2016 US FOREST SERVICE EMPLOYEE RADIO USE SURVEY:

EMPLOYEE PERCEPTIONS OF HANDHELD RADIOS AND EFFECTIVENESS OF RADIO TRAINING PROGRAMS

By

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(Under the Direction of B. Bynum Boley & Gary T. Green)

ABSTRACT

The US Forest Service (FS) employs over 40,000 staff who manage 193 million acres of federal land. In order to mitigate risks to its field-going employees, the FS maintains a network of handheld and mobile radios, which provide a direct and efficient line of communication during emergencies and daily operations. Data from the 2016 FS Radio Use Survey was analyzed to determine employee satisfaction with handheld radios and the relationship between radio training effectiveness and frequency of handheld radio use. Analyses were segmented by employee job type to determine if different types of FS jobs influenced perceptions. The Importance-Performance Analysis revealed that to increase satisfaction with handheld radios among both fire and non-fire employees, the FS should improve radio reception and signal. To encourage the target safety behavior of frequent handheld radio use, effective on-the-job radio training should be standardized across the agency.

INDEX WORDS: Effective training, Communication technology, Crisis communication, Federal employee, Importance Performance Analysis (IPA), Land management agency, Radial Importance Performance Analysis (RIPA), Radios, Risk Management, Safety, US Department of Agriculture (USDA), US Forest Service (USFS),

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B.S., University of Georgia, 2014

A Thesis Submitted to the Graduate Faculty of The University of Georgia in Partial Fulfillment of the Requirements for the Degree

MASTER OF SCIENCE

ATHENS, GEORGIA

2017

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ACKNOWLEDGEMENTS

I would like to thank my co-advisors, Dr. Bynum Boley and Dr. Gary T. Green, for guiding me through the creation and analysis of the 2016 FS Radio Use Survey as well as the research and drafting of this thesis. I would also like to thank my committee members, Dr. Seock-Ho Kim and Mr. Robert Izlar, for their time and feedback. I would like to express my appreciation to Doug King, Colin Watts, and Simon Strickland for their valuable input during the creation of the survey. I would also like to thank the USDA Forest Service and USDA National Institute of Food and Agriculture for funding my research. Many thanks to the Warnell School of Forestry and Natural Resources at the University of Georgia for providing me with a home away from home and never-ending support.

Thank you to my boyfriend, Noah Hill, as well as his parents, Chris and Jan Hill, for their valuable input on my research as well as their love and support over the last five years. Thank you to my Grandparents, Christine and Edward Fulmer, for their unconditional love and support. Finally, I would like to thank to my parents, Eric and Erika Fulmer, and all five of my siblings Meredith, Nathaniel, Greyson, Ben, and Kate for the love, laughter, and support that they have provided me.

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CHAPTER 1

INTRODUCTION

Communication across vast expanses of wilderness has always been one of the greatest challenges for the USDA Forest Service (FS). The FS attempted to utilize a variety of communication systems in its infancy, from carrier pigeons to telephones, but the feasibility of these systems was challenged by one or more of the following: cost, severe weather conditions, access, or poor reliability (Gray, 1982). In the early twentieth century, the FS created the Land Mobile Radio (LMR) program to increase communication amongst its growing staff. Since this time, the FS has invested millions of dollars in mobile radios, handheld radios, towers, and repeaters (Hilliard et al., 2011).

Currently, the FS employs over 40,000 staff who manage 193 million acres of federal land. Managing large tracts of remote forestland is an inherently risky endeavor. While on the job, FS employees encounter a range of biotic and abiotic risks such as wildfires, falling trees, inclement weather, dangerous animals and illegal human activity. The FS acknowledges the inherent risks of managing remote areas and stresses the importance of safety to its employees (Tidwell, 2015). The following quote from FS Chief Tom Tidwell embodies the agency's safety outlook:

> Safety is not just a firefighting issue. Even something as simple as crossing the street or getting behind the wheel of a car entails a certain amount of risk that has to be managed. At the Forest Service, safety across the board has become one of our major emphasis areas… We are therefore dedicated to creating a learning organization where everyone

> learns from both successful and unsuccessful [safety] outcomes in a fair and non-punitive way. We want to be an organization where learning is considered just as important as delivering services or accomplishing targets.

The importance of safety on the job is highly evident to wildland firefighters, who compose one-quarter of FS staff. The risk level to FS wildland firefighters is rising as unprecedented fire seasons become commonplace (McKinney, 2004). In 2015 alone, over sixty-eight thousand wildfires occurred (National Interagency Fire Center, 2017). Wildfires in 2015 consumed more than ten million acres of forestland, which was 145% of the national ten-year average. Additionally, wildfires are expected to become more frequent and widespread due to long-term drought conditions, especially in the western United States. As wildfires become more frequent and widespread, the risk of fatalities increases. In fact, in 2013, nineteen smokejumpers unfortunately lost their lives during a wildfire at Yarnell Hill (National Interagency Fire Center, 2017). The FS Wildland firefighters are highly aware of the inherent danger of their jobs and some believe that fatalities are inevitable in order to fulfill the mission of the FS (Dialogos International, 2007). However, the agency advocates a safety goal of zero fatalities, which it hopes to attain by reducing risks to employees (Tidwell, 2015).

A direct and efficient line of communication is imperative to the safety of FS employees, many of whom complete fieldwork in remote, isolated locations. The risk and remoteness involved in forestry and fighting forest fires is further amplified by the lack of standard telecommunication infrastructure. In areas where this infrastructure is lacking, handheld radios provide a direct line of communication between employees and centralized dispatchers. Field-going employees in the FS rely heavily on handheld and mobile radios as a direct and efficient line of communication to dispatchers and other crew members.

Although communication is vital to operating safely in remote forestlands, there has been little research on employee perceptions of FS handheld radios. With this research gap in mind, the first article of this thesis presented in Chapter 2 has the following three objectives:

1) Assess employee perception of FS handheld radios via an Importance Performance Analysis (IPA) of respondents to the 2016 FS Radio Use Survey.

2) Compare IPA results by employee risk level (fire vs. non-fire employees).

3) Propose a new methodology called Radial Importance Performance Analysis (RIPA).

Forest Service employees encounter risk both in day-to-day operations and during emergency situations (Tidwell, 2015). Risk management and crisis communication are two concepts that are pertinent to the field of natural resource management, both on federal and private land. During day-to-day operations, FS employees engage in risk management communication, which seeks to inform those involved about potential dangers (Seeger, Sellnow, & Ulmer, 2003; Seeger, 2006). Higher-risk, unpredictable situations like wildfires require event-centered and incident-specific communication. This type of communication is called crisis communication. Crisis communication emphasizes the importance of distributing accurate, timely, and useful information as emergency situations evolve (Seeger, 2006).

Although risk management and crisis communication have separate bodies of literature (Steelman & McCaffrey, 2013), the end goal of both communication strategies is to reduce employee risk. Steelman and McCaffrey (2013) posited that risk management and crisis communication must intersect to reduce risks to field employees who manage natural resources. Risks encountered by field-going employees toe the line between risks and crises depending on the circumstances of a given incident. Examples of risks that employees may encounter in the field include wildfires, falling trees, inclement weather, dangerous animals, and potentially

illegal human activity. These risks could elicit panic in the minds of members of the general public, but they are largely commonplace in the day-to-day field operations of FS employees. Thus, the best management practices in both risk and crisis communication must be combined within the FS to ensure employees are adequately trained and prepared for the risks they may encounter.

Risks can be managed through targeted safety behaviors such as frequent radio use, especially when an employee is working in an isolated location. Effective training may increase the frequency of target safety behaviors. Part of effective training entails building a learning organization, in which managers make policy decisions, evaluate outcomes, and adapt policies based on those outcomes (Garvin, 2000). Brown, Squirrell, and Harris (2010) emphasized the need for the FS to build a stronger learning organization so that the agency can continuously adapt to a changing environment, changing public needs, and a changing workforce. Garvin (2000) hypothesized that three factors are essential for organizational learning: 1) supportive learning environment 2) concrete learning processes and practices and 3) leadership behavior that provides reinforcement. The FS has already attempted to form a supportive learning environment when it comes to safety through the introduction of the *Safety Journey* (Lane et al., 2014).

To mitigate risks to its field-going employees and encourage learning throughout all levels of the organization, the FS has developed a bi-annual safety training program titled the *Safety Journey*. The *Safety Journey* was introduced to FS employees in 2011 to promote two major tenets: personal-organizational resilience and workload-safety balance (Lane et al., 2014). The *Safety Journey* was administered in the form of information sessions followed by seminars, which allowed employees to share personal anecdotes related to accidents, near misses, and other

safety topics. Employees were not trained on-site, but instead traveled to central locations in order to attend the *Safety Journey* sessions. In 2015, employees were asked to provide feedback on the first three iterations of the Safety Journey via the 2015 Safety Survey (Ghimire, Cordell, & Green, 2015).

Results of the 2015 Safety Survey were largely positive, however FS employees in high-risk jobs such as firefighting and law enforcement were more skeptical of the program than other employees in lower-risk positions (Ghimire, Cordell, & Green, 2015). Many high-risk employees were frustrated by the abstract nature of the program, which was not directly applicable to situations they might encounter in the field. Skeptics of the Safety Journey criticized its lack of hands-on training methods in favor of abstract discussions and "feel-good" messages. Employees in high-risk jobs were also less likely to use the risk management strategies proposed by the Safety Journey in their daily work. Only after concrete learning processes are standard throughout the agency can the FS fully attain its goal of becoming a learning organization. This goal includes the need for concrete learning processes for handheld radios.

Research indicates that hands-on training methods improve outcomes, especially for safety training, since they incorporate all three domains of Bloom's Taxonomy of Learning: the cognitive domain, the psychomotor domain, and the affective domain (Bloom, 1984; Wilder, 2016). The cognitive domain equips employees with the knowledge necessary for safety, including the various buttons on a radio and their functions. The psychomotor domain provides safety skills through repetition, such as physically holding a radio, setting it to the correct frequency, and making practice calls during simulated emergencies. Finally, the affective domain forms positive attitudes among employees regarding the value of radios to personal safety on the job. Although theory and past findings support the benefits of hands-on training, more research is

warranted to determine the effectiveness of different training types used in the FS and how the effectiveness of each training type impacts target safety behaviors such as frequency of handheld radio use.

