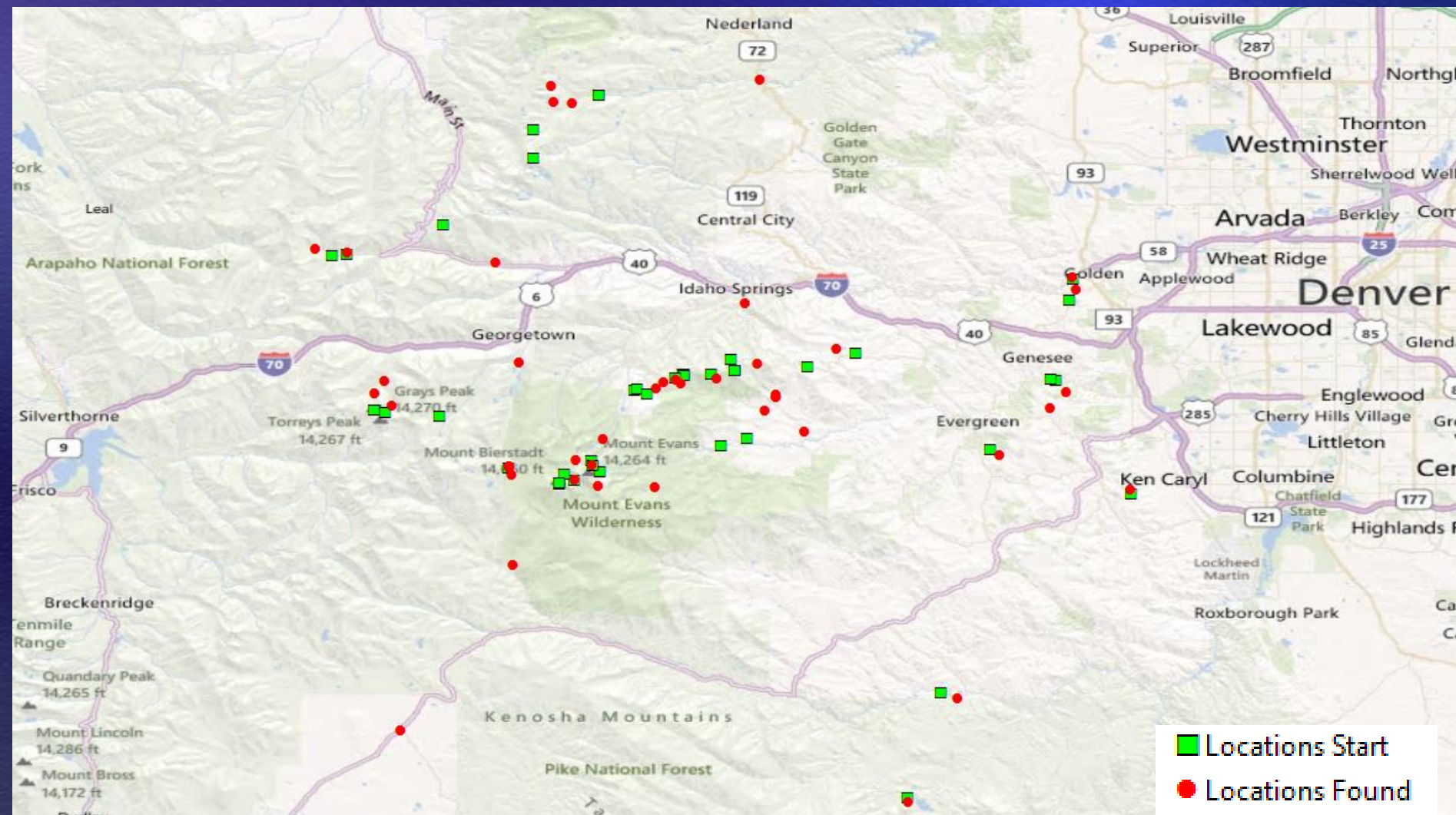
Missions

Data
Collected
using ISRID
database
