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# A GIS Evaluation of Emergency Medical System (EMS) Response to Alaskan Car Crashes

Marie Flanigan, Kevin Majka, Alan Blatt
CUBRC

and

Ron Perkins, Beth Schuerman
Alaska Injury Prevention Center

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AIPC



CUBRC

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- Mary Russell (CUBRC)
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# Response to Car Crashes in Alaska

**Introduction**

- There were 327 motor vehicle crash (MVC) deaths & over 25,000 MVC injuries (2001-2004).
- CUBRC & AIPC are working on a project to:
  - Improve EMS response to car crashes (especially in rural areas)
  - Develop metrics to measure these improvements.

**This Paper**

- Uses Geographic Information System (GIS) tools to study access to trauma care in Alaska considering locations of:
  - Fatal motor vehicle crashes (over 4 year period)
  - Ground ambulance depots & air medical rotor wing (RW) bases
  - Hospitals and trauma centers

**Objective**

- Develop metrics to model & analyze emergency medical response to MVCs.
  - Examine 'computed' travel times from Ambulance Base to Scene to Hospital

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# EMS Has Come a Long Way…

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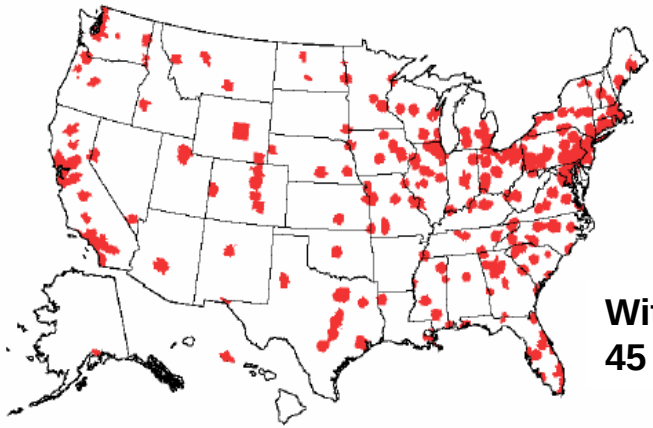
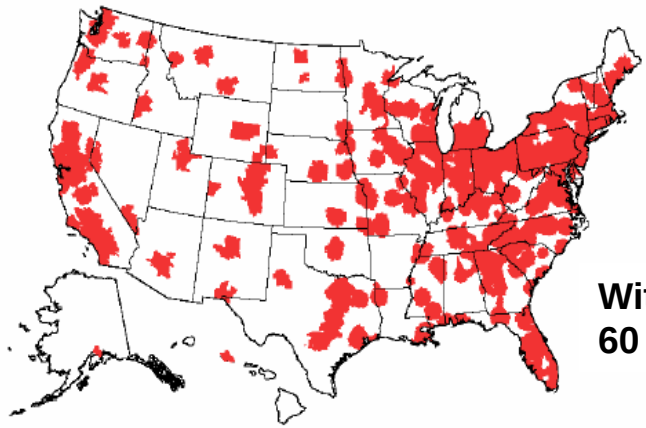
# Background Literature

- **Patients with serious injuries benefit from receiving definitive surgical care at a trauma center**
  - MacKenzie, EJ, et. al., "**A National Evaluation of the Effect of Trauma center Care on Mortality',** New England Journal of Medicine, Vol 354:366-378, January 26, 2006
- **Previous studies looked at access to trauma care by state based on trauma center locations & population distributions**
  - **Number & type of trauma centers by state**
    MacKenzie EJ, Hoyt DB, Sacra JC, Jurkovich GJ, Carlini AR, Teitelbaum SD, and Teter Jr H., **National Inventory of Hospital Trauma Centers**, JAMA, 2003;289:1515-1522
  - **Calculated travel time by ground or air (from census blocks) to trauma centers**
    Branas CC, MacKenzie EJ, Williams JC, Schwab CW, Teter HM, Flanigan MC, Blatt AJ, ReVelle CS. **Access to trauma centers in the United States**. *JAMA* 2005; 293(21):2626-2633




Maps Adapted from Branas, 2005




***Theoretical study presented here will look at travel times to the hospital relative to fatal crash injury location in the State of Alaska.***

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# Data Sources

## Scene Locations

- Crash Locations
  - Fatal Crashes from Fatality Analysis Reporting System (FARS) - 2001 through 2004. Developed & geocoded by NHTSA's National Center for Statistics & Analysis (NCSA)
  - Future studies will include serious injury crashes as well as fatal crashes

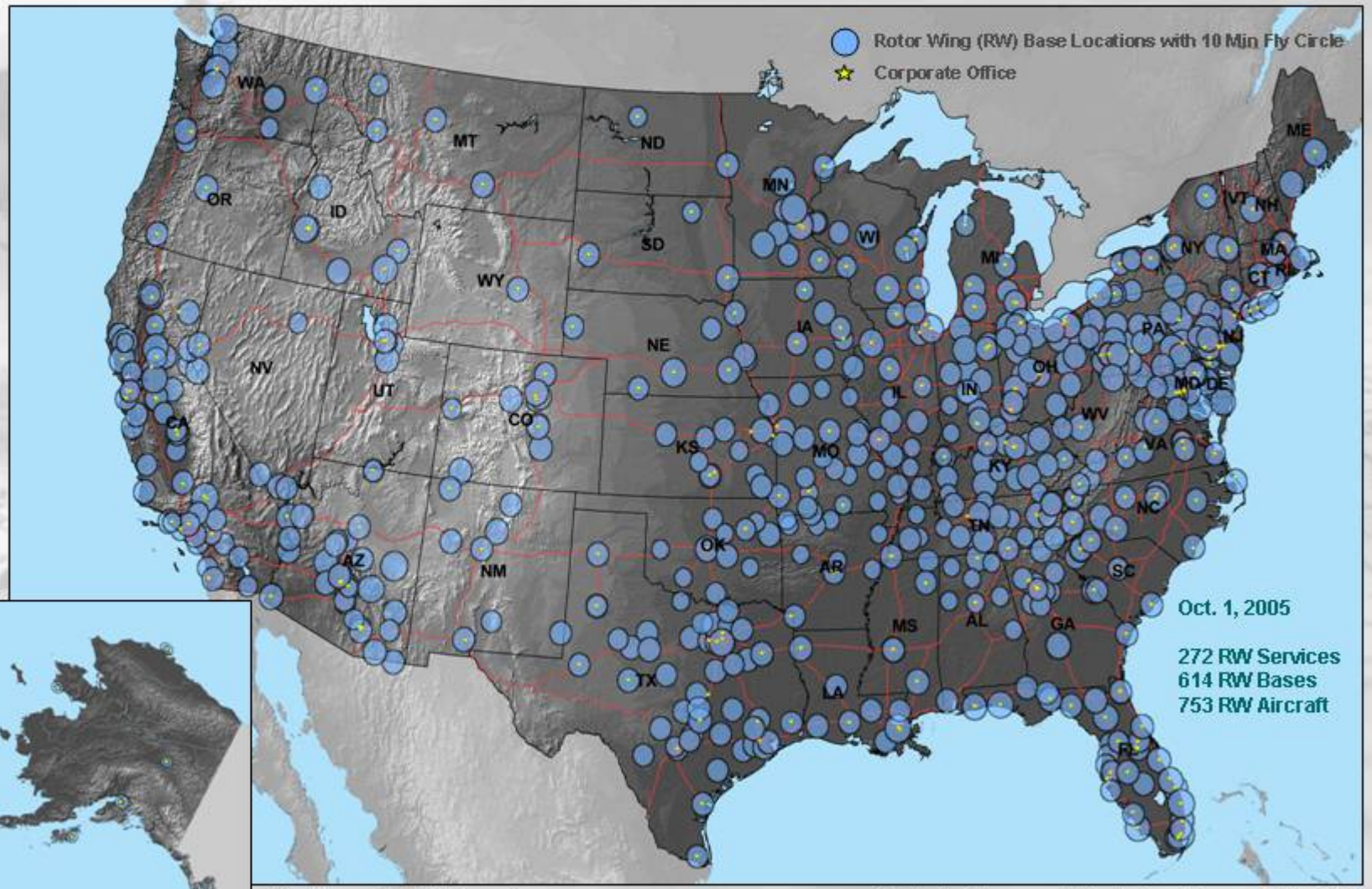
## Infrastructure Locations & Attributes

