UNIVERSITY OF IDAHO
College of Natural Resources
EXPERIMENTAL FOREST

University of Idaho
College of Natural Resources

GNSS AND LOCATION TECHNOLOGIES FOR LOGGING SAFETY

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Associate Prof. of Forest Operations
Director and Forest Manager
University of Idaho Experimental Forest

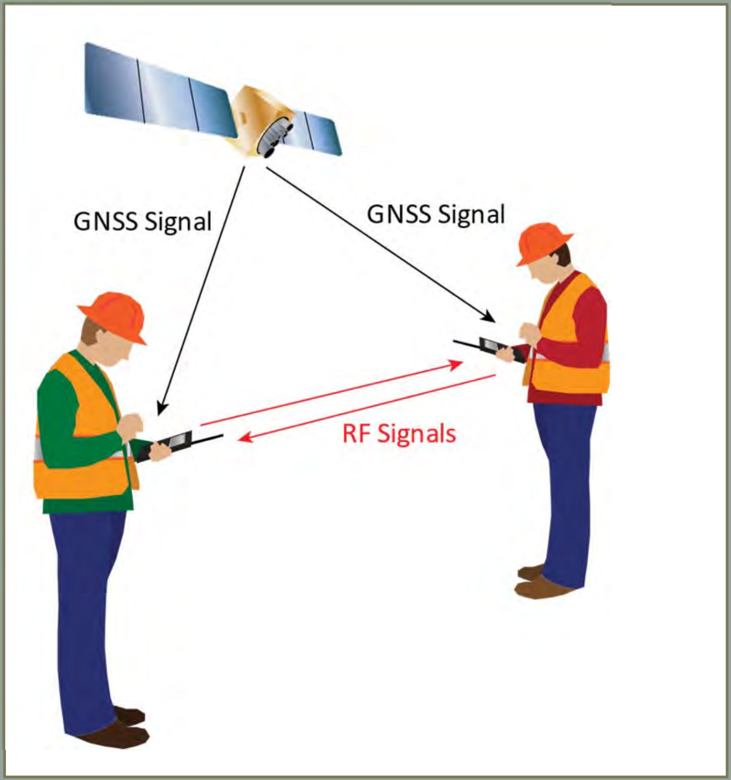
Cooperative agreement 5 U01 OH010841

OUTLINE

- Introduction
- Safety benefits of location-sharing in forestry
  - *Avoidance*
  - *Detection*
  - *Response*
- Perceptions of location-sharing
- Discussion


DEERE


INCREASING SITUATIONAL AWARENESS



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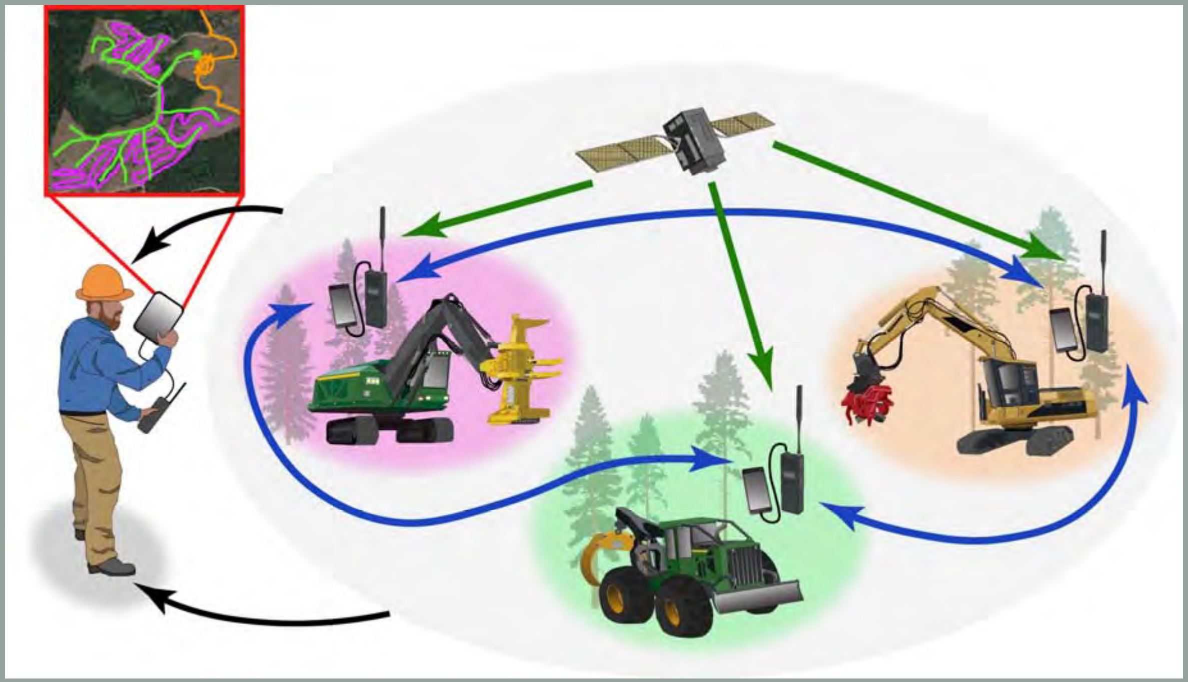