Although previous studies have addressed FS employee perceptions of the *Safety Journey*, further research was warranted in terms of radio use patterns across different FS job types and the factors that may or may not have influenced use. With the aforementioned research gap in mind, the second article of this thesis presented in chapter three has the following primary objectives:

1) Analyze FS employees' perceptions of training effectiveness to determine which type of training is the most preferred.
2) Test the relationship between training effectiveness and frequency of radio use.
3) Compare radio use patterns between four FS job types (administrative, biologists, fire, recreation).

CHAPTER 2

"CAN YOU HEAR ME NOW?" USING RADIAL IMPORTANCE-PERFORMANCE ANALYSIS TO GAUGE US FOREST SERVICE EMPLOYEE SATISFACTION WITH HANDHELD RADIOS[1]

[1] Fulmer, A.P., Boley, B.B., & Green, G.T. To be submitted to *The Journal of Forestry*

ABSTRACT

Due to the remote nature of their work, employees in the Forest Service (FS) rely on handheld radios to manage job-related risks and maintain a direct line of communication. In order to compare results by risk-level, this study segmented 6530 respondents from the FS into two groups: fire (n = 1615) and non-fire employees (n = 4915). Both Importance Performance Analysis (IPA) and a modified methodology called Radial Importance Performance Analysis (RIPA) were used to gauge employee perceptions of twelve salient radios attributes. Managerial implications differed for reliability, clarity of calls, and battery life based on the type of analysis and employee risk level. Both the IPA and RIPA matrices highlighted the need for improvement of reception/signal according to both low- and high-risk employees, as well as the need to redirect funding from ergonomics. Results of the RIPA were uniform across risk levels, exemplifying its increased statistical validity.

MANAGEMENT AND POLICY IMPLICATIONS

Field-going employees in the Forest Service (FS) rely heavily on handheld radios, both in day-to-day risk management and during emergency situations such as wildfires. Hence, this study sought to determine how to increase satisfaction and safe use of radios among FS employees by employing a modified importance-performance analysis. Importance-performance analysis (IPA) provides managers with information on how stakeholders evaluate both the importance and performance of a salient attribute. Subsequently, IPA was applied to two groups of FS employees (fire & non-fire) to gauge their perceptions of handheld radios. Results of the IPA and the modified Radial Importance-Performance Analysis (RIPA) indicated the FS should direct funding toward improving reception and signal by building more radio towers and repeaters. These actions could help reduce the amount and size of dead zones in the field for

employees, while helping to reduce barriers to communication. Clear, reliable and consistent communication for employees, especially those in hazard environments such as fire fighters is crucial in helping to maintain employee safety. Results from this study will also be applicable to other land management agencies as they deal with the ongoing safety issues of their own employees when dealing with various human-made or natural disasters.

INTRODUCTION

The practice of forestry is inherently risky and entails working in remote locations. In federal land management agencies, employees are subject to these risks while managing the land for the benefit of the public. The United States Forest Service (FS) alone manages 193 million acres of forestland, or approximately 28% of all federal land. The agency also employs over 40,000 staff members with varying levels of risk based on the type of work being done (e.g., low-risk administrative desk workers to high-risk smokejumpers).

One of the primary functions of the Forest Service (FS) is to prevent and suppress wildfires. One-quarter of agency employees are professional wild land firefighters. The risk level of fighting fire in the FS is rising as unprecedented fire seasons are becoming more commonplace (McKinney, 2004). In 2015 alone, there were over sixty-eight thousand wildfires consuming more than ten million acres of forestland (National Interagency Fire Center, 2017). The acreage burned in 2015 was 145% of the national ten-year average. Wildfires are expected to become more frequent and widespread due to long-term drought conditions, especially in the western United States (National Interagency Fire Center, 2017). Professional wildland firefighters are highly aware of the inherent danger of their jobs and many believe that some fatalities are inevitable in order to fulfill the mission of the FS (Dialogos, 2007). However, the

FS advocates a safety goal of zero fatalities, which it hopes to attain by reducing risks to employees.

The risk and remoteness involved in forestry and fighting forest fires is further amplified by the lack of standard telecommunication infrastructure. Field-going employees in the FS rely heavily on handheld and mobile radios, both in day-to-day operations and during emergency situations such as wildfires. Any issues or malfunctions with radios can severely inhibit communication between field-going employees and dispatchers. Inefficiencies in communication can prevent the relay of essential information, increasing risks. While radio malfunctions were not cited as the direct cause of recent tragedies such as the death of 19 smokejumpers at Yarnell Hill (National Interagency Fire Center, 2017), these tragic events demonstrate the need for federal agencies like the FS to have effective communication strategies.

Although communication is vital to operating safely in remote forestlands, there has been little research on employee perceptions of FS handheld radios. With this research gap in mind, this study has the following three objectives:

1) Assess employee perception of FS handheld radios via an Importance Performance Analysis (IPA) of respondents to the 2016 FS Radio Use Survey.

2) Compare IPA results by employee risk level (fire vs. non-fire employees).

3) Propose a new methodology called Radial Importance Performance Analysis (RIPA).

These three objectives carry both managerial and theoretical implications for those involved in the practice and study of forestry. For practitioners who are responsible for employee communication in remote forestland, IPA and RIPA may help identify common problem areas that need to be improved to increase effective communication and ultimately to create a safer working environment. The methodology used to assess employees perceptions of the importance

and performance of FS handheld radios can also be adapted to other federal or state land management agencies such as the Bureau of Land Management, the National Park Service, Fish and Wildlife service and departments of natural resources. For researchers, and practitioners, the applied methodology of subtracting performance ratings from importance ratings and graphing them by their standard deviations from the mean provides a more statistically valid methodology for identifying aspects or issues that require additional funding.

LITERATURE REVIEW

Employees in federal land management agencies such as the FS encounter risk both in day-to-day operations and during emergency situations (Tidwell, 2015). Both risk management and crisis communication are pertinent to FS employees as well as employees in other federal or state land management agencies. During day-to-day operations, FS employees engage in risk management communication. Risk management seeks to inform those involved about potential future harm and associated dangers so that employees might take action to mitigate the risk (Seeger et al., 2003; Seeger 2006). Emergency situations like wildfires require event-centered and incident-specific communication. In the literature, this type of communication is called crisis communication. Crisis communication emphasizes the need to distribute accurate, timely, and useful information as emergency situations evolve (Seeger, 2006).

Although risk management and crisis communication have separate bodies of literature (Steelman & McCaffrey, 2012), the end goal of both types of communication is to reduce employee risk. Steelman and McCaffrey (2012) stress that these two types of communication must intersect to reduce risks to employees who manage natural resources. Risks encountered by field-going employees, which can be biotic or abiotic in nature, toe the line between risks and crises depending on the specific circumstances. Examples of risks that employees may encounter

in the field include wildfires, falling trees, inclement weather, dangerous animals and potentially illegal human activity. These risks would be interpreted as crises by the majority of the population, but they are largely commonplace in the day-to-day fieldwork of employees in federal land management agencies. Thus, the best management practices in both risk and crisis communication must be combined within a land management agency such as the FS.

The need for effective risk management and crisis communication among FS employees is clear, especially among high-risk fire employees. However, applied employee feedback on communication infrastructure, especially performance of handheld radios, has been lacking despite several agency-wide surveys over the past decade. The 2016 Federal Employee Viewpoint Survey specifically emphasized the need for performance feedback from employees on agency practices, calling for specific, actionable, and prompt feedback from employees. This performance feedback is critical to productive supervisor–employee communication and teamwork. Brown, Squirrell, and Harris (2009) called for additional longitudinal studies of FS employee attitudes to track agency performance gaps and employee preferences for agency resource management. Unfortunately, the first round of the FS Radio Survey, which was administered in 2010, lacked performance feedback on specific features of handheld radios. This survey collected information regarding radio inventory, utilization, training, and other aspects of the radio program. There have been other FS related surveys and publications pertaining to employee safety and the bi-annual Safety Journey training program (Lane et al., 2014; Ghimire, Cordell, & Green, 2015), but these studies also lacked applicable feedback pertaining to the radio program. This study was designed to fill the gap in the previous research on FS employee perceptions of Handheld Radios and the Land Mobile Radio Program.

METHODS

Survey Methods

In 2016, FS officials were seeking feedback from employees on the Land Mobile Radio (LMR) program. Thus, the 2016 FS Radio Use Survey was commissioned. The research team at a land-grant university updated the 2010 survey with input from LMR officials. The FS administered the survey internally via email to all employees with FS email addresses. The survey was administered in two separate rounds (February 2016 and July 2016) in an effort to increase participation of seasonal employees. The 2016 FS Radio Use Survey received 6,530 respondents for an overall response rate of approximately 16%. Employees from all nine regions as well as the Washington Office were represented with a response rate of 17% across the nine regions. Analyses were completed using Microsoft Excel and IBM Statistical Package for the Social Sciences (SPSS).

Importance Performance Analysis (IPA) Methods

Managers of the LMR program were particularly interested in employee perceptions of handheld radios. Handheld radios are personally assigned to employees as opposed to mobile radios, which are installed in shared agency vehicles. In order to gauge employee opinion on the performance of handheld radios and highlight any aspects that needed improvement, the survey team decided to perform an Importance Performance Analysis (IPA) of twelve handheld radio aspects (Martilla & James, 1977). Employees were asked to rate each aspect's importance and performance on a five-point Likert (1932) Scale (not at all important/not at all satisfied with performance to very important/very satisfied with performance).

Twelve aspects of Handheld Radios were selected for analysis:

- Battery life
- Battery recharge ability
- Clarity of calls
- Durability
- Ease of use
- Ergonomics
- Reception/signal
- Reliability
- Replacement time
- Size
- Standardization of radios across FS
- Weight

IPA is an analytical methodology that provides direct management implications for the improvement of problematic aspects of a program or product (Martilla & James, 1977). The IPA has been well-used within the business, recreation and tourism literature to gauge customers' perception of the importance of service attributes and the firm's performance on those salient attributes (Hollenhorst, Olson, & Fortney, 1992; Hammitt, Bixler, & Noe, 1996). Although IPA has traditionally been implemented to analyze feedback from consumers, supply-side implementation from employees has been lacking, especially among federal agencies (Boley, McGehee, & Hammett, 2017). The 2016 Radio Survey team decided to utilize IPA to evaluate the performance of twelve handheld radio aspects in order to provide FS Land Mobile Radio (LMR) Officials with feedback and management implications.