format

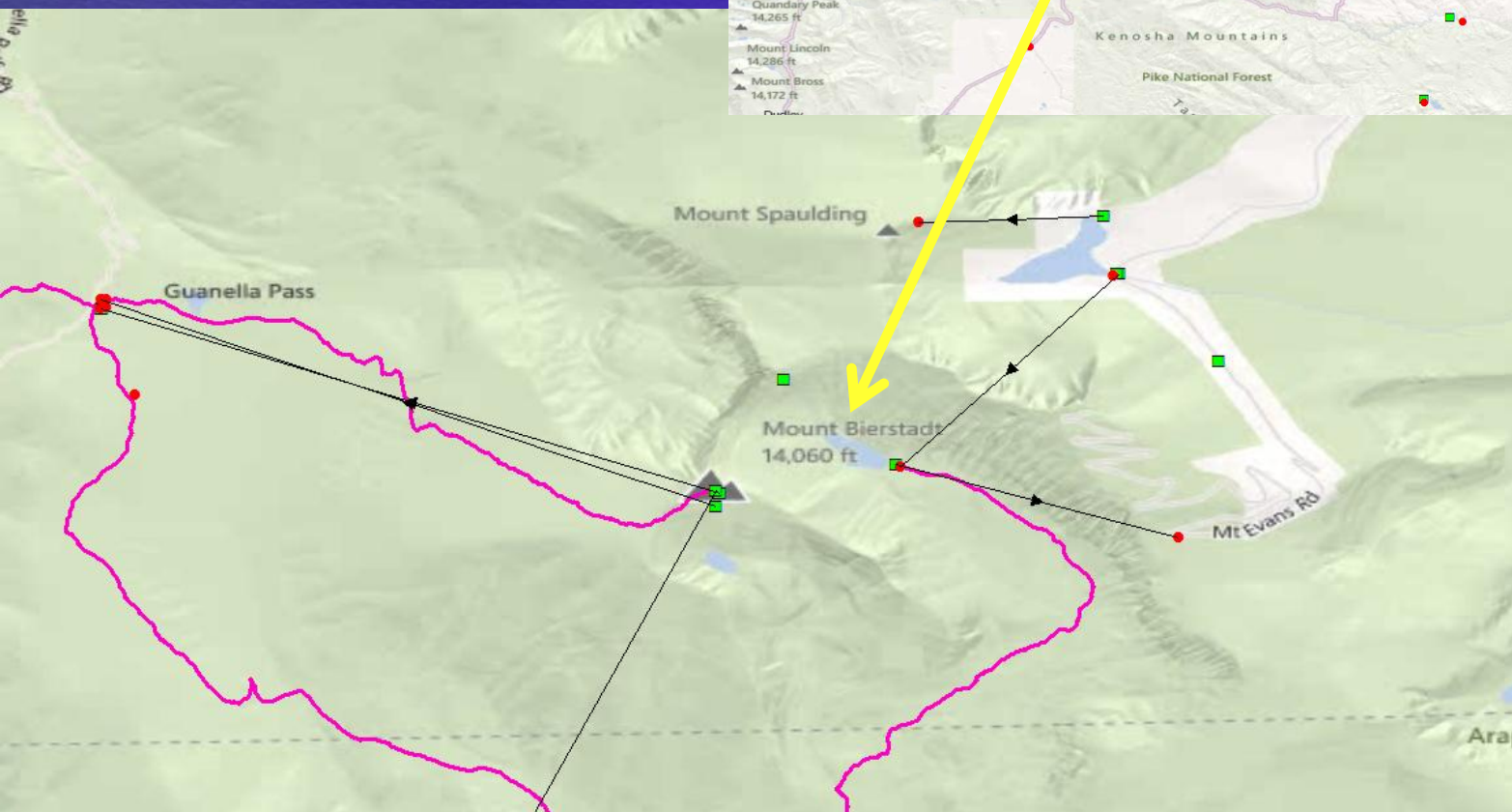
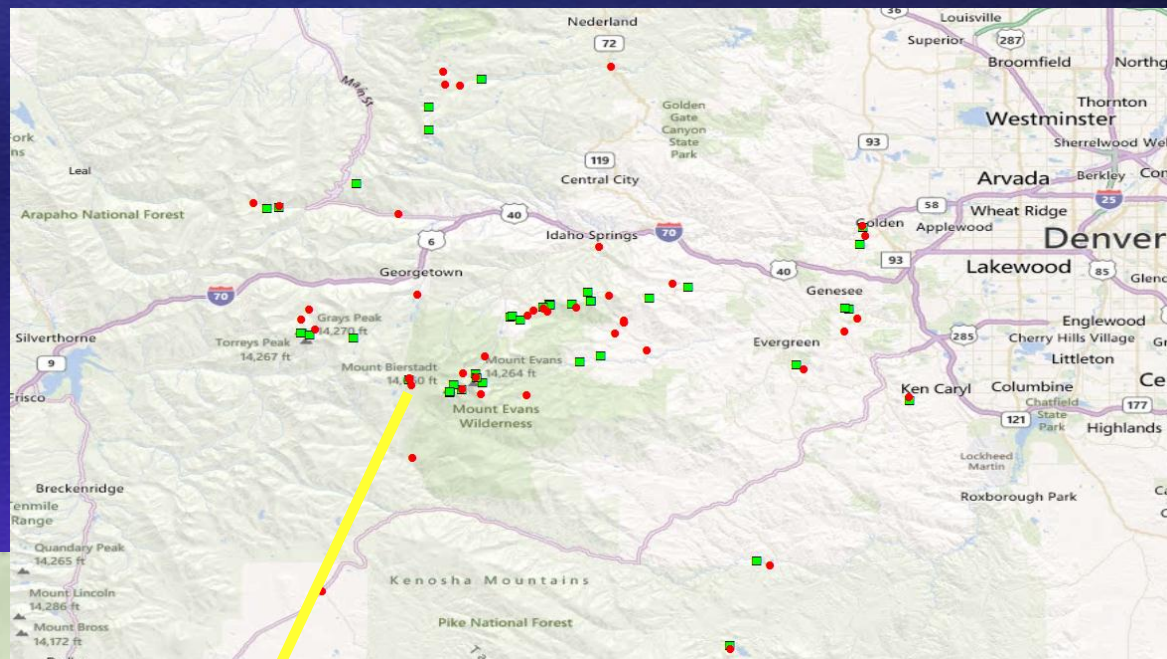