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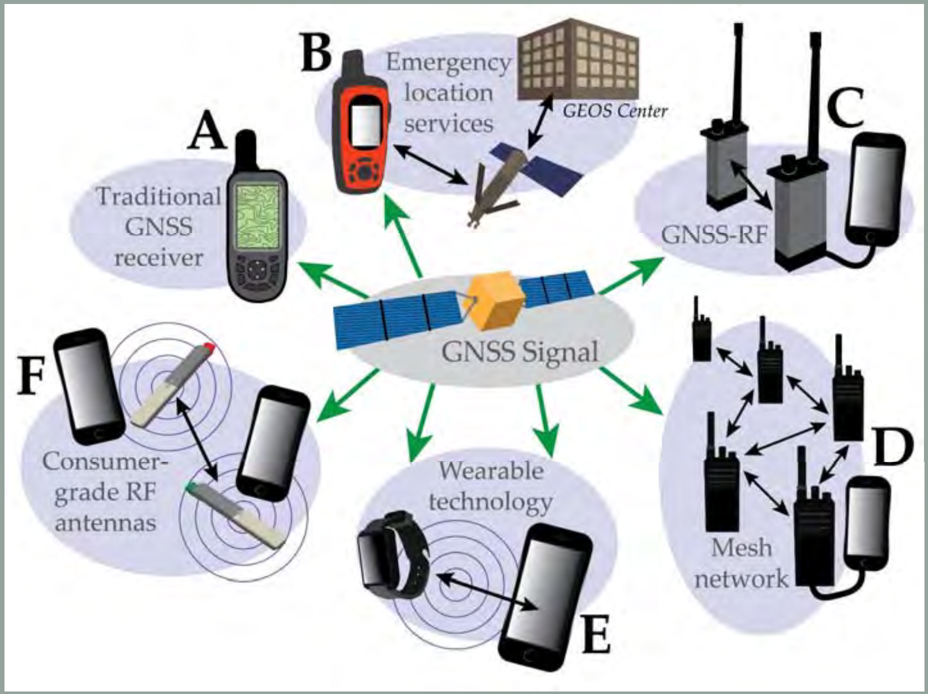
LOCATION SHARING DEVICES



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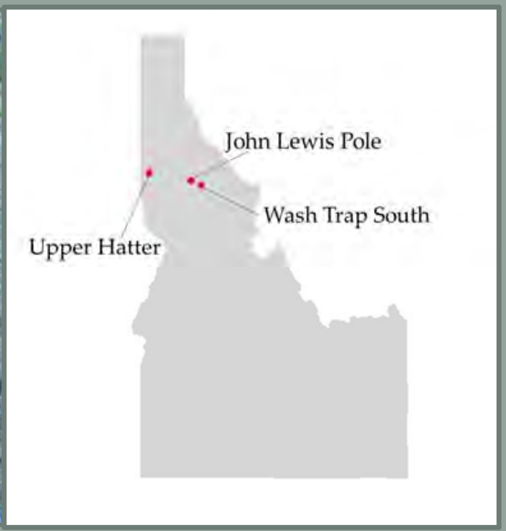
AVOIDANCE: GEOFENCES



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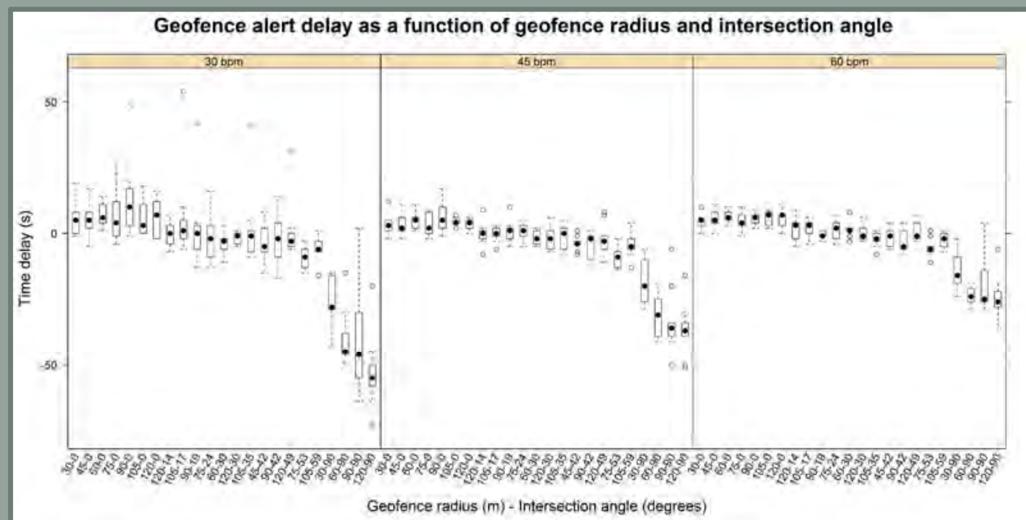

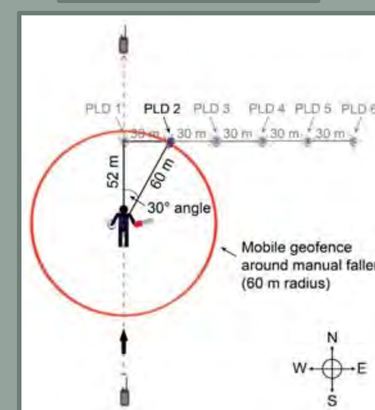

Article

Hazards in Motion: Development of Mobile Geofences for Use in Logging Safety

Eloise G. Zimbelman *, Robert F. Keefe, Eva K. Strand, Crystal A. Kolden and Ann M. Wempe

AVOIDANCE: GEOFENCES

Article

Characterizing Rigging Crew Proximity to Hazards on Cable Logging Operations Using GNSS-RF: Effect of GNSS Positioning Error on Worker Safety Status