- Hospitals & Trauma Centers
  - Alaska Injury Prevention Center (AIPC), Alaska Community Health & Emergency Medical Services (CHEMS), Alaska State Sources
- Ground Ambulance Depots
  - Alaska Injury Prevention Center (AIPC) & Alaska Community Health & Emergency Medical Services (CHEMS)
- Air Medical Rotor Wing Base Helipads
  - Atlas & Database of Air Medical Services (ADAMS) 2004. Developed by CenTIR / Association of Air Medical Services / USDOT

# Atlas & Database of Air Medical Services

## Third Edition National Air Medical Services GIS Database

ADAMS 2005




http://www.ADAMSairmed.org

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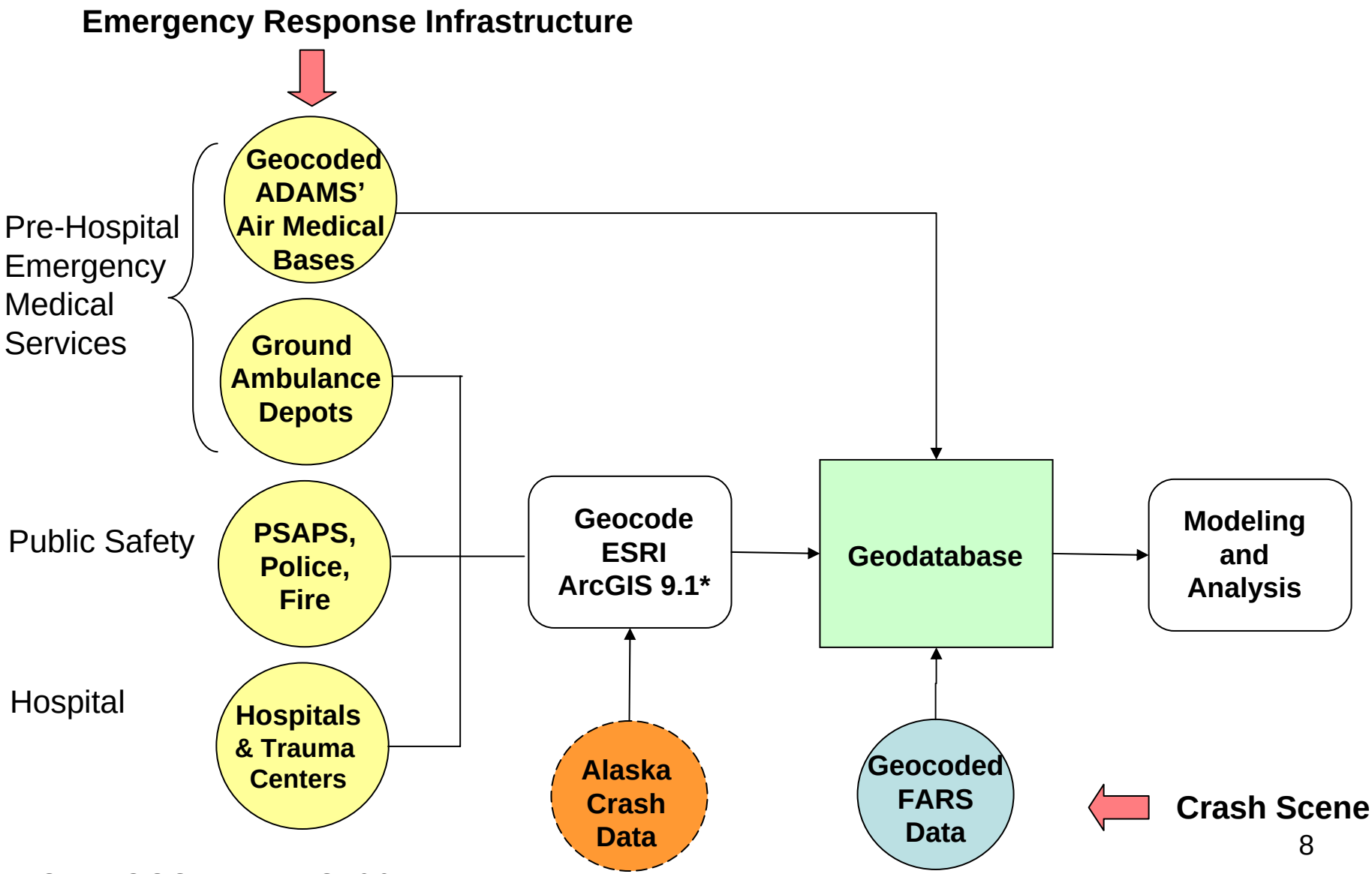
# Methodology




*ESRI ArcGIS StreetMaps USA 8.3

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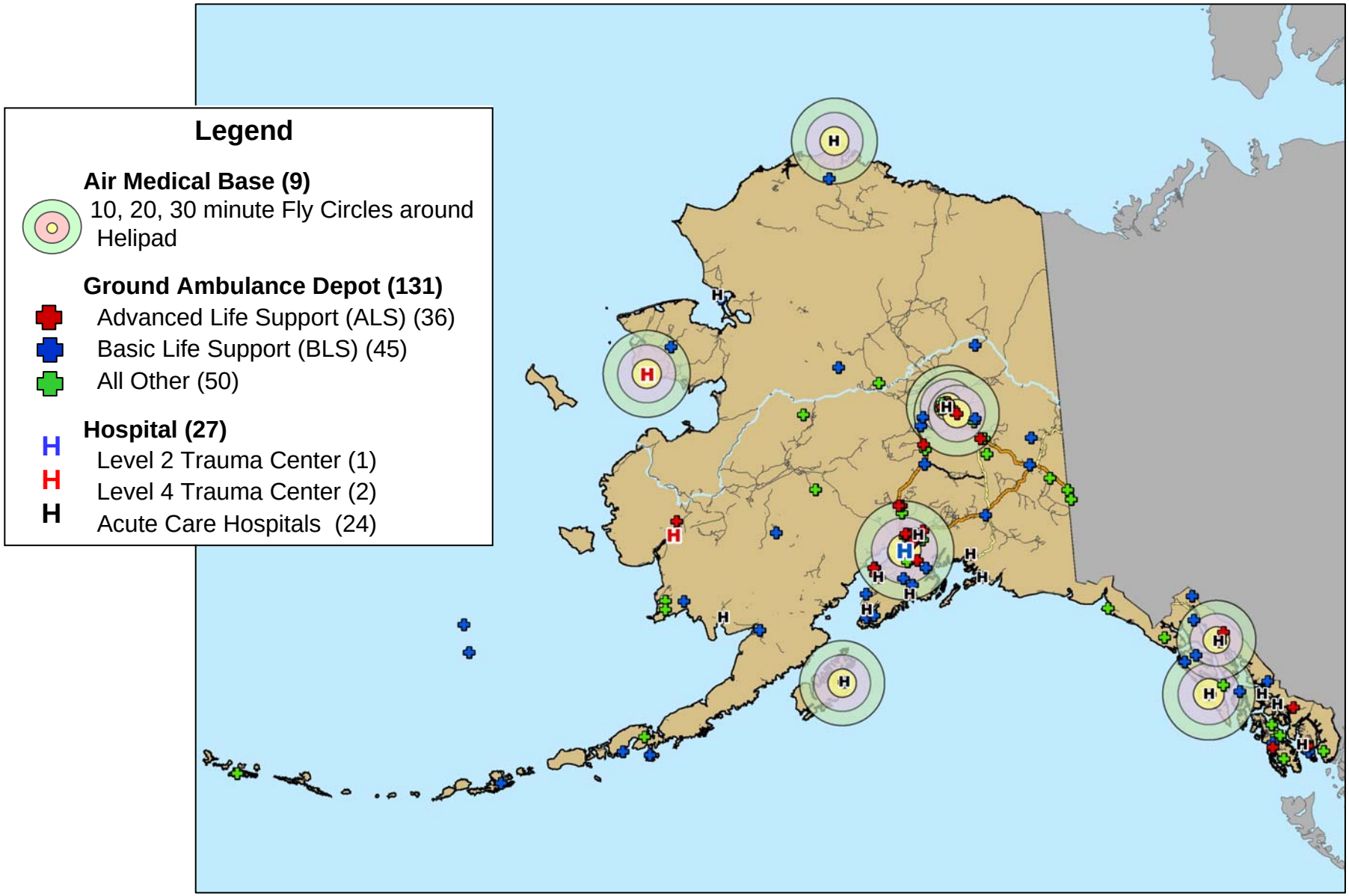
# Alaska Geocoded Emergency Medical Infrastructure Locations