In order to conduct the IPA, the mean importance rating and mean performance rating of each handheld radio aspect was calculated based on the range of employee responses. Next, each aspect was plotted on the IPA matrix using the mean performance rating of that aspect as the x-value and the mean importance rating of that aspect as the y-value.

On the IPA matrix, aspects fall into one of four quadrants with different managerial implications. Aspects with high ratings for both importance and performance fall into the "keep up the good work" quadrant. Aspects with low ratings for both indicators fall into the "lower priority" quadrant. The "possible overkill" quadrant encompasses aspects with low importance

but high performance. Finally, those aspects with high importance but low performance fall into the "concentrate here" quadrant. Hence, to increase satisfaction, managers should focus on improving aspects in the "concentrate here" quadrant while maintain high performance for aspects that fall in the "keep up the good work quadrant."

While IPA has been heavily embraced within other bodies of literature (Hollenhorst, Olson, & Fortney, 1992; Hammitt, Bixler, & Noe, 1996), a common struggle among researchers adopting the technique is where to place the crosshairs dividing the four quadrants (Azzopardi & Nash, 2013; Boley, McGehee, & Hammett, 2017). Two common options for cross-hair placement include plotting crosshairs using a scale-centered or data-centered technique (Azzopardi & Nash, 2013). Implications for managers differ based on which technique is used. A scale-centered technique places the crosshairs at the midpoint of the 1-5 answer scale. While this was originally embraced by Martilla and James (1977) in their first study to use IPA, Oh (2001) recognizes that when researchers work with managers to choose salient aspects of a program or product to evaluate, they are likely to focus on aspects with inherently high importance and ignore other, less important aspects, leading to inflated respondent-rated importance and performance scores. Thus, when the scale-centered technique is used, most aspects tend to fall into the "Keep up the Good Work" quadrant due to what Oh (2001) dubs the "ceiling effect." Using a data-centered technique that uses the mean ratings of importance and performance to compare the relative importance and performance of aspects against one another can help mitigate the ceiling effect. Taplin (2012) also advocated for the data-centered technique over the scale-centered technique, especially in situations where managers have a limited budget and funds must be shifted from one aspect to another.

In this analysis, the crosshairs of the IPA matrix were set using a data-centered technique. First, the overall mean importance of all aspects was calculated. A horizontal line was plotted with the y-intercept at the overall mean importance value. Next, the overall mean performance of all aspects was calculated. A vertical line was plotted with the x-intercept at the overall mean performance value. Plotting two crosshairs on the IPA matrix at the overall mean importance and performance values delineated the four quadrants.

Radial Importance Performance Analysis (RIPA) Methods

In order to improve suggestions for managers, some modifications to the traditional IPA matrix have been proposed. For instance, researchers have proposed alterations to the IPA methodology that can help avoid confusion surrounding aspects that fall close to the crosshairs that divide the four quadrants. Tarrant and Smith (2002) included the standard error for both importance and performance of each aspect, creating a series of "crosspoints." If an aspect's crosspoint fell fully in one quadrant, researchers could be confident in the management suggestions for that attribute. Dolinsky and Caputo (1991) suggested that building additional crosshairs into each quadrant of the standard IPA matrix may improve accuracy in classifying attributes and deriving strategic suggestions. Bacon (2003) also modified the standard IPA method by including a 45-degree iso-diagonal line within the matrix. This line encompassed the points at which importance and performance are equal. A one-to-one ratio of importance to performance is beneficial because it reduces the four quadrants two triangles based on whether stakeholders are satisfied (P>I) or dissatisfied (I>P) with the attribute.

Building off this literature, our study presents the results using both traditional IPA graphs as well as a new method titled Radial Importance Performance Analysis (RIPA). The RIPA is a simple modification to the existing IPA methodology that improves statistical validity

and simplifies four quadrants into three concentric, circular zones ("reduce funding", "maintain funding", and "increase funding") that are delineated using standard deviations above and below the mean difference between importance and performance.

To perform a Radial Importance Performance Analysis (RIPA), the mean performance rating of each aspect is subtracted from the mean importance rating of each aspect. Aspects with an importance rating that is higher than performance will have positive values. Aspects with a performance rating that is higher than importance will have negative values. Aspects are then plotted on a radar chart in Microsoft Excel with importance minus performance as the scale.

Next, the overall mean and standard deviation of aspect differences is calculated. Two circles are plotted on the radar chart at one standard deviation above the mean difference value and one standard deviation below the mean difference value. These circles delineate the three zones in a RIPA. Aspects that are more than one standard deviation above the overall mean difference fall into the "increase funding" zone around the outside of the graph. Aspects that are more than one standard deviation below the overall mean difference fall into the "reduce funding" zone in the center of the graph. All other aspects are deemed "maintain funding" and fall within one standard deviation of the overall mean difference between importance and performance. The "maintain funding" zone is the donut-shaped area that encircles the center of the graph.

RESULTS

Importance and Performance Ratings

On average, respondents rated all handheld radio aspects at least moderately important. The overall mean importance rating for handheld radio aspects was 4.13/5 (see Table 1). Reception/signal, reliability, and clarity of calls were the three handheld radio aspects with the

highest importance. Ergonomics had the lowest importance, followed by size and weight. Respondents were on average at least moderately satisfied with the performance of all handheld radio aspects with an overall mean performance rating for handheld radio aspects of 3.35/5. Though none of the aspects evaluated had a performance rating above 3.75/5, the three aspects with the highest performance were durability, ergonomics, and ease of use. Reception/signal had the lowest performance, followed by replacement time and standardization of radios.

Most aspects had a higher rating for importance than performance indicating that the FS has room to improve the handheld radio program. The mean difference between the importance and performance of all aspects was 0.78 (see Table 1). Ergonomics was the only aspect with a higher rating for performance than importance, and thus a negative difference between importance and performance (-0.28).

Table 1

Mean Importance and Performance Ratings for Twelve US Forest Service Handheld Radio Aspects

HANDHELD RADIO ASPECTS	Importance[1]	Performance[2]	Importance - Performance
Battery Life	4.44	3.42	1.01
Battery Recharge Ability	3.89	3.32	0.57
Clarity of Calls	4.61	3.29	1.31
Durability	4.49	3.75	0.74
Ease of Use	4.24	3.46	0.78
Ergonomics	3.27	3.55	-0.28
Reception/Signal	4.78	3.06	1.71
Reliability	4.78	3.37	1.41
Replacement Time	3.89	3.16	0.73
Size	3.56	3.32	0.24
Standardization of Radios Across FS	3.90	3.17	0.73
Weight	3.62	3.24	0.38
MEAN	**4.13**	**3.35**	**0.78**

[1] **Importance**: "How important is the following handheld radio aspect?" on a 5-point scale of: 1=Not At All Important and 5 = Very Important

[2] **Performance**: "How satisfied are you with the performance of the following handheld radio aspects?" on a 5-point scale of: 1=Not at all satisfied and 5= Very Satisfied

When comparing ratings from fire and non-fire respondents, there was a statistically significant difference in importance on 10 out of 12 aspects and in performance on 9 out of 12 handheld radio aspects. Employees who used their handheld radios for firefighting were more prone to place higher importance on radios aspects measured (see Table 2). While there was a pattern in fire employees placing a high level of importance on handheld radio attributes, the differences in perceptions of performance were more mixed between the two groups. Seven handheld radio aspects had significant differences in both importance and performance (clarity of calls, durability, reliability, replacement time, size, standardization, and weight. Although, t-test display differences in importance and performance in means between the two groups, they do not provide the clear managerial implications associated with IPA.

Table 2

Mean Importance and Performance Ratings and t-test Results for Twelve US Forest Service Handheld Radio Aspects

Handheld Radio Aspect	Fire (n = 1615)		Non-Fire (n = 4915)		Importance t-test		Performance t-test	
	I[1]	P[2]	I	P	*t*	*p*	*t*	*p*
Battery Life	4.59	3.32	4.37	3.46	9.38	.000	-4.96	.131
Battery Recharge Ability	3.73	3.17	3.97	3.39	-6.47	.000	-6.54	.526
Clarity of Calls	4.75	3.31	4.55	3.28	10.64	.000	0.86	.039
Durability	4.70	3.68	4.41	3.79	12.96	.000	-4.42	.000
Ease of Use	4.29	3.59	4.22	3.41	2.48	.145	5.82	.016
Ergonomics	3.41	3.62	3.22	3.53	5.25	.771	3.33	.003
Reception/Signal	4.88	3.13	4.74	3.03	8.39	.000	3.08	.128
Reliability	4.89	3.45	4.75	3.34	8.65	.000	3.49	.024
Replacement Time	4.24	2.97	3.75	3.25	15.74	.000	-8.56	.000
Size	3.69	3.41	3.52	3.28	4.26	.000	4.40	.000
Standardization of Radios	4.22	2.99	3.77	3.25	12.65	.000	-7.70	.000
Weight	3.68	3.34	3.61	3.20	2.27	.003	4.58	.000

[1] **Importance**: "How important is the following handheld radio aspect?" on a 5-point scale of: 1=Not At All Important and 5 = Very Important

[2]**Performance**: "How satisfied are you with the performance of the following handheld radio aspects?" on a 5-point scale of: 1=Not at all satisfied and 5= Very Satisfied

Importance Performance Analysis (IPA) Results

Using importance and performance ratings, handheld radio aspects were plotted on the IPA matrix made up of four quadrants with different managerial implications. Two separate IPA graphs were generated in order to examine differences in perception of handheld radios among high- and low-risk employees.

The first IPA graph was generated including only those respondents in high-risk jobs whose primary use of handheld radios is for fire suppression and preparedness (n = 1615). On the IPA graph of fire respondents, reception/signal, clarity of calls, and battery life fell into the "concentrate here" quadrant (see Figure 1). Reliability, durability, and ease of use fell into the "keep up the good work" quadrant, and weight, size, and ergonomics fell into the "overkill" quadrant. All other aspects fell into the "low priority" quadrant.