Ann M. Wempe * and Robert F. Keefe

AVOIDANCE: GEOFENCES

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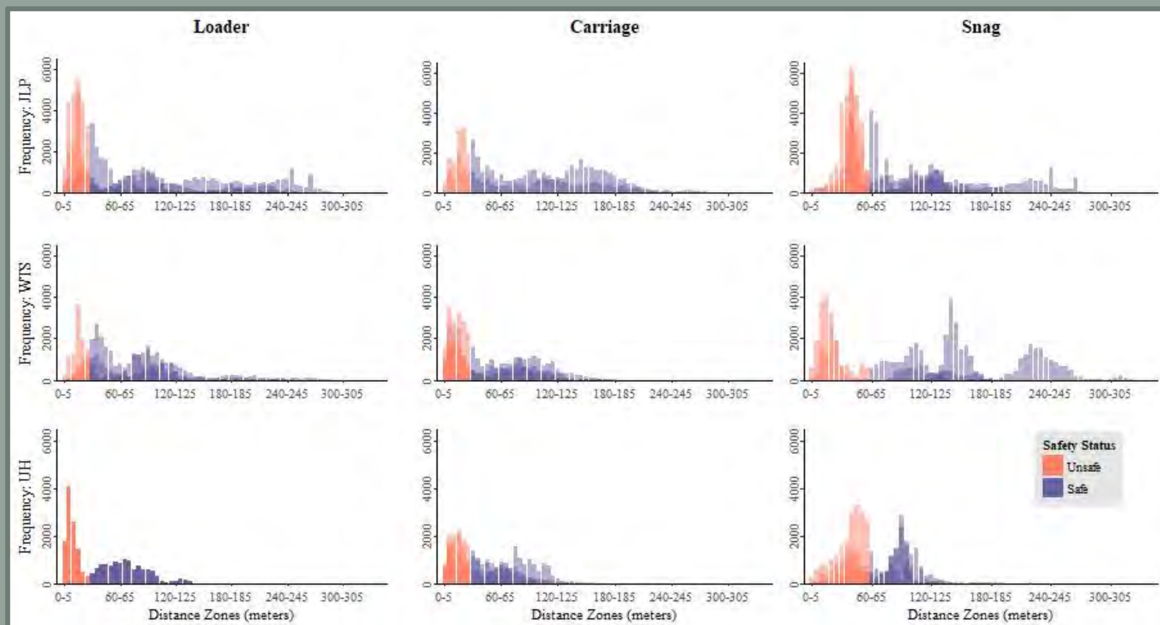

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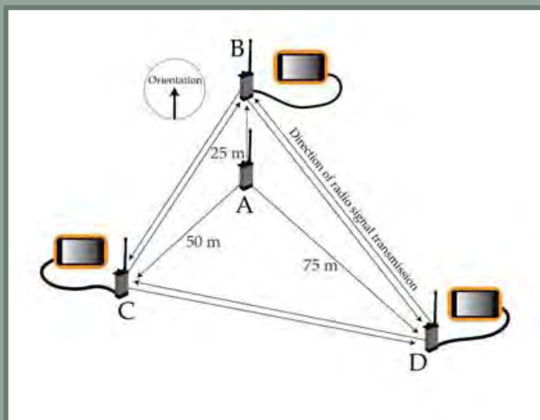

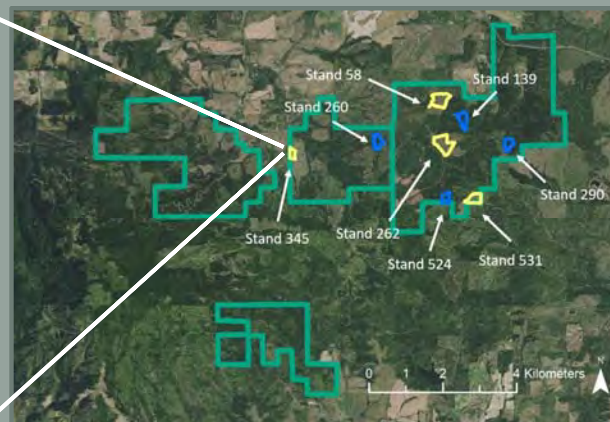

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Article

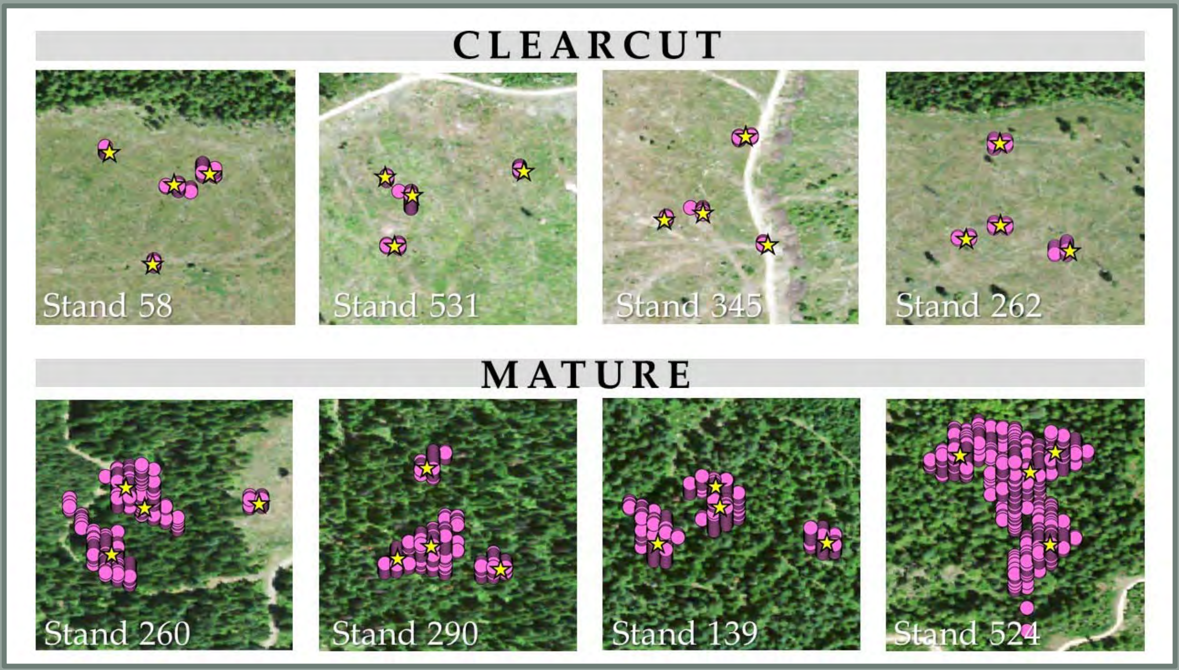
Characterizing Rigging Crew Proximity to Hazards on Cable Logging Operations Using GNSS-RF: Effect of GNSS Positioning Error on Worker Safety Status