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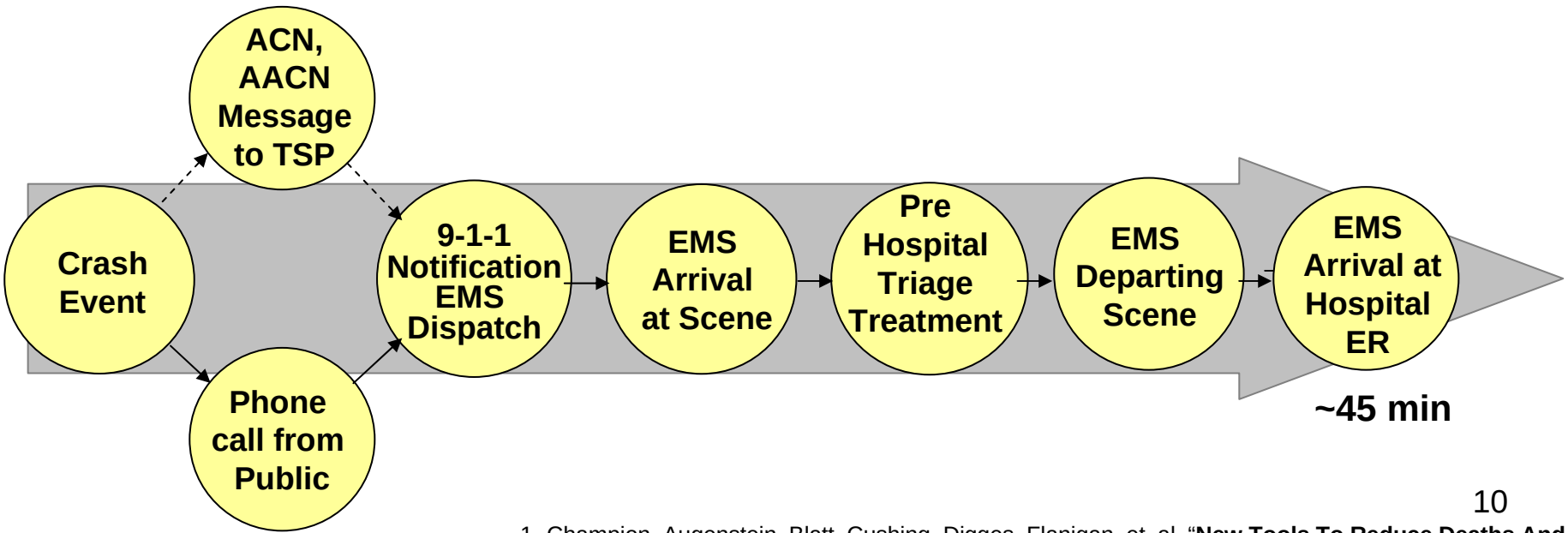
# Crash Event Timeline and Time Budgets[1] To Reach Surgery in 'Golden Hour'






1- Champion, Augenstein, Blatt, Cushing, Digges, Flanigan, et. al, "**New Tools To Reduce Deaths And Disabilities by Improving Emergency Care**" Paper 0501-91, ESV Conference, 2005

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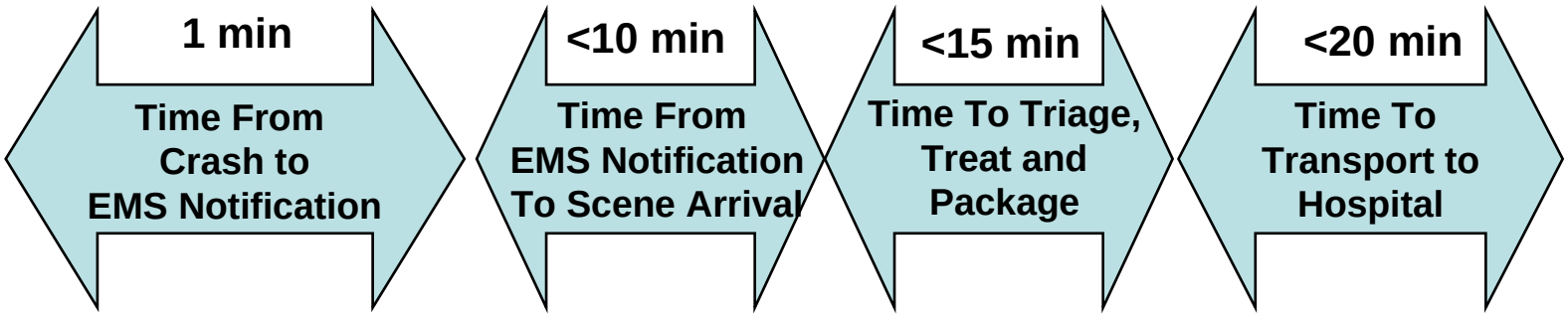
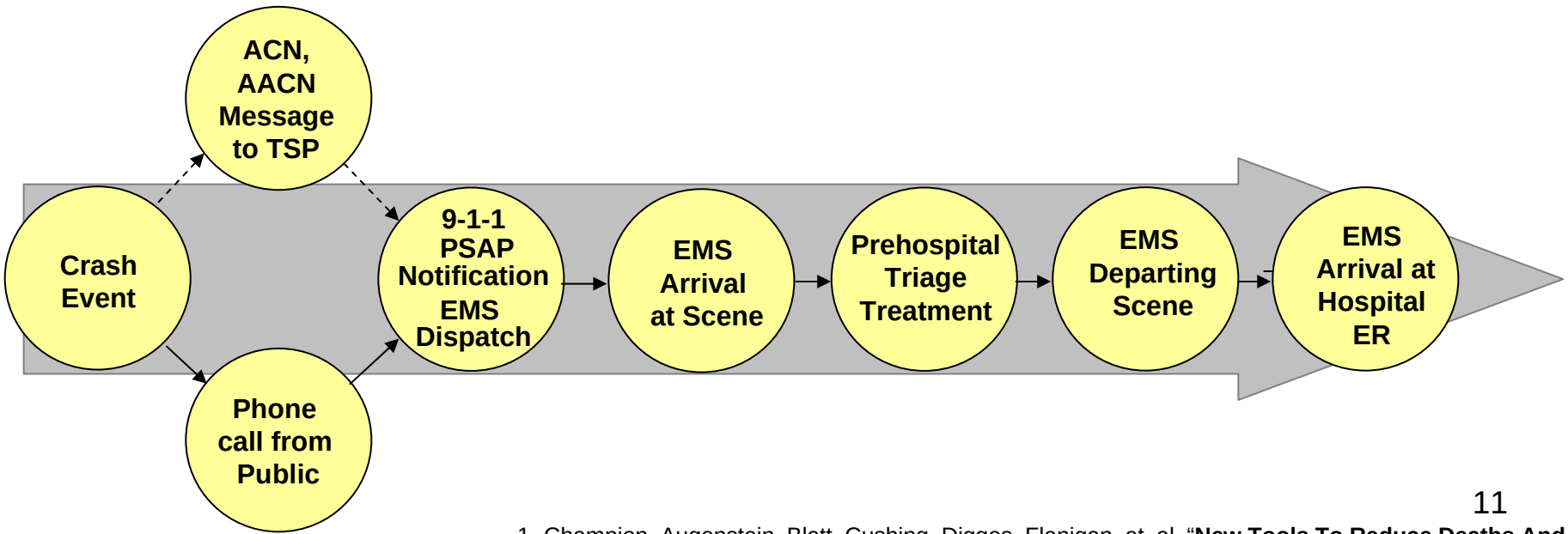
# Crash Event Timeline and Time Budgets[1] To Reach Surgery in 'Golden Hour'