day	mo	year	incdtype	personcat	noper	Age	Sex	totsrc	plstutmea	plstutmo	ndutme	ndutmn	fndelev	plsdistm	diffelev	fndby	fndfeat	perstat	fndmobil	fndrespo
								h	st	rth	ast	orth							e	nse
28	9	2010	search	hiker	1	64 f		1	460330	4392020	3484.0	456720	4392230	3303.0	3616.1	181.0	hasty tean ridge	uninjured	mobile	responsive
23	7	2011	search	hiker	1			1	442610	4381300	4239.0	439000	4382900	3553	3948.7	686.0	law enforc road	uninjured	mobile	responsive
27	8	2011	rescue	hiker	1	66 m		1				440660	4382390	3576			hasty tean trail	uninjured	mobile	responsive
27	8	2011	rescue	hiker	1	32 f		1				440660	4382390	3576			hasty tean trail	uninjured	mobile	responsive
3	8	2009	rescue	hiker	1	24 m		1				444720	4409490	3324			bystanders snowfield	injured	immobile	responsive
9	7	2008	rescue	hiker	1	f		1				444790	4409450	3297			bystanders snowfield	injured	immobile	responsive
28	8	2010	rescue	mountain t	1	35 f		1.25				468451	4389824	2389.0			hasty tean trail	injured	immobile	responsive
2	3	2010	rescue	hiker	1	m		1.5				425100	4390970	3700.0			friends slope	injured	immobile	responsive
30	5	2010	missing pe	hiker	2	m,f		1.5	448070	4389930	3231.0	449500	4390030	3284.0	1433.5	-53.0	bystanders road	uninjured	mobile	responsive
10	6	2010	missing pe	hiker	1	41 m		1.5	451510	4391310	3366.0	450090	4390600	3327.0	1587.6	39.0	confineme road	uninjured	mobile	responsive
13	8	2011	rescue	hiker	1	17 m		1.5				457180	4398720	2355			bystanders slope	uninjured	mobile	responsive
6	9	2009	rescue	ATV rider	2	58, 62 m, m		1.5				442200	4404100	3059			self trail	injured	immobile	responsive
6	9	2009	search	hiker	1	26 f		1.5				452090	4389910	2855			hasty tean trail	uninjured	mobile	responsive
13	9	2008	rescue	despondar	1	16 f		1.5				438520	4383240	3551			bystanders cliff	uninjured	mobile	responsive