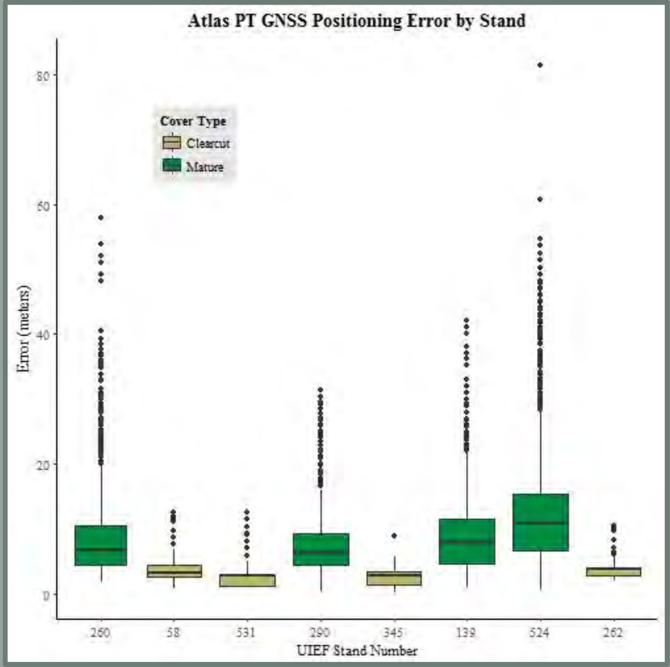
Ann M. Wempe * and Robert F. Keefe

Table 1. Controlled experiment: University of Idaho Experimental Forest stand characteristics and sampling conditions.

Stand	Cover	Mean Height (m)	Mean DBH (cm)	Azimith (°)	Slope (%)	Date	Mean Satellites	Mean PDOP
260	Mature	23.52	33	95	37	10/12/16	7	1.6
58	Clearcut	NA	NA	352	18	10/17/16	8	1.3
531	Clearcut	NA	NA	165	35	10/19/16	8	1.4
290	Mature	14.6	25	35	5	10/19/16	7	1.5
345	Clearcut	NA	NA	130	8	10/24/16	10	1.3
139	Mature	16.7	31	347	43	10/24/16	6	1.6
524	Mature	17.3	31	27	14	11/10/16	6	1.7
262	Clearcut	NA	NA	205	2	11/17/16	8	1.2

AVOIDANCE: GEOFENCES





AVOIDANCE: GEOFENCES

RESEARCH ARTICLE

Real-time positioning in logging: Effects of forest stand characteristics, topography, and line-of-sight obstructions on GNSS-RF transponder accuracy and radio signal propagation

Eloise G. Zimbelman*, Robert F. Keefe

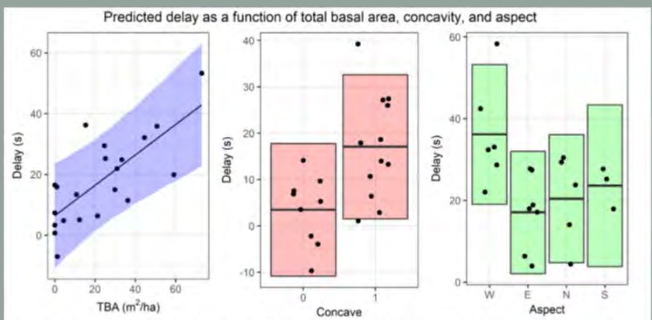


Fig 5. Mixed-effects model predictions for geofence intersection alert delay. Predicted delay as a function of the three model variables (TBA, concave, and aspect). Predictions for each variable were made using the mean of the other predictors. 95% confidence intervals computed using the bootstrap are shown as colored bands. Points on each plot represent partial residuals.

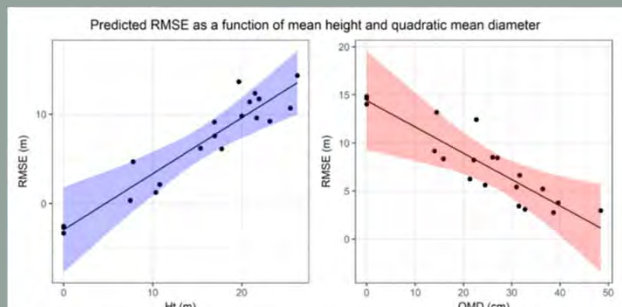
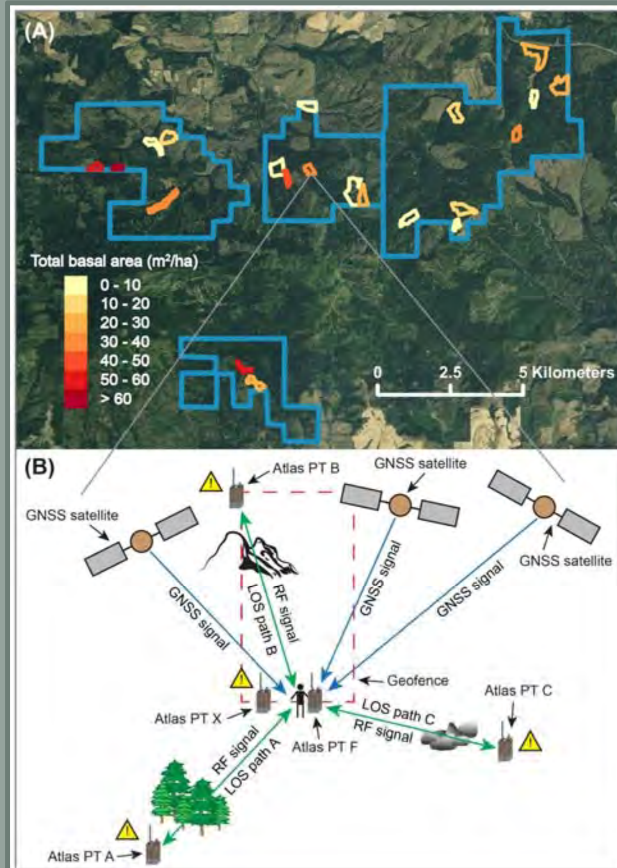