~45 min ~60 min



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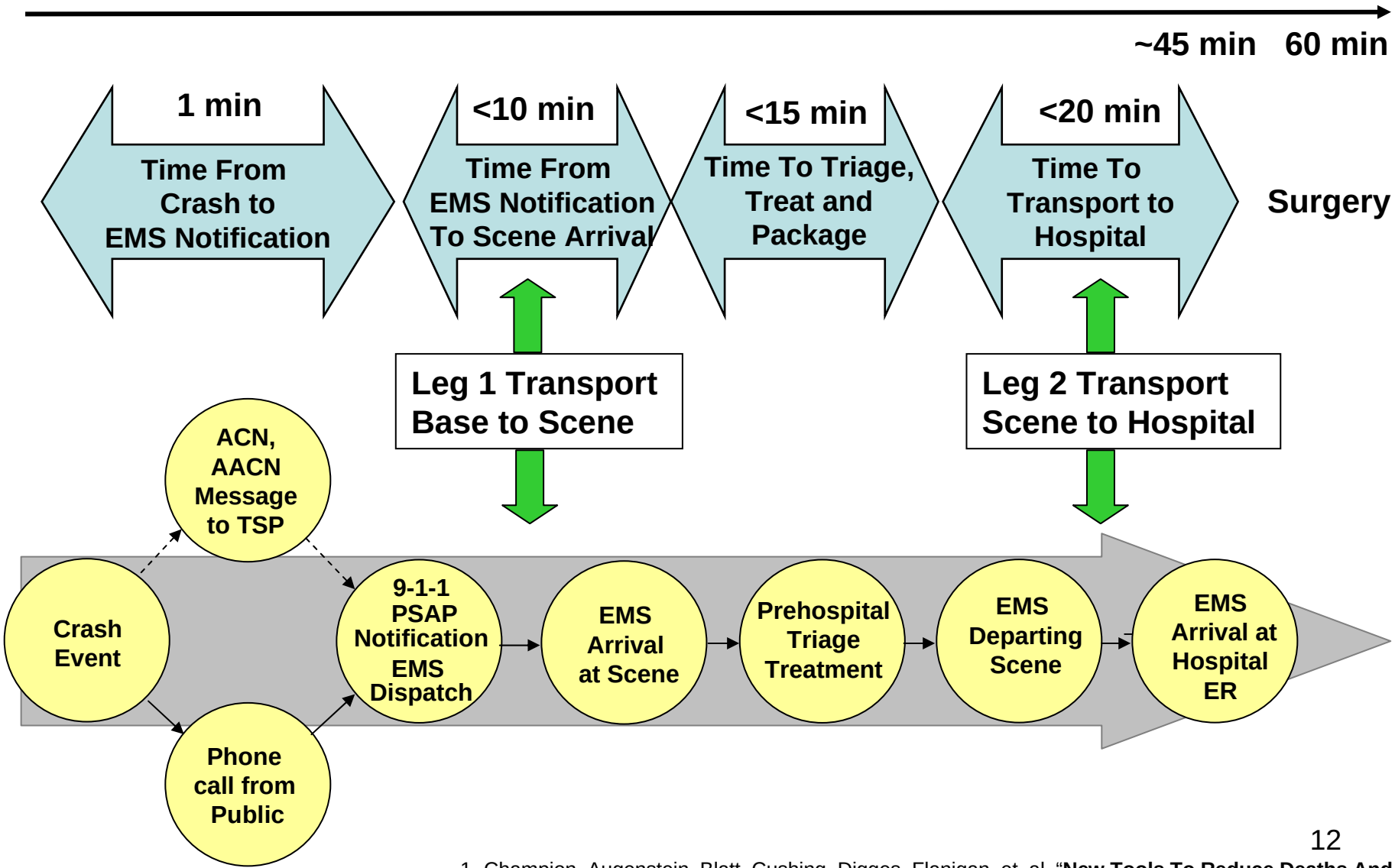




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# Air Ambulance Travel Times

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# Fatal Crash Locations Color Coded by 'Computed' Air Medical Transport Times for Leg 1

## Helipad Base to Scene

**Approach**

- **Distance (as crow flies) from Helipad Base to Crash Scene.**
- **Flight distance converted to time using average speed in ADAMS (129 knots).**

**Legend**

**Dots show locations of 307 fatal crashes. Colors indicate flight times.**

- **0 - 5**
- **6 - 10**
- **11 - 30**
- **31 - 60**
- **> 60 minutes**

Distribution: NHTSA permission granted to show (at conference) but not release maps of geocoded FARS data.

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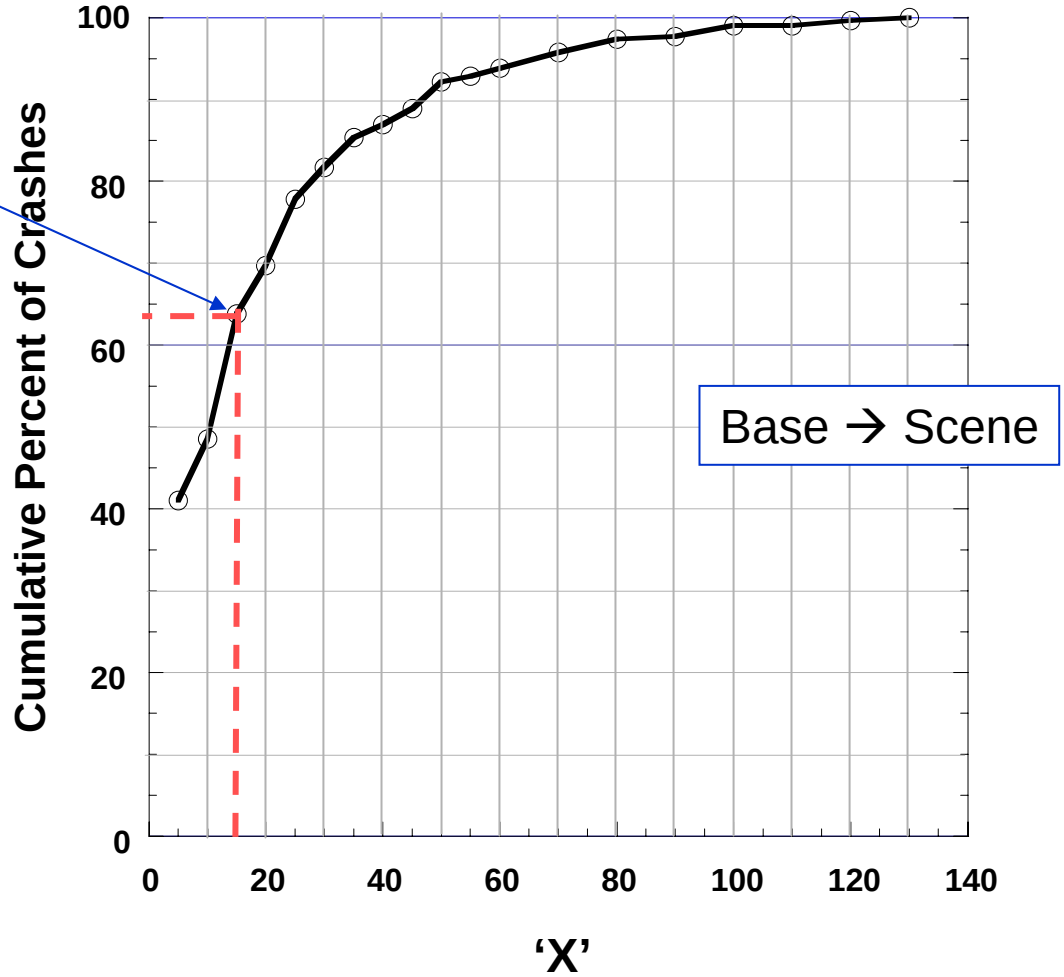
# Cumulative Percent of Crashes with 'Computed' Flight Time ≤ 'X' for Transport Leg 1