The second IPA graph was generated including respondents in lower-risk jobs whose primary use of handheld radios is for non-fire purposes (n = 4915). On the IPA graph of non-fire respondents, reception/signal, clarity of calls, and reliability fell into the "concentrate here" quadrant (see Figure 2). Battery life, durability, and ease of use fell into the "keep up the good work" quadrant. Battery recharge ability and ergonomics fell into the "overkill" quadrant. All other aspects fell into the "low priority" quadrant.

The key differences between the two IPA graphs were the placement of battery life and reliability. For high-risk fire respondents, battery life fell into the "concentrate here" quadrant. For lower-risk respondents, battery life was a "keep up the good work" aspect whereas reliability was a "concentrate here" aspect.

Radial Importance Performance Analysis (RIPA) Results

The RIPA transforms the four-quadrant IPA graph with two axes into a single-axis radial graph with three circular zones. These zones provide managerial recommendations for increase, maintenance, or reduction in funding. The 12 handheld radio aspects were plotted on the RIPA matrix by the difference between their importance and performance scores (I-P). Again, two separate RIPA graphs were generated in order to examine differences in perception of handheld radios among high- and low-risk employees.

In the RIPA of fire employees (see Figure 3), reception/signal was the only aspect that fell into the outer "increase funding" zone. Both ergonomics and size fell into the center "reduce funding" zone. All other aspects fell within one standard deviation of the mean difference between importance and performance into the "maintain funding" zone.

In the RIPA of non-fire employees (see Figure 4), reception/signal and reliability fell into the outer "increase funding" zone. Ergonomics was the only aspect that fell into the center "reduce funding" zone. All other aspects fell within one standard deviation of the mean difference between importance and performance into the "maintain funding" zone.

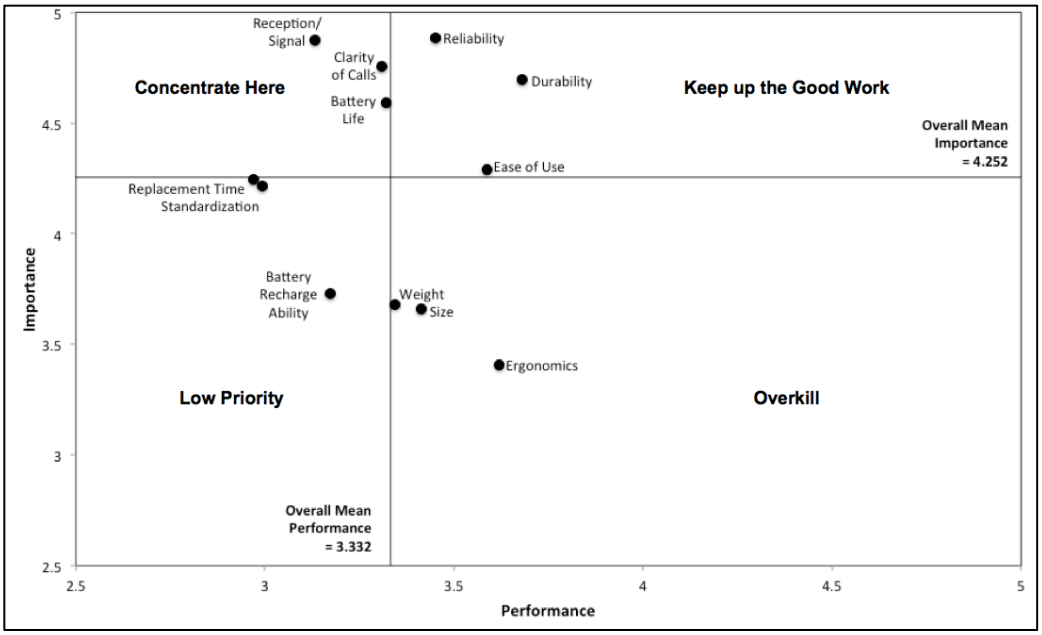

Figure 1. The IPA matrix of twelve US Forest Service handheld radio aspects (fire respondents, *n* = 1615).

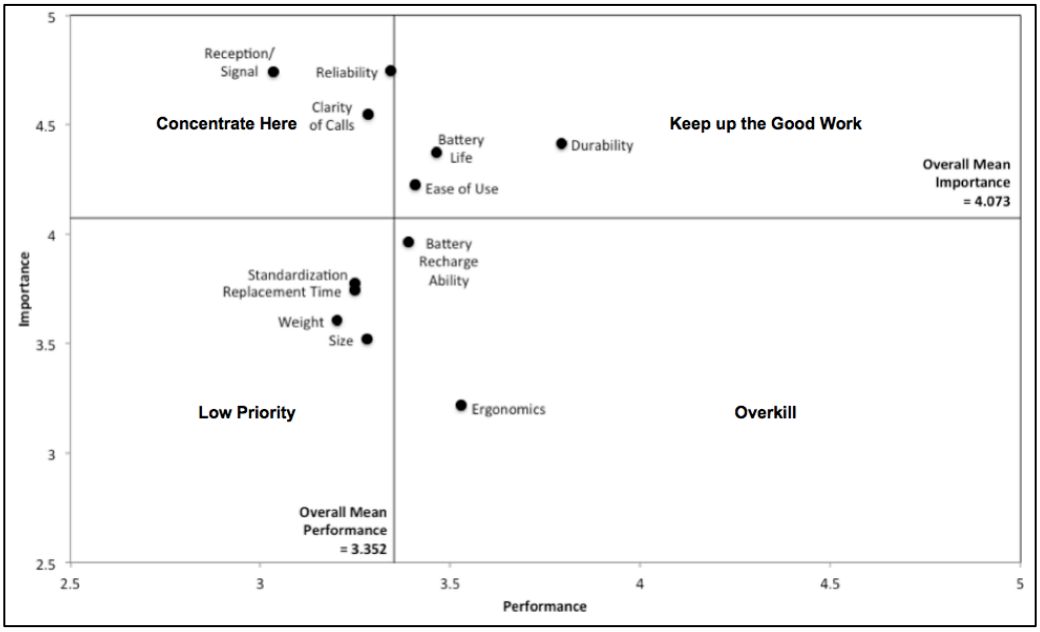

Figure 2. The IPA matrix of twelve US Forest Service handheld radio aspects (non-fire respondents, *n* = 4915).

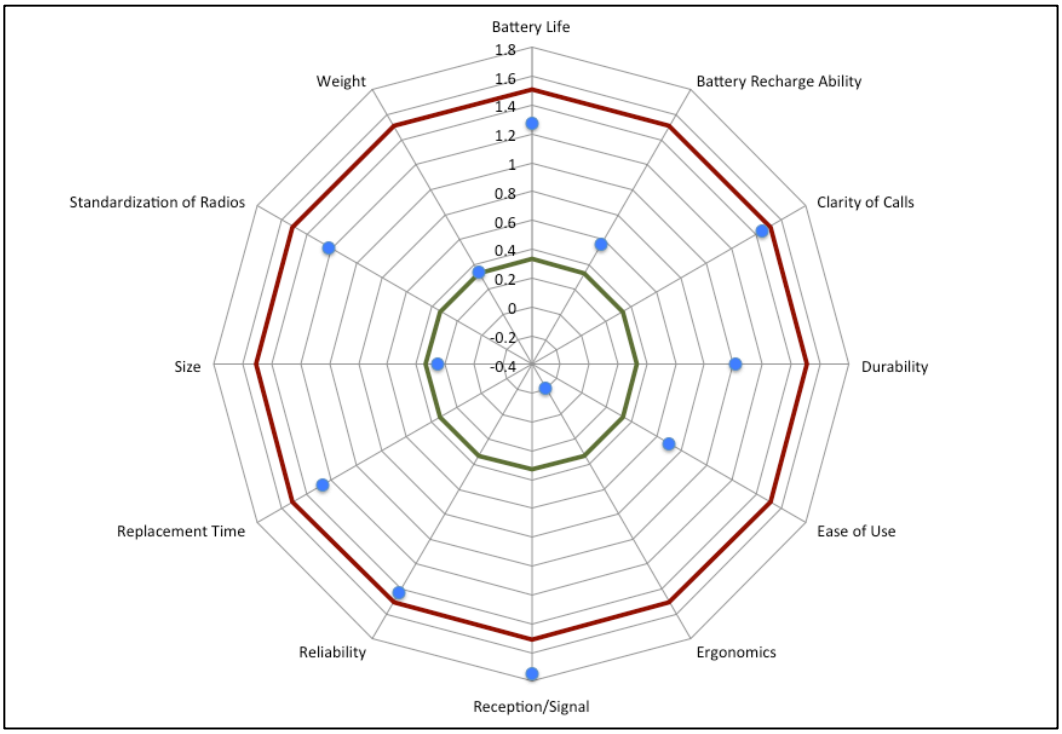

Figure 3. The RIPA matrix of twelve US Forest Service handheld radio aspects (fire respondents, *n* = 1615).

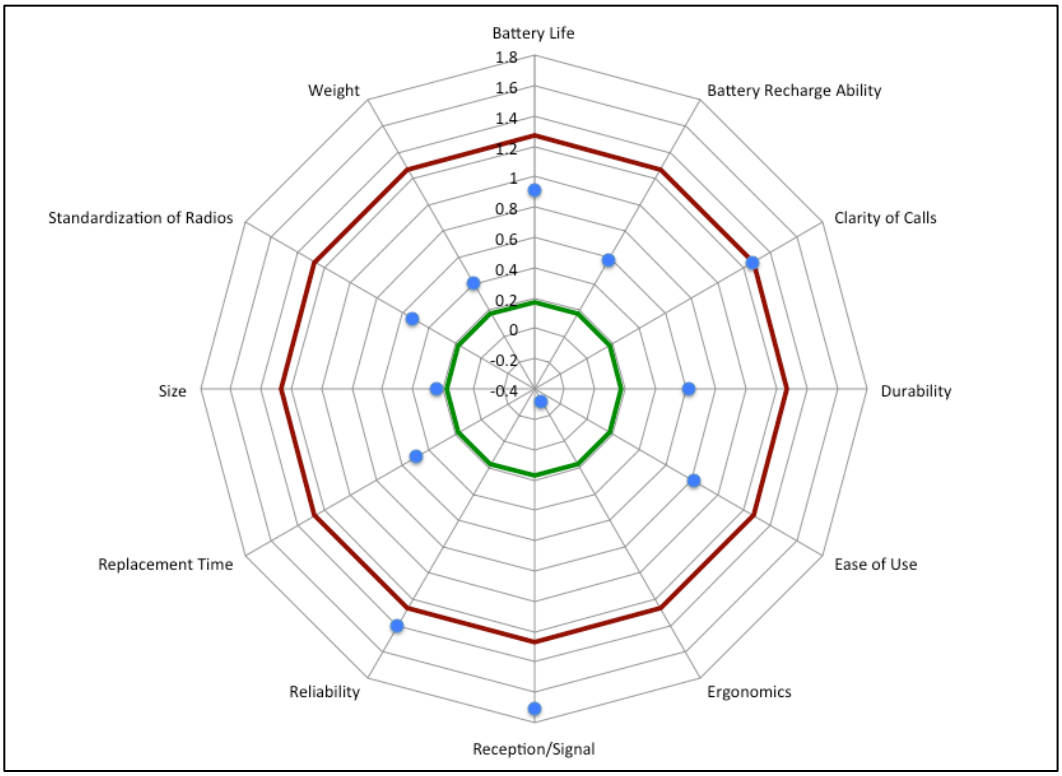

Figure 4. The RIPA matrix of twelve US Forest Service handheld radio aspects (non-fire respondents, n = 4915).