Fig 4. Mixed-effects model predictions for PT RMSE. Predicted RMSE as a function of the two model variables (Ht and QMD). Predictions for each variable were made using the mean of the other predictor. 95% confidence intervals computed using the bootstrap are shown as colored bands. Points on each plot represent partial residuals.



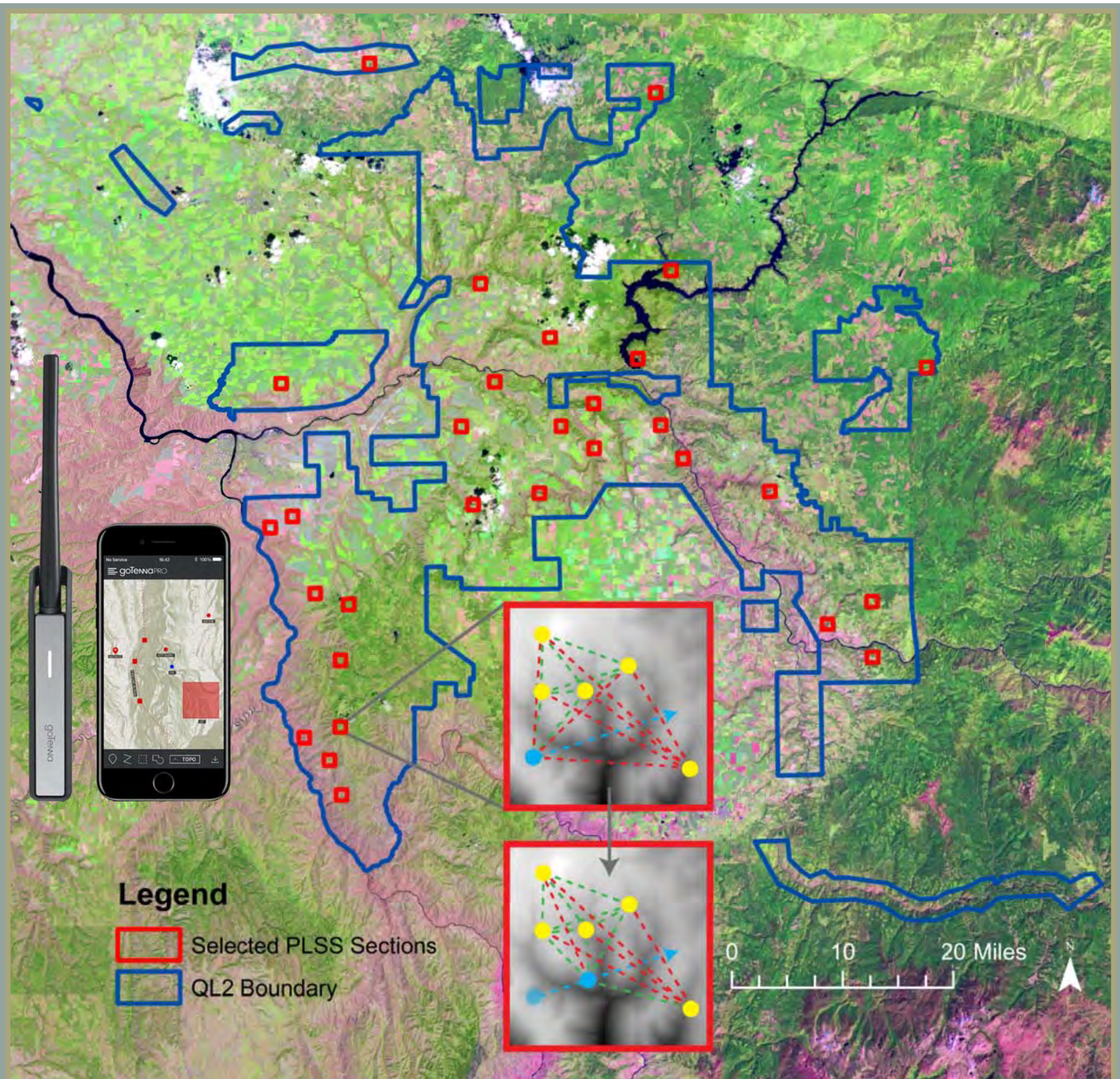
AVOIDANCE

Evaluating connectivity of smartphone-based mesh networks in irregular, forested terrain

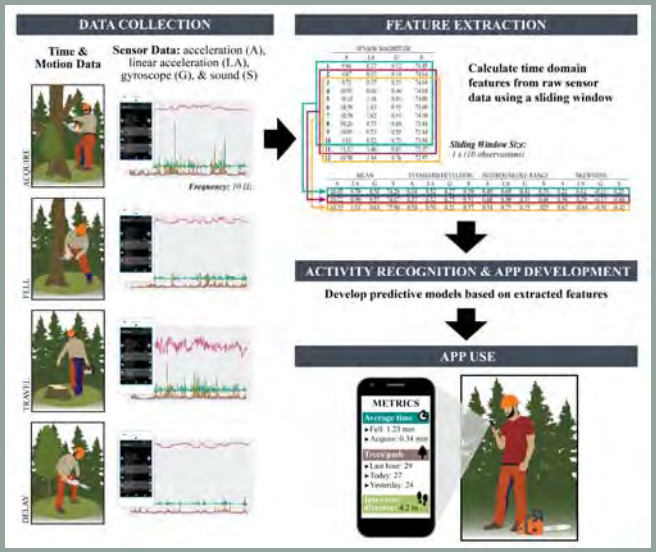
-30 Public Land Survey System (PLSS) sections: 1 mi^2 (260 ha)