Missions with Lost and Found Locations

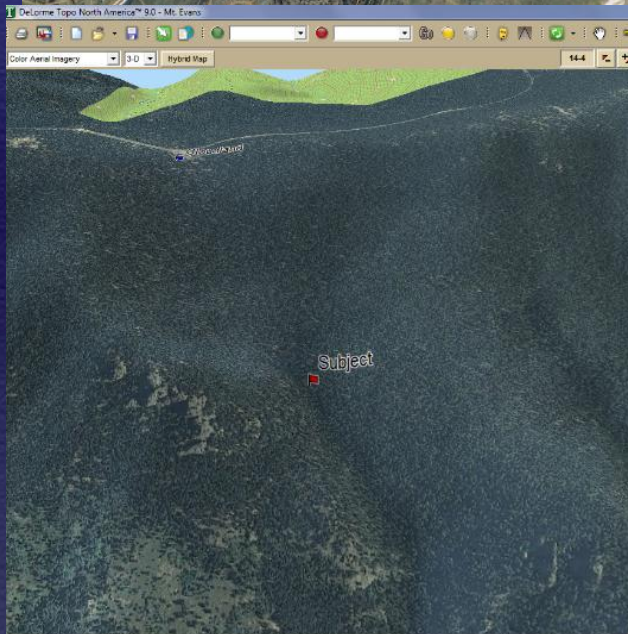
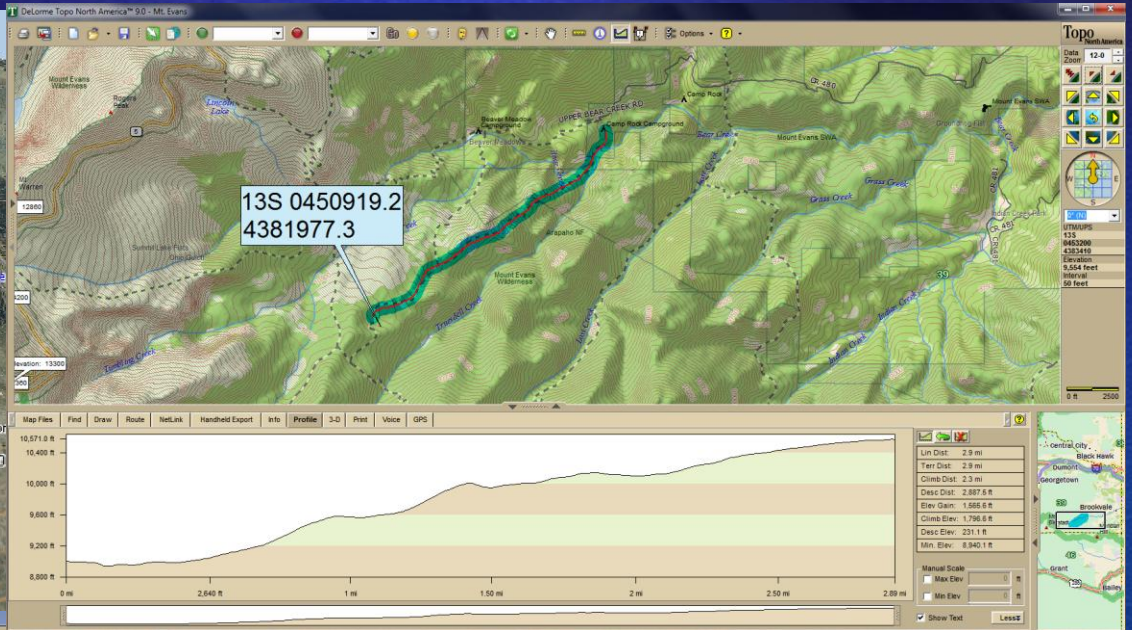