DISCUSSION

Implications for the Radio Program

According to both the IPA and RIPA methodologies, in order to increase employee satisfaction with both handheld radios and the LMR program, the FS should primarily focus on improving reception and signal, with clarity of calls as a second priority. According to both fire and non-fire respondents, reception/signal had the highest relative importance of all aspects (4.78/5) and the lowest performance rating (3.06/5) when averaged across all respondents. The results of the IPA and RIPA analyses were further confirmed by post-hoc analyses using additional questions pertaining to dead zones in the survey.

Many employees confirmed issues with dead zones, where their handheld radio was unable to make or receive calls. Although most respondents only encounter dead zones rarely (27.2%) or occasionally (33.6%), almost one-quarter of respondents (24.4%) claimed to work in dead zones at least half of the time. Although most respondents carried a smart phone, tablet, or basic cellular phone while on the job, 18.5% of respondents claimed that there was no backup form of communication when working in radio dead zones. Issues with dead zones in radio reception could increase risk for field-going employees, especially during unpredictable wildfires, since communication with dispatchers would be hindered. The Forest Service can redirect funding from ergonomics to build more radio towers and repeaters, which would reduce the amount and size of dead zones in the field.

Based on the IPA results, reliability and battery life should also be improved as secondary priorities, though there was not a consensus among fire and non-fire respondents on the management implications of these aspects. According to the fire IPA, reliability was an aspect on which managers could “keep up the good work.” However, significantly higher

importance ratings and significantly lower performance ratings from non-fire respondents placed reliability in the "concentrate here" quadrant. In the RIPA, due to the disparity between its importance and performance ratings from non-fire respondents, reliability fell solidly into the "increase funding" zone. However, reliability fell within one standard deviation of the mean I-P difference in the RIPA for fire respondents, placing it within the "maintain funding" zone. It is not clear why non-fire respondents were more critical of reliability of handheld radios than fire respondents. The significant difference in importance and performance ratings for reliability should be further examined in future iterations of the radio use survey.

Non-fire employees were satisfied with both the importance and performance of battery life. However, fire respondents gave battery life significantly higher importance ratings, which placed the aspect in the "concentrate here" quadrant. Since fire employees spend the majority of their time in the field, they have fewer opportunities to charge their handheld radios. Thus, their reasoning for placing higher importance on battery life is clear.

Implications for Radial Importance Performance Analysis (RIPA)

The RIPA simplifies the four quadrants from IPA into three zones. The three zones in a RIPA matrix make for a very straightforward explanation to managers with limited budgets: reallocate funds from those aspects in the "reduce funding" zone to the "increase funding" zone; maintain funding of all other aspects. Although the "keep up the good work" and "low priority" quadrants in a traditional IPA are opposite one another on the matrix, they both quadrants represent those aspects that have a similar rating for both importance and performance. The managerial implications for both quadrants are the same: maintain current funding levels. Thus, combining the two quadrants into one "maintain funding" zone does not eliminate any valuable information for managers.

One of the main strengths of IPA methodology is its simplicity. Unfortunately, the simplicity of separating the aspects into four quadrants on the IPA matrix can create statistical uncertainty, especially when several aspects fall very close to the crosshairs (Bacon, 2003). The crosshairs are demarcated by the overall mean, and the mean is easily skewed by outliers in the data. Using the mean to separate the quadrants fails to take into account the statistical dispersion of aspect ratings. A statistically insignificant difference in the position of an aspect on the traditional IPA matrix can significantly impact its managerial implications. The RIPA uses the standard deviation of aspect ratings to define the three zones. Thus, RIPA is statistically more robust than the traditional IPA.

Another benefit of using RIPA as opposed to traditional IPA is the ability to alter the matrix based on the number of aspects and their dispersion. In theory, with enough aspects and a large enough range of importance and performance ratings, additional zones could be created using concentric circles representing second and third standard deviations above and below the mean difference between importance and performance. Thus, managers could receive prioritized recommendations with those aspects falling closest to the outer rim as number one priority for an increase in funding and those aspects falling closest to the center as number one priority for a decrease in funding.

LIMITATIONS & FUTURE RESEARCH

As with all research, there were limitations with this study. The first is associated with the subjective nature of survey data. It is hard to tease out whether or not the problems with reception, signal, and reliability are actual problems or just perceived problems from inexperienced radio operators. Additionally, although other land management agencies encounter similar challenges in employee communication, the results of this study can only be generalized

to the US Forest Service. Lastly, this research is only a cross-sectional look at the Land and Mobile Radio program at one point in time. Future rounds of the FS Radio Use Survey should include an IPA of the same twelve handheld radio aspects in order to study longitudinal changes in employee perceptions. The FS may also want to include additional salient aspects as they emerge.

While IPA has been used heavily within the business literature, it appears that its application has been lacking in the field of natural resource management. Future research could utilize the combined IPA/RIPA methodology to measure employee perceptions of communication in other agencies such as the National Park Service, Bureau of Land Management, and Fish and Wildlife Service. The IPA/RIPA methodology could also be used by other federal land management agencies to gauge constituents' attitudes towards various issues, policies, programs, equipment, etc.

CONCLUSION

Federal and state land managers deal with a range of abiotic and biotic risk factors which make for a challenging work environment. This study has attempted to shed light on the lacking application of IPA methodology within the field of natural resource management. The IPA and RIPA will prove useful to the FS in gauging employee perceptions of FS handheld radios. For instance, results revealed that improvement of reception and signal is critical for increasing satisfaction with handheld radios, and thus the LMR program, among Forest Service employees. It appears that, if possible, the Forest Service should redirect funding to build more radio towers and repeaters, which would reduce the amount and size of dead zones in the field. Reducing issues with dead zones would improve the communication infrastructure and allow for an increase in day-to-day risk communication between field-going employees, dispatchers, and

upper management. Improving reception and signal would also enhance crisis communication, allowing the FS to respond promptly and effectively to wildfires while reducing risks to smokejumpers, wildland firefighters, and other employees in high-risk jobs. Results from this study could also be applicable to other land management agencies as they deal with the ongoing safety issues of their own employees when dealing with various human-made or natural disasters.

CHAPTER 3

SAFETY FIRST: HOW RADIO TRAINING EFFECTIVENESS IN THE US FOREST SERVICE IMPACTS HANDHELD RADIO USE AMONG HIGH- AND LOW-RISK EMPLOYEES[2]

[2] Fulmer, A.P., Boley, B.B., Green, G.T., & Kim, S. To be submitted to *The Journal of Organizational Behavior.*

ABSTRACT

Managing large tracts of remote forestland is inherently risky. In order to mitigate risks to field employees, the USDA Forest Service (FS) emphasizes personal safety and requires safety training for its employees. Radio training is not currently mandatory or standardized in the FS and little is known about employee perception of training effectiveness or how these perceptions influence radio use. This study analyzed data from the 2016 FS Radio Use Survey to determine the relationship between training effectiveness and frequency of handheld radio use. Results were compared by employee job type (administrative, fire, and recreation) to see if significant differences existed. Most respondents received at least five types of radio training. These training types received by employees ranged from formal classrooms and safety meetings to hands-on coworker or on-the-job training. Respondents across three job types rated on-the-job training as the most effective training type (3.58/4). There was a statistically significant, positive relationship between effectiveness of on-the-job training and frequency of radio use across three job types. Interestingly, effectiveness of safety meeting training had a statistically significant, positive relationship with frequency of radio use among administrative respondents and a statistically significant, negative relationship with frequency of radio use among fire respondents. Results suggest that the FS should encourage on-the-job radio training for all employees and reserve classroom-based training for less risky job types such as administration.

INTRODUCTION

Managing large tracts of remote forestland is an inherently risky endeavor. While on the job, natural resource managers encounter a range of biotic and abiotic risks such as wildfires, falling trees, inclement weather, dangerous animals and illegal human activity. In the United States, two federal departments (the Department of the Interior [USDOI] and the Department of

Agriculture [USDA]) combined manage over 600 million acres of land. The USDA Forest Service (FS) alone employs over 40,000 staff who manage 193 million acres of this federal land. The FS acknowledges the inherent risks of managing remote areas and stresses the importance of safety to its employees (Tidwell, 2015). To mitigate risks to field-going employees, the FS has developed a vast communication infrastructure in the form of both handheld and mobile radios.