**64% of the crashes have base-to-crash scene flight times ≤ 15 minutes.**

**Total Travel Budget (Legs 1+2) limited to 30 minutes to meet 'Golden Hour' goal.**



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# Flight Time 'Computed' from Nearest Rotor Wing Base → Crash Scene → Level 2 Trauma Center

## Transport Legs 1 + 2

**Legend**

**Dots indicate locations of 307 fatal crashes. Colors indicate travel times. (129 knots average speed)**

- **0 - 10**
- **11 - 30**
- **31 – 60**
- **61 - 150**
- **> 150 minutes**

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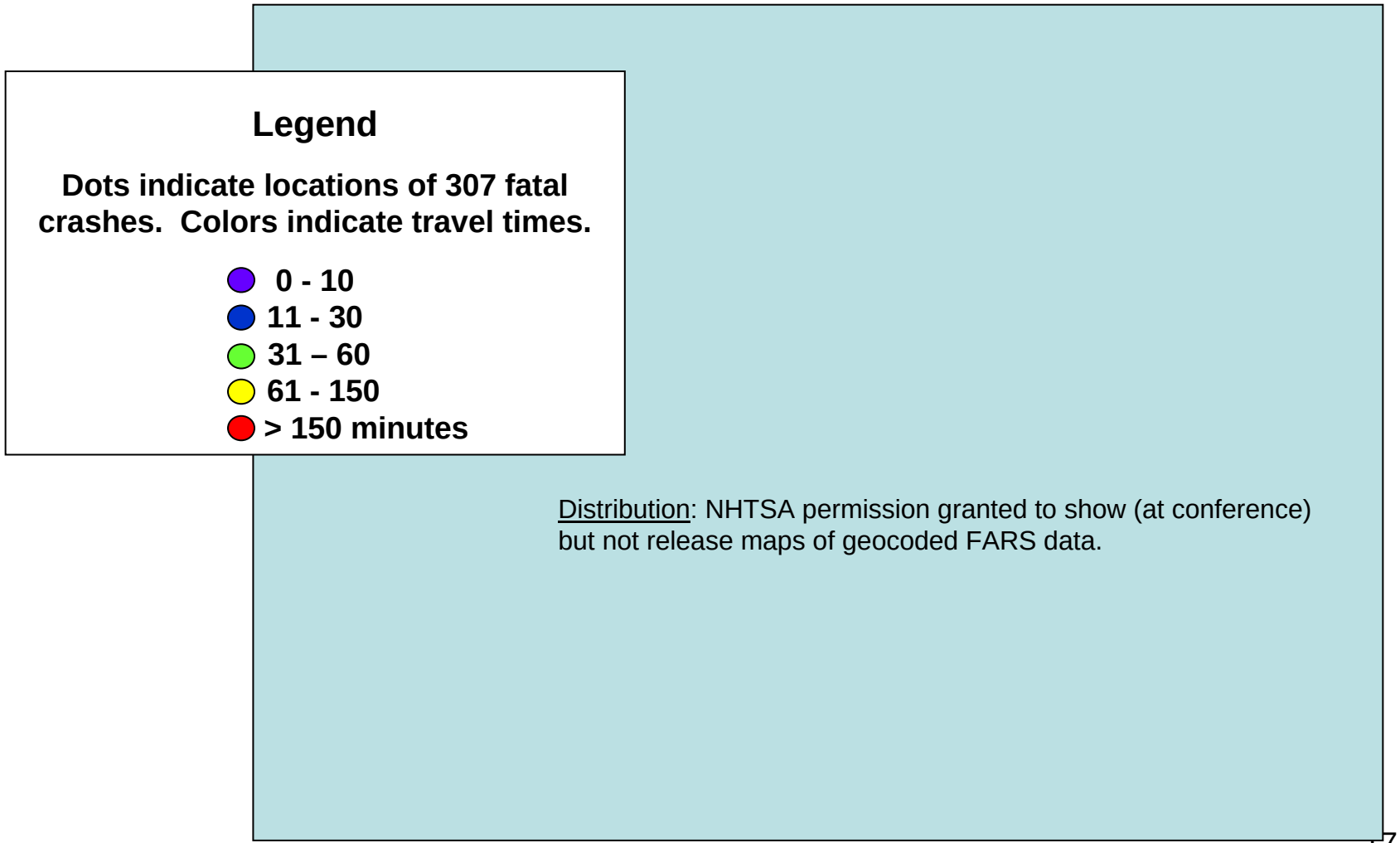
# Flight Time 'Computed' from Nearest Rotor Wing Base → Crash Scene → Closest Hospital

## Transport Legs 1 + 2

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1- Geocoded FARS data provided by NHTSA/NCSA

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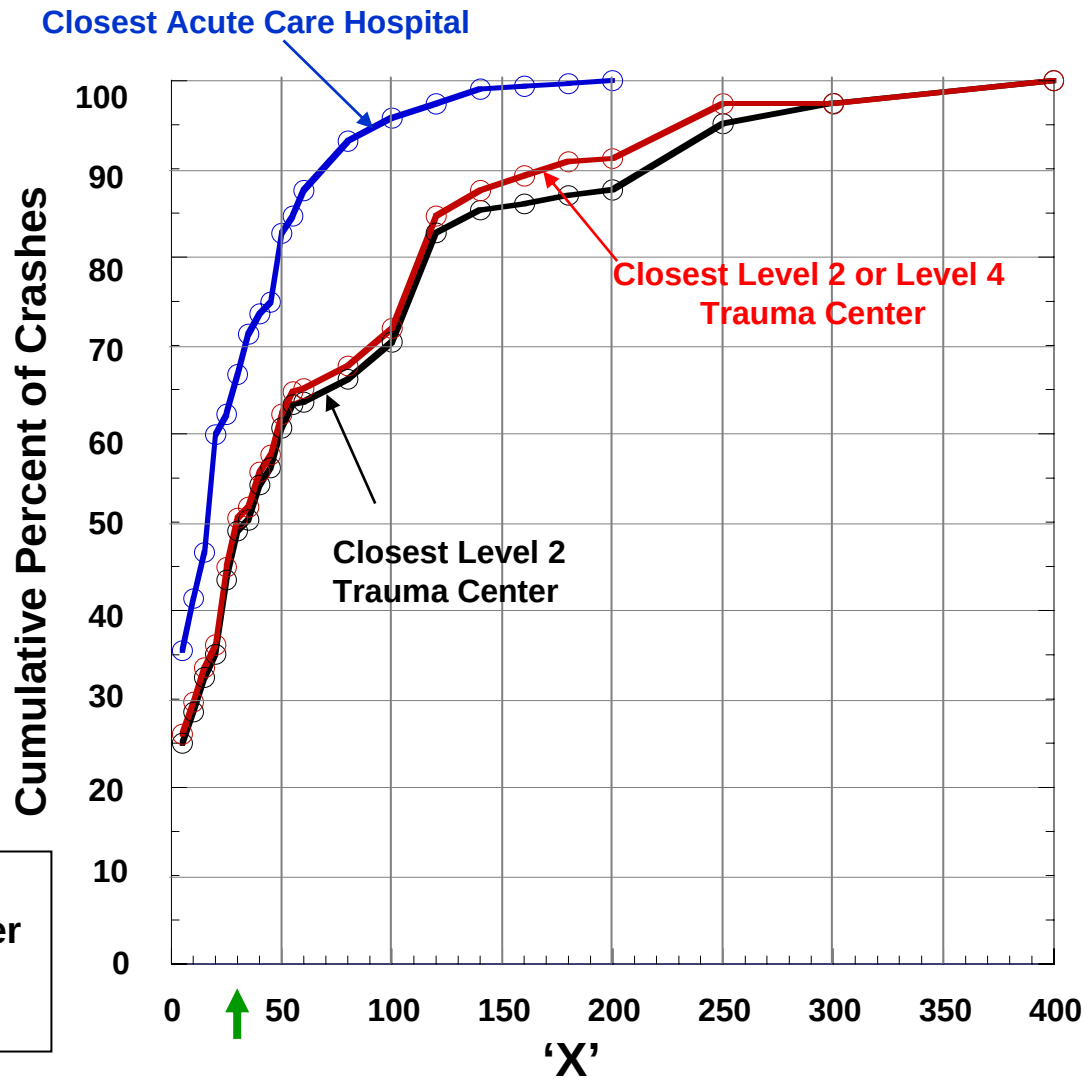
# Cumulative Percent of Crashes with 'Computed' Flight Time ≤ 'X' for Transport Legs 1 + 2