Mission Connectivity and Routes



- Locations Start
- Locations Found
- Trails
- ➔ Directional Movement

Post-Mission Debriefing and Analysis



Additional Data Sources

- Climbing and hiking forums such as 14ers.com
- Trails shared on Open Street Map
- Geocaching logs

14ers.com Mt. Bierstadt
Main Page

14ers Routes Trip Reports Trailheads Weather Forum Shop

Home < 14ers < Mt. Bierstadt (Main Page)

Hello, lorenfau [Logout]

Elevation: Mt. Bierstadt (14,060') More stats/info...
Location: Bierstadt is in the Mount Evans Wilderness 2 miles west of Mt. Evans (14,264'). It can be seen by taking Guanella Pass from Georgetown (from the north - Interstate 70) or Grant (from the south - U.S. 285) or from the Colorado 5 that snakes to the top of Mt. Evans.

14erology

- Name History
- Climbing History
- Mining
- Geology
- More Information

Add Information My Entries

14ERS WITHIN 10 MILES

- Grays Peak (8.68 miles)
- Torrey's Peak (9.12 miles)
- Mt. Evans (1.4 miles)
- "West Evans" (1.11 miles)
- Mt. Bierstadt (0 miles)

13ERS WITHIN 2 MILES

- Mt. Spalding (1.35 miles)
- The Sawtooth (0.61 miles)

Map of Nearby Peaks
View/Download...
Towns: Georgetown, Idaho Springs, and Grant
Nat. Forests: Pike, Arapaho

OpenStreetMap

View Edit History Export GPS Traces User Diaries

The Free Wiki World Map

Search Where am I? Go

examples: 'Aikmaar', 'Regent Street, Cambridge', 'CB2 5AQ', or 'post offices near Lünen' more examples...

OpenStreetMap is a free editable map of the whole world. It is made by people like you.

OpenStreetMap allows you to view, edit and use geographical data in a collaborative way from anywhere on Earth.

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The 5th annual international OpenStreetMap Conference

Challenges

- So, new geospatial data and GIS has the potential to be a game changer in SAR
- But there are...
 - Education needs
 - Tool needs
 - Expertise that is lacking on SAR teams
 - Money (as in lack of)