A direct and efficient line of communication is imperative to the safety of FS employees, many of whom complete fieldwork in remote, isolated locations. Handheld radios provide a direct line of communication between employees and centralized dispatchers. The importance of effective communication is especially evident within the elite team of FS Smokejumpers who risk parachuting into wildfires from low-flying planes. Communication is critical in such high-risk jobs. The risk level to FS wildland firefighters is rising as unprecedented fire seasons are becoming commonplace (McKinney, 2004). In 2015 alone, there were over sixty-eight thousand wildfires (National Interagency Fire Center, 2017). Wildfires in 2015 consumed more than ten million acres of forestland, which was 145% of the national ten-year average. Wildfires are expected to become more frequent and widespread due to long-term drought conditions, especially in the western United States. Wildland firefighters are highly aware of the inherent danger of their jobs and many believe that some fatalities are inevitable in order to fulfill the mission of the FS (Dialogos, 2007). However, the FS advocates a safety goal of zero fatalities, which it hopes to attain by reducing risks to employees (Tidwell, 2015). In order to properly utilize radio communication, employees must first be trained on radio use. Thus, effective radio training and safety training are paramount to achieving the agency's goal of zero fatalities. The following quote from FS Chief Tom Tidwell (2015) embodies the agency's attitude toward employee safety:

> "Safety is not just a firefighting issue. Even something as simple as crossing the street or getting behind the wheel of a car entails a certain amount of risk that has to be managed. At the Forest Service, safety across the board has become one of our major emphasis areas… We are therefore dedicated to creating a learning organization where everyone learns from both successful and unsuccessful [safety] outcomes in a fair and non-punitive way. We want to be an organization where learning is considered just as important as delivering services or accomplishing targets."

To mitigate risks to its field-going employees and encourage learning throughout all levels of the organization, the FS has developed a bi-annual safety training program titled the *Safety Journey*. The *Safety Journey* was introduced to FS employees in 2011 to promote two major tenets: personal-organizational resilience and workload-safety balance (Lane et al., 2014). The *Safety Journey* was administered in the form of information sessions followed by seminars, which allowed employees to share personal anecdotes related to accidents, near misses, and other safety topics. Employees were not trained on-site, but instead traveled to central locations in order to attend the *Safety Journey* sessions. In 2015, employees were asked to provide feedback on the first three iterations of the Safety Journey via the 2015 Safety Survey (Ghimire, Cordell, & Green, 2015). Results of the 2015 Safety Survey were largely positive, however FS employees in high-risk jobs such as firefighting and law enforcement were more skeptical of the program than other employees in lower-risk positions. Many high-risk employees were frustrated by the abstract nature of the program, which was not directly applicable to situations they might encounter in the field. Skeptics of the Safety Journey criticized its lack of hands-on training methods in favor of abstract discussions and "feel-good" messages. Employees in high-risk jobs

were also less likely to use the risk management strategies proposed by the Safety Journey in their daily work.

One important question left unanswered by previous surveys of FS employees was the relationship between effectiveness of radio training and frequency of handheld radio use. Increased frequency of handheld radio use is one of the primary goals of the FS Radio Program because efficient communication is critical to the safety of field employees. Although the FS emphasizes personal safety and radio use among employees, radio training is not currently standardized within the FS. Radio training types received by employees range from formal classrooms and safety meetings to hands-on coworker or on-the-job training. Conversely, some employees may not receive any radio-specific training before being personally issued a handheld radio.

Training effectiveness and frequency of radio use have significant implications for FS employees' ability to manage risks in remote areas. Additionally, employees at varying risk levels who engage in different primary uses of radios may have dissimilar perceptions of training effectiveness. Employees in high-risk jobs may benefit from different types of training than employees engaging in less dangerous lines of work (e.g. administrative). Results of this study could have broader implications for training in other land management agencies, like the Department of Interior, and provide insights on how to improve training programs associated with safety and communication across large, remote tracts of land.

With the aforementioned research gap in mind, this study had two primary objectives:

1) Analyze FS employees' perceptions of training effectiveness to determine which type of training is the most preferred among three job types (administrative, fire, and recreation).

2) Test the relationship between training effectiveness and frequency of radio use for three job types.

LITERATURE REVIEW

Forest Service employees encounter risk both in day-to-day operations and during emergency situations (Tidwell, 2015). Risk management and crisis communication are two concepts that are pertinent to the field of natural resource management, both on federal and private land. During day-to-day operations, FS employees engage in risk management communication, which seeks to inform those involved about potential dangers (Seeger et al., 2003; Seeger, 2006). Higher-risk, unpredictable situations like wildfires require event-centered and incident-specific communication. This type of communication is called crisis communication. Crisis communication emphasizes the importance of distributing accurate, timely, and useful information as emergency situations evolve (Seeger, 2006).

Although risk management and crisis communication have separate bodies of literature (Steelman & McCaffrey, 2013), the end goal of both communication strategies is to reduce employee risk. Steelman and McCaffrey (2013) posited that risk management and crisis communication must intersect to reduce risks to field employees who manage natural resources. Risks encountered by field-going employees toe the line between risks and crises depending on the circumstances of a given incident. Examples of risks that employees may encounter in the field include wildfires, falling trees, inclement weather, dangerous animals, and potentially illegal human activity. These risks could elicit panic in the minds of members of the general

public, but they are largely commonplace in the day-to-day field operations of FS employees. Thus, the best management practices in both risk and crisis communication must be combined within the FS to ensure employees are adequately trained and prepared for the risks they may encounter.

Risks can be managed through targeted safety behaviors such as frequent radio use, especially when an employee is working in an isolated location. Effective training may increase the frequency of target safety behaviors. Part of effective training entails building a learning organization, in which managers make policy decisions, evaluate outcomes, and adapt policies based on those outcomes (Garvin, 2000). Brown, Squirrell, and Harris (2010) emphasized the need for the FS to build a stronger learning organization so that the agency can continuously adapt to a changing environment, changing public needs, and a changing workforce. Garvin (2000) hypothesized that three factors are essential for organizational learning: 1) supportive learning environment 2) concrete learning processes and practices and 3) leadership behavior that provides reinforcement. The FS has already attempted to form a supportive learning environment when it comes to safety through the introduction of the *Safety Journey* (Lane et al., 2014). Most employees in the FS were supportive of the *Safety Journey* (Ghimire, Cordell, & Green, 2015). However, concrete learning processes and practices were lacking according to higher-risk respondents to the 2015 Safety Survey. Only after concrete learning processes are standard throughout the agency can the FS fully attain its goal of becoming a learning organization. This includes concrete learning processes for handheld radios.

Research indicates that hands-on training methods improve outcomes, especially for safety training, since they incorporate all three domains of Bloom's Taxonomy of Learning: the cognitive domain, the psychomotor domain, and the affective domain (Bloom, 1984; Wilder,

2016). The cognitive domain equips employees with the knowledge necessary for safety, including the various buttons on a radio and their functions. The psychomotor domain provides safety skills through repetition, such as physically holding a radio, setting it to the correct frequency, and making practice calls during simulated emergencies. Finally, the affective domain forms positive attitudes among employees regarding the value of radios to personal safety on the job. Although theory and past findings support the benefits of hands-on training, more research is warranted in order to determine the effectiveness of different training types used in the FS and how the effectiveness of each training type impacts target safety behaviors such as frequency of handheld radio use.

METHODS

In 2016, FS officials were in need of feedback from employees on the Land Mobile Radio (LMR) program. Thus, the 2016 FS Radio Use Survey was commissioned. The survey collected data from employees including primary use of handheld radios, frequency of radio use, training type received, and training effectiveness. The FS emailed a link to the online survey to all employees with FS email addresses. The survey was administered in two separate rounds (February 2016 and July 2016) in an effort to increase participation of seasonal employees. The 2016 FS Radio Use Survey received 6,530 respondents in total for an overall response rate of approximately 16%. Employees from all nine regions as well as the Washington Office were represented with response rates across the nine regions of 17% or more. Analyses were completed using Microsoft Excel and IBM Statistical Package for the Social Sciences (SPSS).

Radio training types included in the 2016 FS Radio Use Survey were coworker, formal classroom, online, on-the-job, safety meeting, user's manual, and other. "Other training" was seldom selected by respondents. It was removed from this analysis due to its uninformative

nature. Respondents were asked whether or not they received each type of radio training and to rate the effectiveness of each type on a four-point Likert (1932) scale: 1) Not at all effective 2) Somewhat effective 3) Moderately effective 4) Very effective. Respondents also rated the frequency of use of their handheld radio use on a six-point scale: 1) Never 2) Only in Emergencies 3) Yearly 4) Monthly 5) Weekly 6) Daily.

The effectiveness of each type of training was used as a predictor variable and frequency of handheld radio use was the response variable. To determine which training types encouraged employees to use handheld radios frequently, spearman's rho was calculated. Spearman's rho is a useful coefficient for interpreting the correlation between two ordinal variables (Spearman, 1904). This analysis was repeated three times in order to determine differences by job type in the relationship between training effectiveness and radio use. Job types were chosen to represent high-risk (fire), moderate-risk (parks), and low-risk (administrative) FS jobs.

The three employee job types included in the analysis were:

1. Administrative
2. Fire Preparedness/Suppression (renamed "Fire")
3. Recreation/Wilderness/Trails (renamed "Recreation")

RESULTS

Most respondents received multiple radio training types (see Table 3). Over 60% of respondents received five out of six training types. On-the-job radio training was received by over 88% of respondents, making it the most widespread type of training across all job types. Online training was the least widespread training type across all job types (see Table 3). There was a significant difference in effectiveness rating by respondent job type for four training types: coworker, on-the-job, safety meeting, and user's manual (see Table 4). On-the-job training was

rated the most effective training type across all job types (see Table 4). Online training was rated the least effective training type across all job types (see Table 4).

A chi-square test of goodness-of-fit was performed to determine whether frequency of handheld radio use was equal across three job types. Frequency of handheld radio use was not equally distributed by job type, X^2 (10, n = 2614) = 373.16, $p < .05$ (see Table 5). Most non-administrative respondents used their handheld radio at least weekly. Compared to other job types, the greatest proportion of fire respondents (62.1%) used radios daily. Recreation respondents were moderate radio users, with approximately one-third using radios daily and another third using radios weekly. Administrative respondents were the most infrequent radio users. Although approximately 40% of administrative respondents used their radios daily or weekly, 21.1% only used radios during emergencies and 7.4% never used radios.