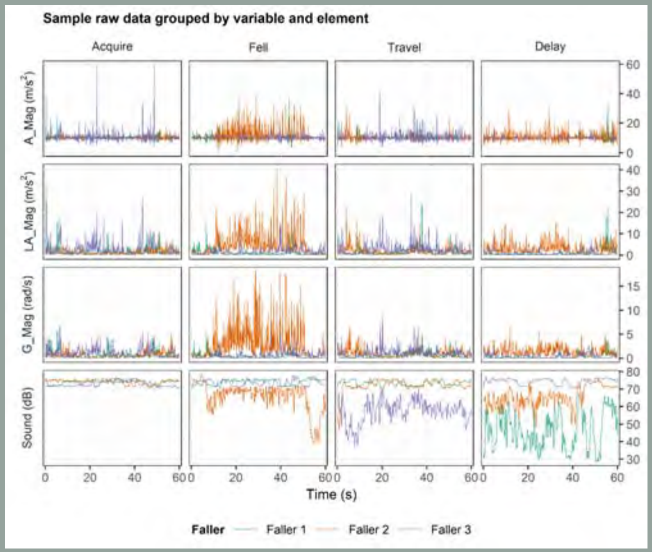
-Selected based on LiDAR-derived rumple index (ratio between surface area and projected area)

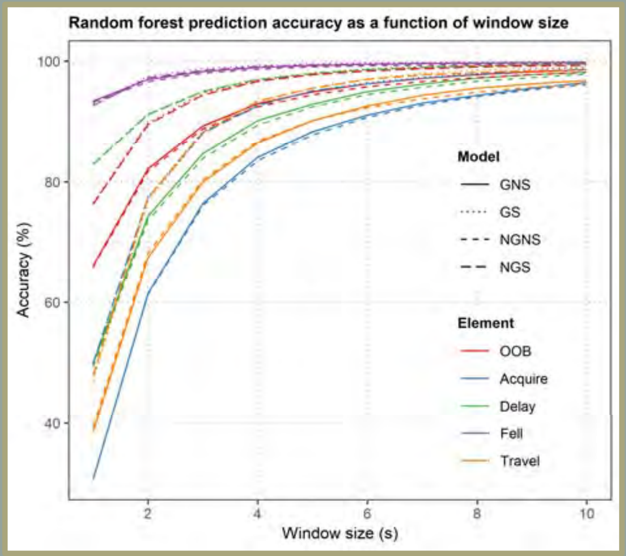
- Exclude sections with rumple indices > 1.2 (limited accessibility) and sections that aren't within 10% of 260 ha
- Ranges from 1.00286–1.199872, divide into 5 categories and randomly select 6 sections from each



DETECTION: ACTIVITY RECOGNITION





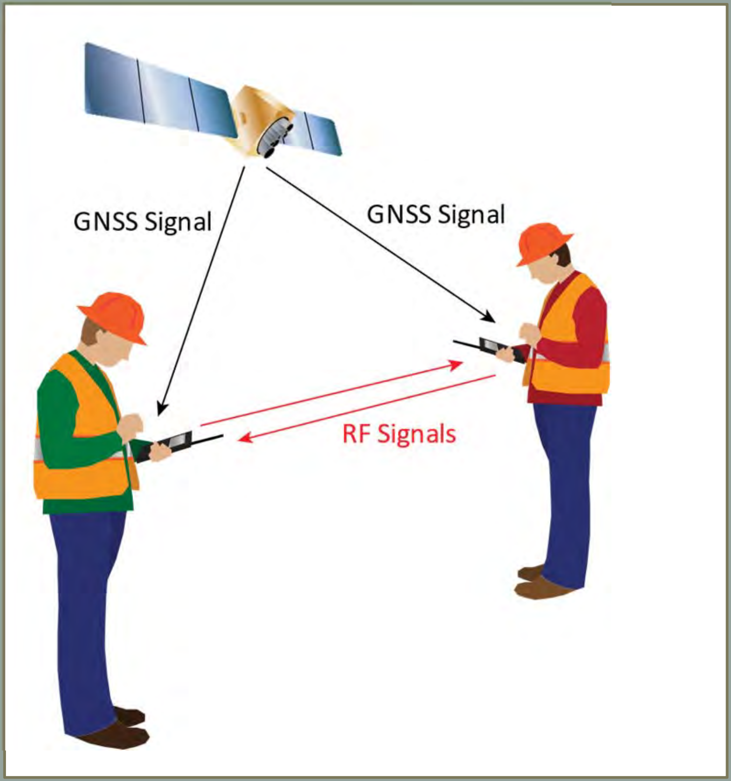


Use of smartphone sensors to quantify the productive cycle elements of hand fallers on industrial cable logging operations

Robert F. Keefe*, Eloise G. Zimbelman* and Ann M. Wempe

Department of Forest, Rangeland and Fire Sciences, University of Idaho, Moscow, ID, USA

RESPONSE


GNSS Signal
GNSS Signal
RF Signals


Bucker
Yarder
Hooker
Loader
Chaser
Hand Faller

CONTRACTOR PERSPECTIVES

Article

Human Factors Affecting Logging Injury Incidents in Idaho and the Potential for Real-Time Location-Sharing Technology to Improve Safety