**Flying at 129 knots**
- **48% could reach L2 Trauma Center**
- **67% could reach Closest Hospital within 30 min Travel Budget**

**Flight Time from Closest Rotor Wing Base → Crash Scene → Closest Specified Medical Facility (mins)**

# Ground Ambulance Computed Travel Distances & Times

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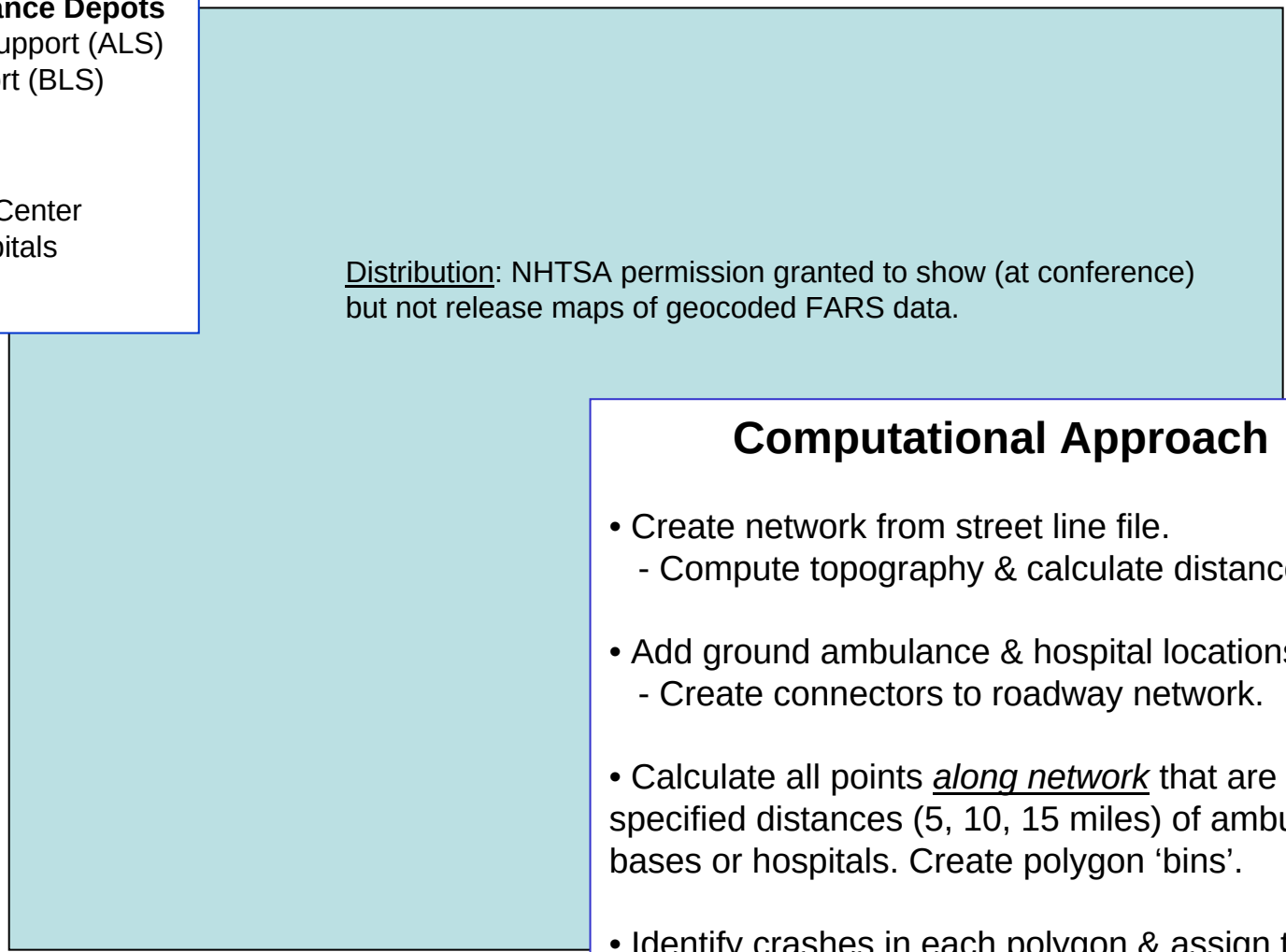
# Determine Driving Distance via Ground Ambulance

## Legend

**Ground Ambulance Depots**
- Advanced Life Support (ALS)
- Basic Life Support (BLS)
- All Other

**Hospitals**
- H Level 2 Trauma Center
- H Acute Care Hospitals

- **Crash Site**



Distribution: NHTSA permission granted to show (at conference) but not release maps of geocoded FARS data.

## Computational Approach

• Create network from street line file.
  - Compute topography & calculate distances.

• Add ground ambulance & hospital locations.
  - Create connectors to roadway network.

• Calculate all points *along network* that are within specified distances (5, 10, 15 miles) of ambulance bases or hospitals. Create polygon 'bins'.

• Identify crashes in each polygon & assign them to 5, 10, 15 mile polygon 'bin'