Table 3

Radio Training Type Received by Job Type

Radio Training Type Received	Administrative		Fire		Recreation	
	n	**%**	***n***	**%**	***n***	**%**
Coworker	368	85.2	1482	91.8	504	88.4
Formal Classroom	270	62.5	1185	73.4	376	66.0
Online	147	34.0	758	46.9	169	29.6
On-the-Job	382	88.4	1526	94.5	527	92.5
Safety Meeting	325	75.2	1241	76.8	446	78.2
User's Manual	295	68.3	1397	86.5	418	73.3

Table 4

Radio Training Effectiveness[1] by Job Type

Radio Training Effectiveness	Administrative	Fire	Recreation
Coworker*	3.41	3.67	3.49
Formal Classroom	3.37	3.28	3.28
Online	2.20	2.14	2.10
On-the-Job*	3.48	3.79	3.58
Safety Meeting*	3.19	2.70	2.99
User's Manual*	2.68	2.92	2.64

[1]Training effectiveness measured on a 4-point scale with 1=Not at all effective and 4=Very Effective.
*Significant difference at $p < .05$ between job types.

Table 5

Frequency of Handheld Radio Use by Job Type

Frequency of Handheld Radio Use	Administrative		Fire		Recreation	
	n	%	*n*	%	*n*	%
Never	32	7.4	35	2.2	14	2.5
Only in Emergencies	91	21.1	107	6.6	47	8.3
Yearly	51	11.8	74	4.6	27	4.8
Monthly	84	19.4	156	9.7	91	16.0
Weekly	92	21.3	240	14.9	173	30.5
Daily	82	19.0	1002	62.1	216	38.0
TOTAL	**432**	**100.0**	**1614**	**100.0**	**568**	**100.0**

On-the-job training was the only radio training type with a statistically significant relationship between effectiveness and frequency of handheld radio use across all three job types (see Table 6). On-the-job training also had a positive value for spearman's rho across all job types, indicating there was a positive relationship between effectiveness of on-the-job training and frequency of handheld radio use. Coworker training had a significant, positive relationship between effectiveness and frequency of handheld radio use among fire and recreation respondents. Effectiveness of user's manual training had a significant, positive relationship with frequency of radio use for administrative and fire respondents. Effectiveness of both formal classroom training and safety meeting training had a significant, positive relationship with radio use for administrative respondents but no others. However, for fire respondents, effectiveness of safety meeting training had a significant, negative relationship with frequency of radio use.

Table 6

Relationship Between Training Effectiveness and Frequency of Handheld Radio Use by Job Type

	Administrative			Fire			Recreation		
Training Type	*n*	ρ	*p*	*n*	ρ	*p*	*n*	ρ	*p*
Coworker	347	.008	.875	1462	.154	.000	492	.118	.009
Formal Class.	263	.235	.000	1171	.043	.140	372	.061	.240
Online	143	.094	.266	747	-.051	.160	166	- .019	.805
On-the-Job	364	.114	.030	1505	.174	.000	514	.118	.007
Safety Meet.	314	.123	.030	1224	- .136	.000	434	- .047	.333
User's Manual	286	.147	.013	1380	.121	.000	412	.039	.427

DISCUSSION

This research sought to investigate differences in employees' perceptions of the myriad of different radio training types employed by the FS. As the FS and other federal and state land management agencies seek to prepare their employees to work in remote settings while mitigating risks, these results suggest that, regardless of job type, employees perceive on-the-job training as most effective. Results also revealed the nature of the relationship between employee perception of training effectiveness and frequency of radio use. Across all job types, respondents who rated on-the-job training as more effective were more likely to use their handheld radios frequently. This result indicates that on-the-job radio training is not only preferred, but that it is also associated with the target safety behavior of frequent radio use in the field.

When it comes to other training types, the influence of training effectiveness on frequency of use varied by job type. Interestingly, effectiveness of safety meeting training had a significant, positive relationship with frequency of radio use among administrative respondents, and a significant, negative relationship with frequency of radio use among fire respondents. These inverse results imply that the FS should have separate training regimens tailored for different job types. For example, radio training for administrative employees could focus on basic radio operation and the purpose of radios within the FS. Conversely, employees in more risky jobs such as firefighters may benefit from more extensive hands-on training programs. These extensive training programs could incorporate simulated emergency and non-emergency scenarios in order to prepare employees for the variety of challenges that arise in remote wilderness.

While on-the-job training was recognized as the most effective type of training, online training was rated the least effective. This finding is pertinent to federal agencies due to the

recent push for online training in an effort to cut costs. While online safety training is efficient due to its speed, reach, and standardization, some employees become resentful when training appears to merely check a box instead of providing valuable experiences and skills (Zielinski 2013). Perhaps employees who received online training were more skeptical of its effectiveness because this training type was so far-removed from fieldwork.

LIMITATIONS & FUTURE RESEARCH

The first limitation of this study is associated with the majority of respondents indicating that they received at least five different types of training. Thus, training type received was not broken into independent groups, preventing the use of chi-square tests for significant differences between group means. Although other land management agencies encounter similar challenges in employee communication and training, the results of this study can only be generalized to the US Forest Service. Additionally, although the results revealed some interesting patterns associated with the benefits of on-the-job training, the question of why these programs are perceived as more effective remains unanswered. The FS should employ more qualitative research to unearth why employees perceived one radio training type as effective and another as ineffective. It would be especially interesting to interview high-risk fire personnel to examine whether this niche group responds to different types of radio training. The present study also lacked a question about the percent of time spent working in the field vs. working at a desk, which would be important to measure. While this study was able to segment employees by job type, it would be interesting to examine how the amount of time spent in the field influences preferences for training type and frequency of use. Lastly, this research is only a cross-sectional look at the Land Mobile Radio program at one point in time. Future rounds of the FS Radio Use

Survey should be administrated, especially after the agency makes any major changes to the radio program or the safety journey.

CONCLUSION

The overarching finding from this research is the significant, positive correlation between effectiveness of on-the-job radio training and frequency of radio use. Findings also imply that some training methods may reduce target safety behaviors among employees. Training methods that are too far-removed from fieldwork may frustrate employees in high-risk jobs who deal with safety risks on a day-to-day basis. Though the results of this analysis are limited in scope to the US Forest Service, employees in other federal, state, and local agencies would likely benefit from effective on-the-job training. All employees, especially those in the field, need a straightforward method of training that provides them with applied knowledge and skills. Through effective on-the-job training, managers can provide their employees with the knowledge, skills, and attitudes that build the foundation for personal safety and risk management.

CHAPTER 4

SUMMARY

Handheld Radios are a valuable tool for FS employees. Frequent communication between employees, managers, and administrators of large, federal organizations is important for many reasons. First and foremost, radios provide a direct and efficient line of communication between coworkers and dispatchers during day-to-day operations as well as in emergencies. Frequent radio use can help employees mitigate risks, especially when working in remote locations where risks include wildfires, inclement weather, falling trees, dangerous animals, and illicit human activity. Employees can utilize handheld radios to alert dispatchers of their location and receive updates about weather conditions or other pertinent information. In this way, frequent handheld radio use can prevent crisis situations in the field. Thus, the FS encourages frequent radio use among field-going employees as a target safety behavior.

Since employee safety through radio use is one of the main goals of the Land Mobile Radio (LMR) program, managers wanted to ensure that employees were satisfied with the performance of handheld radios. Subsequently, to pinpoint any possible issues with handheld radios, Importance Performance Analysis (IPA) and a modified version called Radial IPA (RIPA) were used to provide management implications for twelve handheld radio aspects. Results of both analyses were segmented into two independent groups regarding the respondents' primary use of handheld radios: fire and non-fire. Results of the IPA differed for fire and non-fire respondents, but there was consensus on the need for improvement of reception and signal. In order to improve the reception and signal of handheld radios in the field, the FS could build

more radio towers and signal repeaters. Improvement of reception and signal of radios would increase employee satisfaction with handheld radios and the LMR program as a whole.

To utilize handheld radios to their full potential, employees must be effectively trained on radio use. The FS does not currently utilize one standardized method of radio training. Instead, most employees receive at least five different types of radio training. Results from the 2016 Radio Survey revealed that on-the-job training was determined to be the most effective training method across three job types: administrative, fire, and parks. Effective on-the-job training was also a significant predictor of frequent handheld radio use for all job types analyzed. In order to encourage the target safety behavior of frequent handheld radio use, the FS should implement an on-the-job radio training program across the entire agency.

Results of the 2016 FS Radio Use Survey provided managers of the LMR program with useful employee feedback. To enhance the LMR program, problems with reception and signal of handheld radios should be addressed and an agency-wide on-the-job training program should be implemented. Although satisfaction with handheld radios and effective training are just two pieces of the employee safety puzzle, this analysis has provided the FS LMR program with concrete recommendations for improvement.

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2016 FS RADIO USE SURVEY INSTRUMENT

2016 USFS Radio Use Questionnaire

1. Radio Use Questions

The 2016 USFS Radio Use Questionnaire was created to better understand patterns of radio use in the Forest Service. Whether you currently use a radio or not, your input as a Forest Service employee is critical. All responses will be kept confidential and anonymous. Data will be analyzed at the University of Georgia. Please take ten to fifteen minutes to complete this questionnaire.

2016 USFS Radio Use Questionnaire

2.