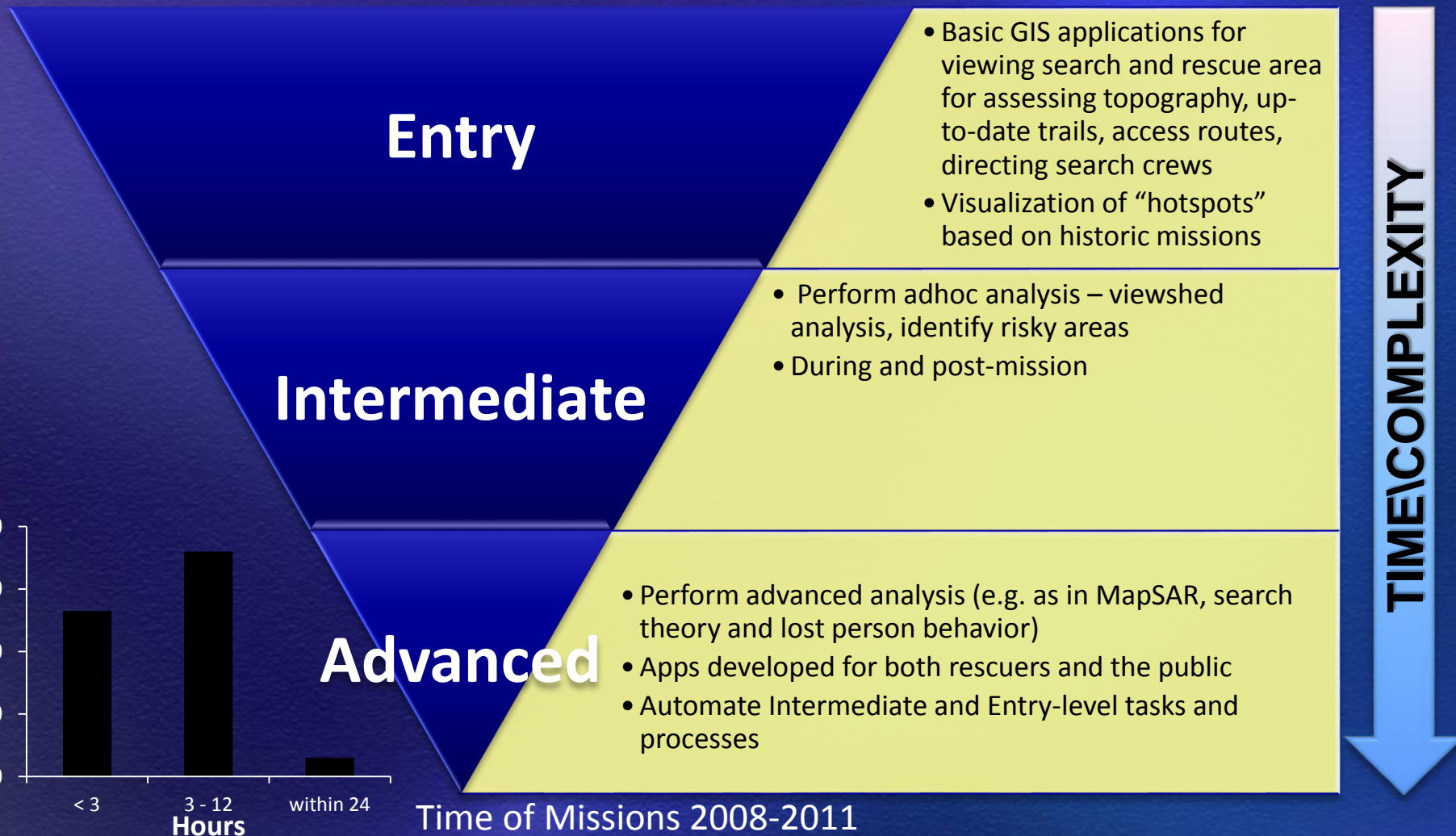
Conclusions

- The types, volumes and sources of geospatial data of use to wilderness SAR are rapidly increasing and can be overwhelming
- These new data sources have the potential to improve SAR outcomes **IF** teams can capitalize upon them
- The SAR community needs help from the GIS community in the form of time, expertise and tool development

In the meantime....

Conclusions

- Geospatial information can be used by SAR at different levels



Questions?

Acknowledgments

- Dr. Justine Blanford
- Alpine Rescue Team
- Mountain Rescue Association

Selected References

- Penn State MGIS Program - <https://gis.e-education.psu.edu/mgis>
- MRA – www.mra.org
- NASAR – www.nasar.org
- MapSAR - www.mapsar.net
- Alpine Rescue Team - <http://www.alpinerescueteam.org/>
- Colorado Search & Rescue Board - <http://www.coloradosarboard.org/>

Thank You

“It is far better to be lost and know it, than to confidently believe you are somewhere that you are not.”

- Tristan Gooley in “The Natural Navigator: A Watchful Explorer's Guide to a Nearly Forgotten Skill”

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