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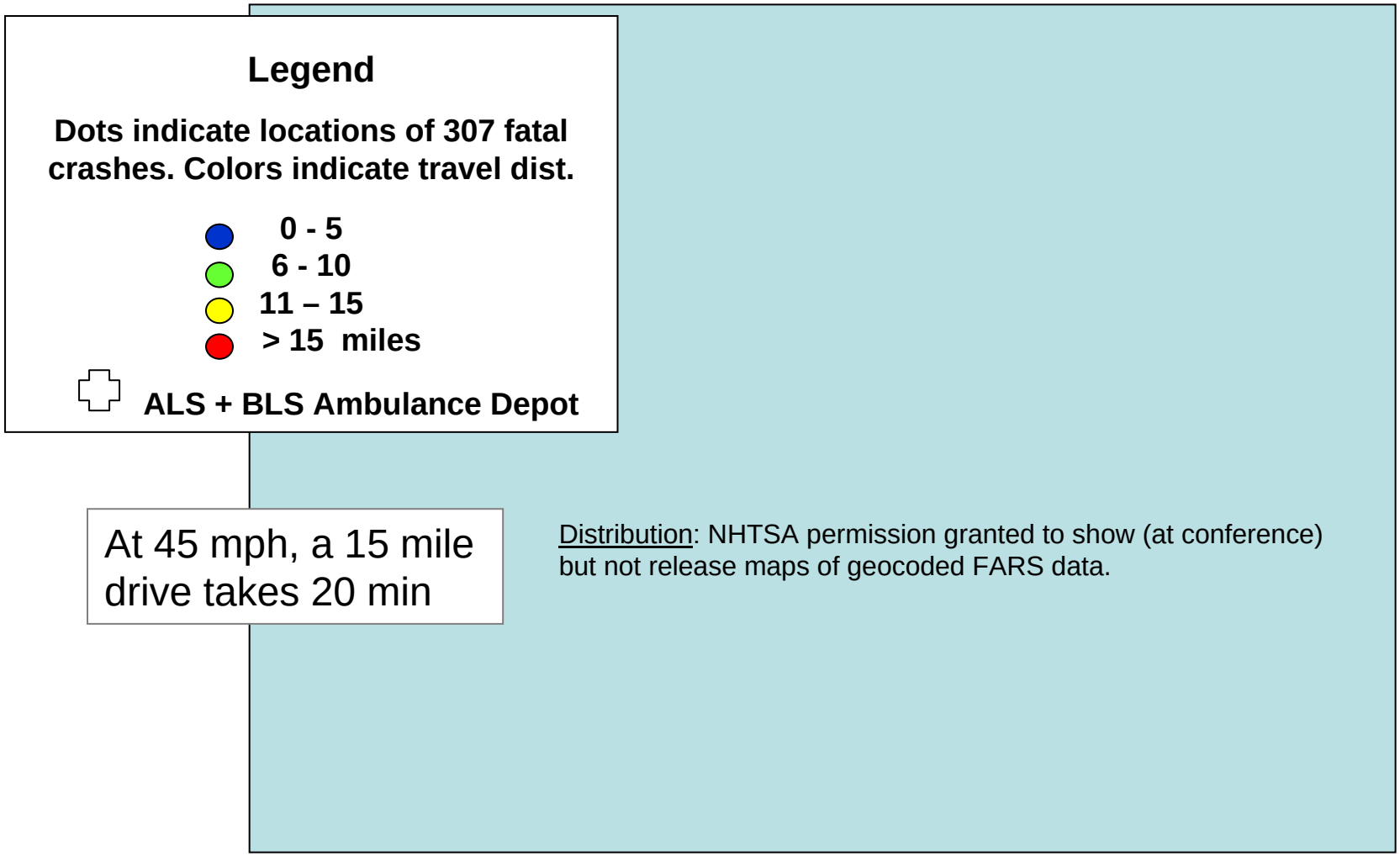
# ‘Computed’ Driving Distance from Nearest State Certified Ground Ambulance Depot to Crash Scene

## Transport Leg 1




At 45 mph, a 15 mile drive takes 20 min

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**Geocoded FARS data provided by NHTSA/NCSA**

307 (of 327) fatal crashes over 4 year period geocoded

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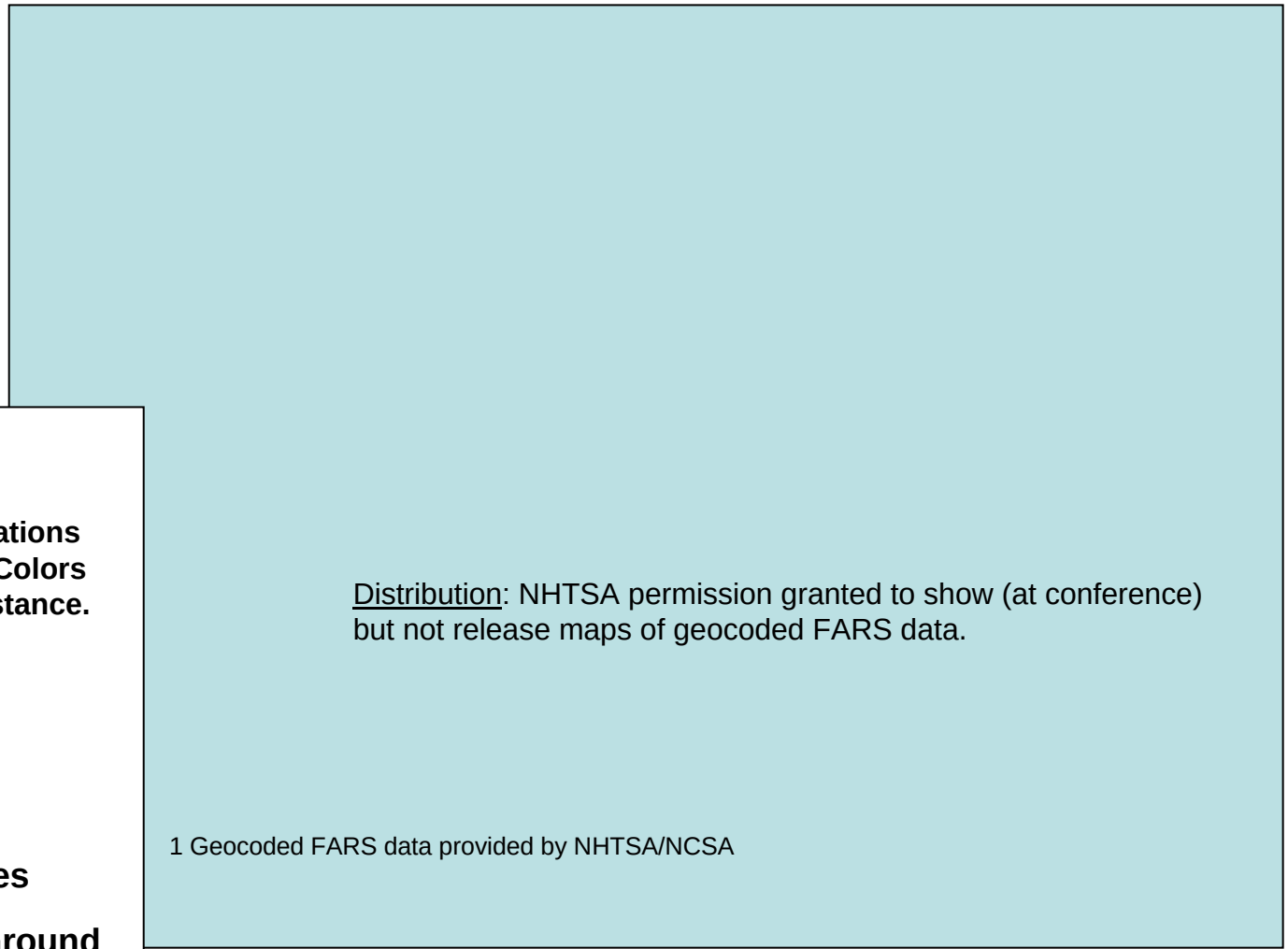
# ‘Computed’ Driving Distance from Nearest State Certified Ground Ambulance Depot to Crash Scene to Closest Hospital.



**Legend**

**Dots indicate locations of fatal crashes. Colors indicate travel distance.**

- **0 - 10**
- **11 - 15**
- **16 - 20**
- **21- 25**
- **26 - 30**
- **> 30 miles**

**ALS + BLS Ground Ambulance Depot**

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1 Geocoded FARS data provided by NHTSA/NCSA