Soren M. Newman [1,*], Robert F. Keefe [2], Randall H. Brooks [2], Emily Q. Ahonen [3] and Ann M. Wempe [2]

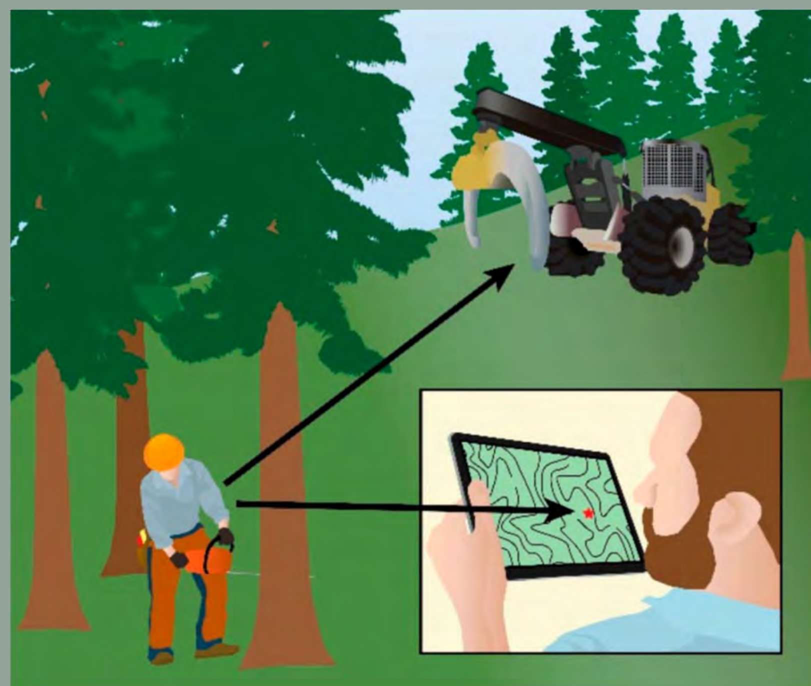
The faller could definitely see where the other guy that's working with him is, knows how far away he is.

People could notice that he's been sitting in the same spot for 15 minutes and the dot hasn't moved. We need to get over there and check on him.

The [yarder] operator a lot of times can't see his hookers down on the ground in the bottom of the strips. So yeah, I do think [GPS] could be beneficial in some areas. Particularly the line skidding operations.

I'm sure there's been times that a buncher has fell timber a little closer to the skidder than what should be happening.

CONTRACTOR PERSPECTIVES

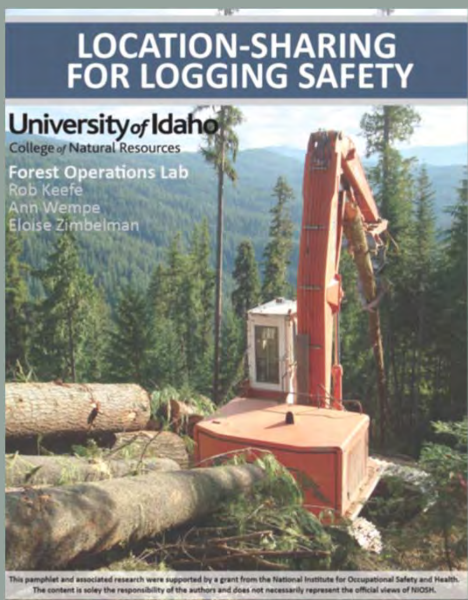


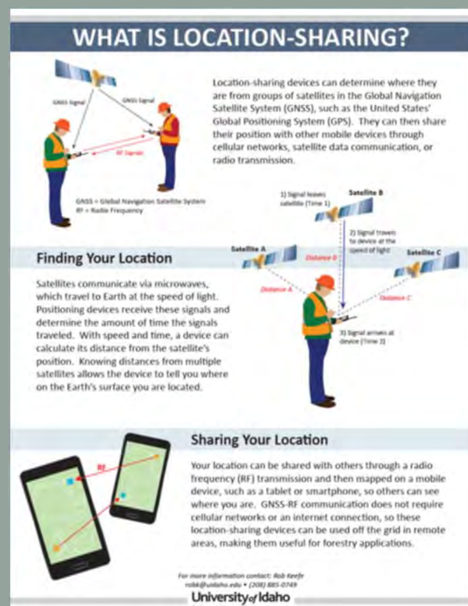
Article

Intent to Adopt Location Sharing for Logging Safety Applications

Ann M. Wempe [1], Robert F. Keefe [1,*], Soren M. Newman [2] and Travis B. Paveglio [3]

CONTRACTOR PERSPECTIVES





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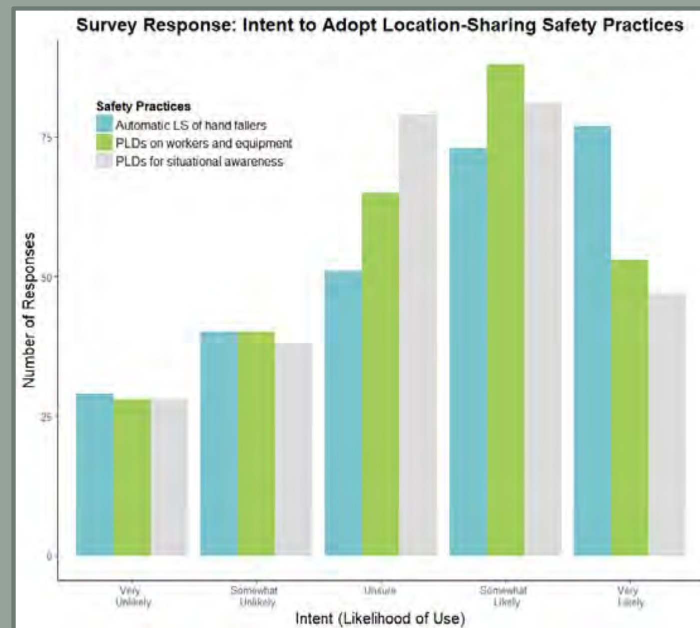
CONTRACTOR PERSPECTIVES