1. What type(s) of radios do you use at work? *Check all that apply.*

- [ ] Aviation
- [ ] CB (Citizens Band)
- [ ] FS Handheld
- [ ] FS Mobile
- [ ] FRS (Family Radio Service)
- [ ] Other Govt. Handheld
- [ ] Other Govt. Mobile
- [ ] Other
- [ ] None of the above

2. How important is radio communication to the following aspects of your work?

	Not at all Important	Somewhat Important	Moderately Important	Important	Very Important
Communicating with Other Agencies	○	○	○	○	○
Communicating with Crew Members	○	○	○	○	○
Emergencies	○	○	○	○	○
Ensuring safety	○	○	○	○	○
Working alone in the field	○	○	○	○	○

2016 USFS Radio Use Questionnaire

3. HANDHELD Radio Questions

3. Are you personally assigned one or more HANDHELD radios?

- ◯ Yes
- ◯ No
- ◯ Don't Know

4. How often do you use HANDHELD radios?

◯ Daily ◯ Weekly ◯ Monthly ◯ Yearly ◯ Only in Emergencies ◯ Never

5. If you are not assigned a radio, how do you obtain a HANDHELD radio for use? *Check all that apply.*

- ☐ Assigned on a fire
- ☐ Pool
- ☐ Shared
- ☐ Other
- ☐ Not applicable

6. How OFTEN is availability of HANDHELD radios a PROBLEM for you?

◯ Always ◯ Often ◯ Occasionally ◯ Rarely ◯ Never ◯ Not applicable

7. The number of HANDHELD radios in your work group is...

- ◯ Less than you need
- ◯ About the right amount
- ◯ More than you need

8. What type of work is your HANDHELD radio primarily used for?

- ◯ Administrative
- ◯ Air Resources
- ◯ Aviation
- ◯ Engineering
- ◯ FIA
- ◯ Fire Preparedness/Suppression
- ◯ Forest Health
- ◯ Fuels Treatment
- ◯ Heritage Resources
- ◯ Hydrology/Soils
- ◯ Job Corps
- ◯ Lands
- ◯ Law Enforcement
- ◯ Minerals/Geology
- ◯ Range
- ◯ Recreation/Wilderness/Trails
- ◯ Research
- ◯ Silviculture
- ◯ Special Uses
- ◯ Timber Sales
- ◯ Wildlife/Fisheries/Botany

9. How important is HANDHELD radio communication to this primary use mentioned above?

◯ Not at all Important ◯ Somewhat Important ◯ Moderately Important ◯ Important ◯ Very Important

◯ Not applicable

10. How often does the HANDHELD radio meet your communication needs?

◯ Always ◯ Often ◯ Occasionally ◯ Rarely ◯ Never ◯ Not applicable

11. How important is a HANDHELD radio to ensuring your personal safety?

◯ Not at all important ◯ Somewhat important ◯ Moderately important ◯ Important ◯ Very important

12. Could you accomplish your work safely without a HANDHELD radio?

- ◯ Yes
- ◯ No
- ◯ Don't know

13. How often do you rely on your HANDHELD radio to work safely?

◯ Daily ◯ Weekly ◯ Monthly ◯ Yearly ◯ Only in Emergencies ◯ Never

14. How **important** are the following HANDHELD radio attributes to you?

	Not at all Important	Somewhat Important	Moderately Important	Important	Very Important
Battery life	○	○	○	○	○
Battery recharge ability	○	○	○	○	○
Clarity of calls	○	○	○	○	○
Durability	○	○	○	○	○
Ease of use (i.e. don't need a manual)	○	○	○	○	○
Ergonomics (i.e. easy to hold in the hand)	○	○	○	○	○
Reception/signal	○	○	○	○	○
Reliability	○	○	○	○	○
Replacement time (i.e. time to fix/replace)	○	○	○	○	○
Size	○	○	○	○	○
Standardization of radios across FS	○	○	○	○	○
Weight	○	○	○	○	○

15. How **satisfied** are you with the performance of the following HANDHELD radio attributes?

	Not at all Satisfied	Somewhat Satisfied	Moderately Satisfied	Satisfied	Very Satisfied
Battery life	◯	◯	◯	◯	◯
Battery recharge ability	◯	◯	◯	◯	◯
Clarity of calls	◯	◯	◯	◯	◯
Durability	◯	◯	◯	◯	◯
Ease of use (i.e. don't need a manual)	◯	◯	◯	◯	◯
Ergonomics (i.e. easy to hold in the hand)	◯	◯	◯	◯	◯
Reception/signal	◯	◯	◯	◯	◯
Reliability	◯	◯	◯	◯	◯
Replacement time (i.e. time to fix/replace)	◯	◯	◯	◯	◯
Size	◯	◯	◯	◯	◯
Standardization of radios across FS	◯	◯	◯	◯	◯
Weight	◯	◯	◯	◯	◯

16. How **important** is it for HANDHELD radios to provide the advanced features of …

	Not at all Important	Somewhat Important	Moderately Important	Important	Very Important
Encryption/privacy	◯	◯	◯	◯	◯
GPS technology	◯	◯	◯	◯	◯
Internet access	◯	◯	◯	◯	◯
Man down/emergency button	◯	◯	◯	◯	◯
Picture/Photo taking	◯	◯	◯	◯	◯
Text messaging	◯	◯	◯	◯	◯

17. Do you use one or more additional devices (e.g. phone, camera, GPS) on the job to meet these advanced needs?

◯ Yes

◯ No

18. What type of additional devices do you use to meet these advanced needs? *Check all that apply.*

- [ ] Basic cellular phone
- [ ] Digital camera
- [ ] GPS locator (SEND/SPOT)
- [ ] Satellite phone
- [ ] Smart phone/tablet
- [ ] Video camera
- [ ] Not applicable
- [ ] Other (please specify)

2016 USFS Radio Use Questionnaire

4. MOBILE Radio Questions

19. Do you use a MOBILE Forest Service radio installed in a vehicle at work?

- ◯ Yes
- ◯ No
- ◯ Don't Know

20. How often do you use the MOBILE radio?

◯ Daily ◯ Weekly ◯ Monthly ◯ Yearly ◯ Only in Emergencies ◯ Never

21. What type of work is your MOBILE radio primarily used for?

◯ Administrative	◯ Fuels Treatment	◯ Range
◯ Air Resources	◯ Heritage Resources	◯ Recreation/Wilderness/Trails
◯ Aviation	◯ Hydrology/Soils	◯ Research
◯ Engineering	◯ Job Corps	◯ Silviculture
◯ FIA	◯ Lands	◯ Special Uses
◯ Fire Preparedness/Suppression	◯ Law Enforcement	◯ Timber Sales
◯ Forest Health	◯ Minerals/Geology	◯ Wildlife/Fisheries/Botany

22. How important is MOBILE radio communication to this primary use?

◯ Not at all Important ◯ Slightly Important ◯ Moderately Important ◯ Important ◯ Very Important ◯ Not Applicable

23. How often does the MOBILE radio meet your communication needs?

◯ Always ◯ Often ◯ Occasionally ◯ Rarely ◯ Never ◯ Not applicable

24. How important is a MOBILE radio to ensuring your personal safety?

◯ Not at all important ◯ Somewhat important ◯ Moderately important ◯ Important ◯ Very important

25. Could you accomplish your work safely without a MOBILE radio?

- ◯ Yes
- ◯ No
- ◯ Don't know

26. How often do you rely on your MOBILE radio to work safely?

◯ Daily ◯ Weekly ◯ Monthly ◯ Yearly ◯ Only in Emergencies ◯ Never

2016 USFS Radio Use Questionnaire

5. Additional Radio Questions

27. How do you know where you have Forest Service radio coverage? *Check all that apply.*

- [ ] Co-workers
- [ ] Local knowledge/word of mouth
- [ ] Maps designating “dead zones”
- [ ] Trial and error
- [ ] Other
- [ ] Not applicable

28. How often do you work in “dead zone” areas?

- ◯ Never
- ◯ Rarely (<10% of the time)
- ◯ Occasionally (about 30% of the time)
- ◯ Sometimes (about 50% of the time)
- ◯ Frequently (about 70% of the time)
- ◯ Usually (about 90% of the time)
- ◯ All the time
- ◯ Not applicable

29. What do you use as a back-up to radios when operating in a “dead zone”?*Check all that apply.*

- [ ] Aircraft
- [ ] Cell phones
- [ ] Check in – Check out
- [ ] GPS locators (SEND/SPOT)
- [ ] Human repeaters
- [ ] Increased party size
- [ ] Other agency radio
- [ ] Satellite phones
- [ ] There is no backup
- [ ] Other
- [ ] Not applicable

30. What is the main obstacle or constraint to radio use for you as an employee?

- ◯ Dead zones/poor coverage
- ◯ Other mode of communication is better (e.g. smartphone)
- ◯ Radio system is unreliable
- ◯ System is too busy
- ◯ Radio is too difficult to use
- ◯ Radio is too bulky to carry
- ◯ No obstacles
- ◯ Other (please explain)

31. Please rate your level of preference for the following eight technologies.

	Very low preference	Low preference	Moderate preference	High preference	Very high preference
Aviation radio	◯	◯	◯	◯	◯
Basic cellular phone	◯	◯	◯	◯	◯
Smart phone/tablet	◯	◯	◯	◯	◯
GPS locator (SEND/SPOT)	◯	◯	◯	◯	◯
HANDHELD radio	◯	◯	◯	◯	◯
MOBILE radio	◯	◯	◯	◯	◯
Pager	◯	◯	◯	◯	◯
Satellite phone	◯	◯	◯	◯	◯

32. Should radio training be mandatory for all field-going employees?

◯ Yes

◯ No

◯ Don't know

33. Please rate the effectiveness of each type of radio training that you have received.
If you have not received a given type of training, please choose NOT APPLICABLE for that training type.

	NOT APPLICABLE	Not at all Effective	Somewhat Effective	Moderately Effective	Effective	Very Effective
Co-worker	◯	◯	◯	◯	◯	◯
Formal Classroom	◯	◯	◯	◯	◯	◯
Online	◯	◯	◯	◯	◯	◯
On-the-job	◯	◯	◯	◯	◯	◯
Safety Meeting	◯	◯	◯	◯	◯	◯
User's Manual	◯	◯	◯	◯	◯	◯
Other	◯	◯	◯	◯	◯	◯

2016 USFS Radio Use Questionnaire

6. Employee Information Questions

The following questions may be of a sensitive nature, hence we want to ensure you that your answers are completely confidential and anonymous. Answers to these questions will only be used to determine if we have a representative group of Forest Service employees. However, you are free to skip any question and to move on to the next question. Your responses are much appreciated. Thank you for your time!

34. Which of the following organizations are you associated with?

35. At what level do you work?

- ◯ Regional Office (RO)
- ◯ Supervisor's Office (SO)
- ◯ Ranger District (RD)
- ◯ Washington Office (WO)
- ◯ Washington Office (WO) Detached
- ◯ Other

36. What is your employment status?

- ◯ Permanent full time
- ◯ Permanent seasonal
- ◯ Temporary/term
- ◯ Volunteer
- ◯ Other

37. What is your duty station zipcode?

38. How many total years have you worked for the Forest Service?

39. What is your age in years?

40. What is your gender?

- ◯ Male
- ◯ Female

41. What is your level of education?

- ◯ Less than high school graduate
- ◯ High school graduate
- ◯ Some college/Associate degree
- ◯ Bachelor's degree
- ◯ Graduate degree

42. What pay plan are you under?

- ◯ GS
- ◯ WG
- ◯ SES
- ◯ AD

Other (please specify)

43. What is your grade level?

44. Please enter any additional comments concerning the USFS Radio Program here.

Thank you for taking the time to complete the 2016 USFS Radio Use Survey.

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