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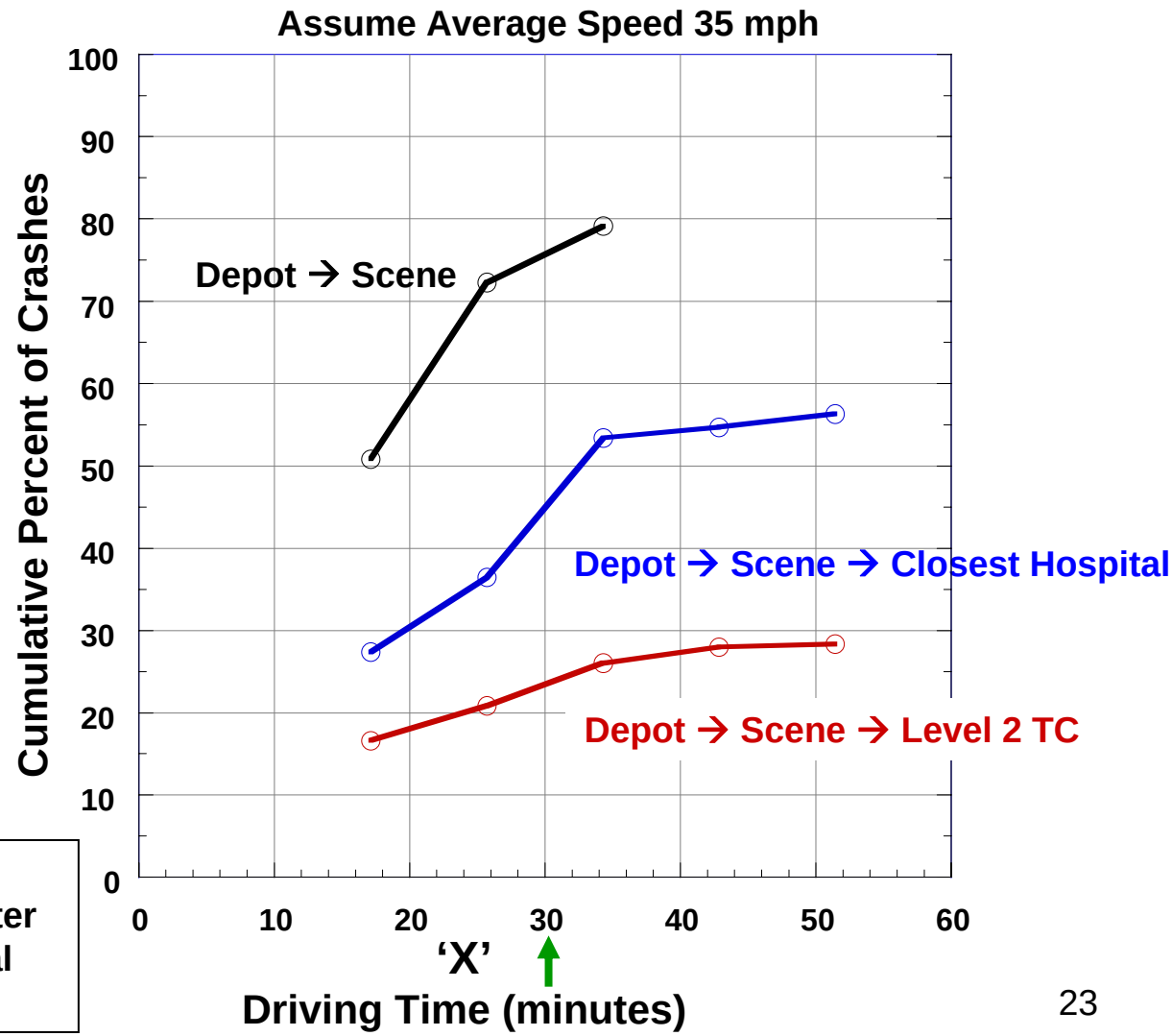
# Cumulative Percent of Crashes with ‘Computed’ Driving Time ≤ ‘X’

## for Transport Legs 1 & Legs 1+2

**State Certified Ground Ambulances (ALS + BLS**




**Driving at 35 mph**
- **24% could reach L2 Trauma Center**
- **45% could reach Closest Hospital within 30 min Travel Budget**

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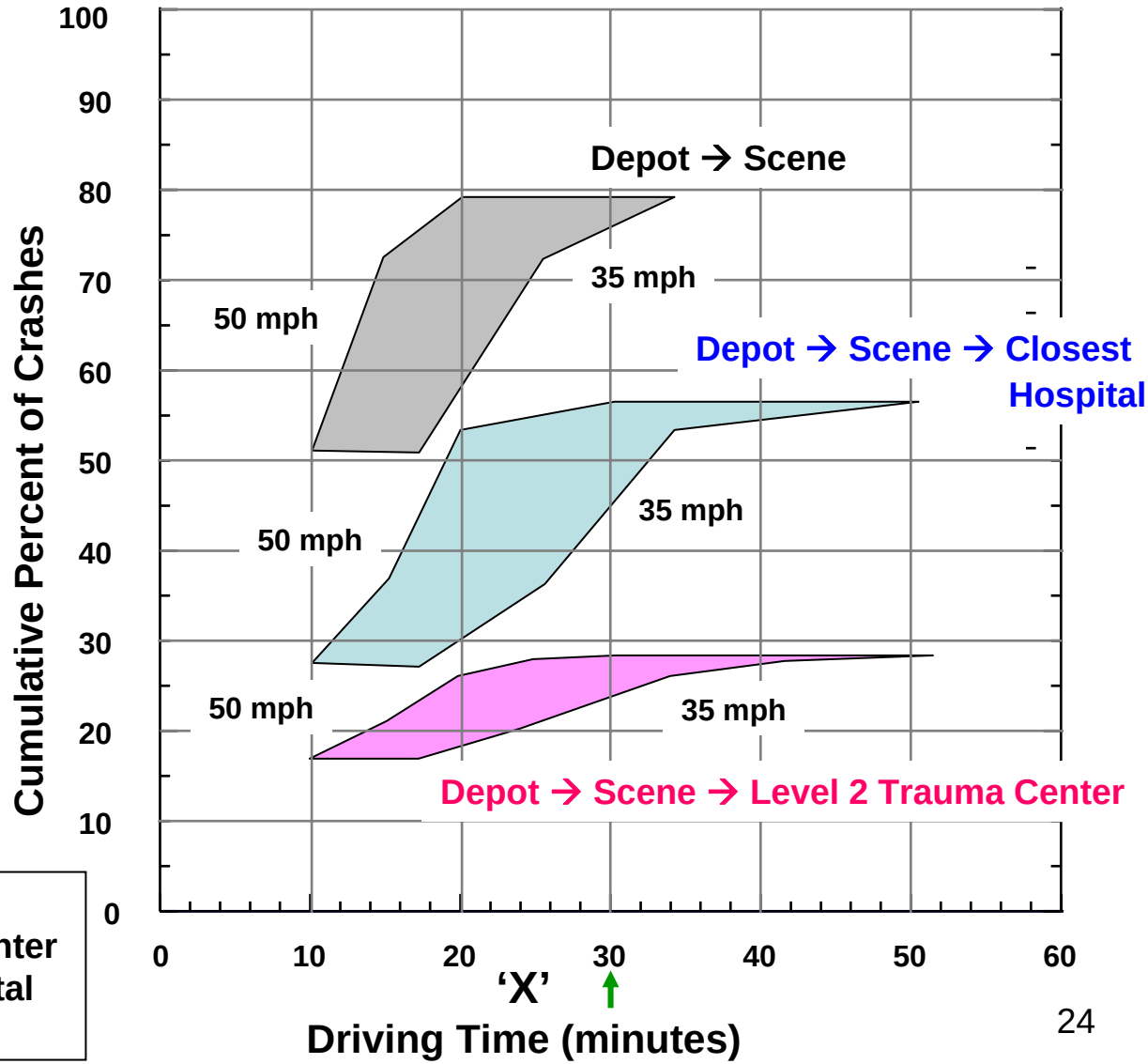
# Envelope of Crashes using Speed as Parameter. 'Computed' Driving Time ≤ 'X'

**State Certified Ground Ambulances (ALS + BLS)**

**Speeds Examined**
- 35 mph
- 45 mph
- 50 mph




**Driving at 50 mph**
- 28% could reach L2 Trauma Center
- 57% could reach Closest Hospital within 30 min Travel Budget

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# Summary & Concluding Remarks

- First steps in study completed:
  - Infrastructure identified and geocoded
  - Computational techniques developed
  - Initial metrics investigated

- Next Steps
  - Implement enhanced Alaska EMS data collection system
  - Refine models and analyze actual event time data
  - Utilize injury crashes in addition to fatal crashes
  - Explore additional metrics to support evaluations of new technologies for emergency notification, dispatch and response.