	Response Percentage (%)		
	No	Unsure	Yes
Previous use of LS devices			
Emergency receivers (n=271)	91.5	1.8	6.6
2-way radios (n=270)	79.3	1.1	19.6
Smartphone receivers (n=271)	87.8	1.1	11.1
Improvement to safety by device			
Emergency receivers (n=263)	16.0	20.5	63.5
2-way radios (n=269)	8.6	12.6	78.8
Smartphone receivers (n=272)	14.0	14.0	72.1
Improvement to safety by feature			
Hazardous area alerts (n=277)	11.9	11.2	76.9
Automatic updates to coworkers (n=275)	13.1	14.2	72.7
Automatic updates to supervisors (n=271)	47.2	18.8	33.9
Help button to coworkers (n=275)	7.3	9.5	83.3
Help button to supervisors (n=274)	24.1	13.5	62.4
Help button to emergency services (n=276)	8.3	12.7	79.0
Messaging (n=273)	12.8	15.0	72.2
Privacy concerns associated with LS			
Coworkers (n=276)	72.5	8.7	18.8
Supervisors (n=273)	56.0	11.4	32.6
Smartphone ownership (n=279)	27.6	NA	72.4



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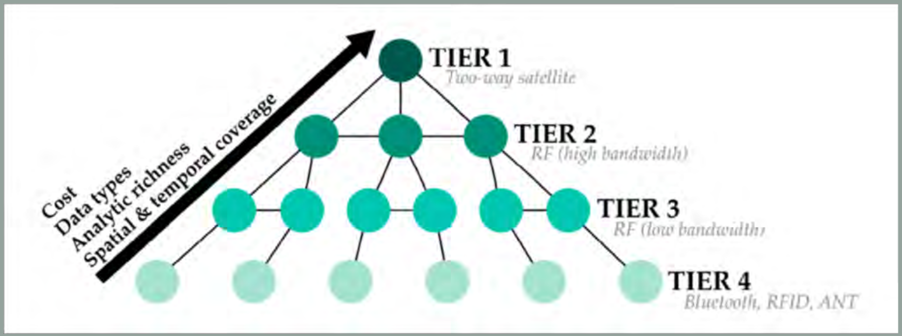
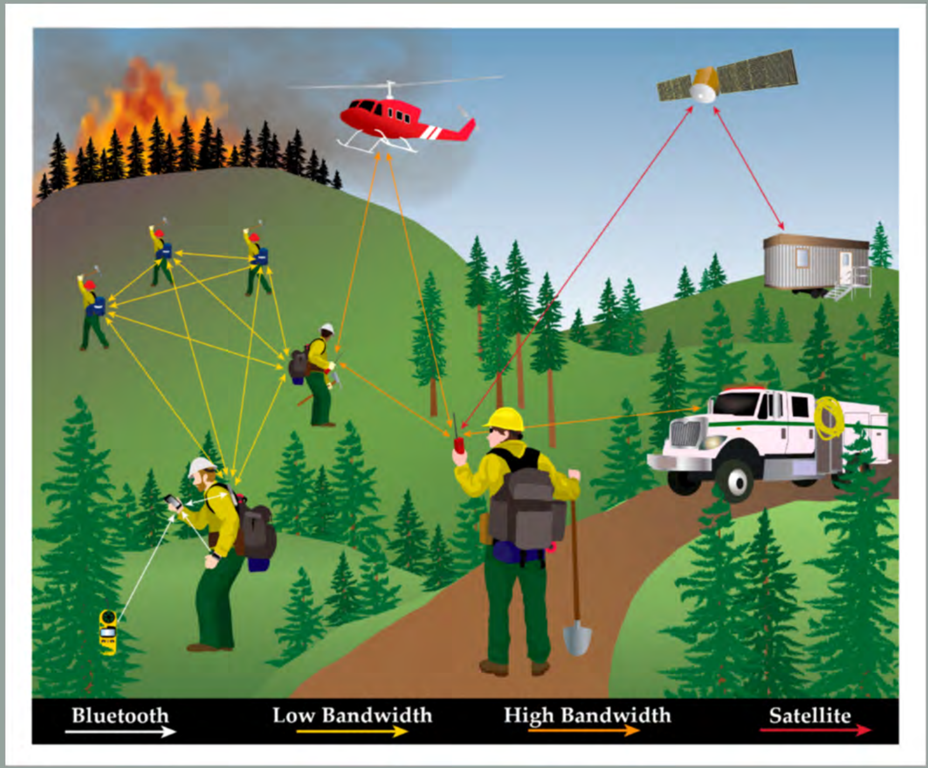
DISCUSSION

1. Accuracy, data rates, device size, etc. depend on application (prevention, detection, response)
2. GPS/GNSS-based solutions for *prevention* should be used for broad situational awareness and not for detailed proximity alerts in the woods
3. Good support among loggers for technology-based solutions to improve safety. We have a very positive, continuing dialog among researchers and contractors
4. Integration of location and activity data into digital health may be useful for increasing SA to improve safety in rural occupations
5. Commercially available mesh RF and satellite devices are useful solutions for different applications– Both are evolving quickly

DISCUSSION





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QUESTIONS?

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Reducing logging fatality and non-fatal trauma incidence rates with new real-time operational GPS-RF communications and safety procedures.f

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Contributors include, among others, Eloise Zimbelman, Ann Wempe, Soren Newman, Jan Eitel, Travis Paveglio, Emily Nagler, Eva Strand, Crystal Kolden, and Randall Brooks