

Firefighter Health and Safety

June 2019

Directive

The Forest Service is directed to provide a report regarding its current and planned research on issues and risks related to firefighter health and safety in wildlands and wildland urban interface. The report should include detailed budget information and identify knowledge gaps and potential remedies to address them. (Explanatory Statement)

Summary

Current policies and recommendations for wildland firefighter health and safety are based on research studies focusing on smoke exposure, physical demands, heat stress, nutrition, and hydration status of this population of occupational athletes. The U.S. Department of Agriculture's (USDA) Forest Service, through its National Technology and Development Program (NTDP), has been studying these areas since the 1960s. This research was accomplished at NTDP, as well as through agreements with various institutions. References regarding a selection of studies relevant to wildland firefighter health and safety can be found at the end of this document.

Current Research

Current research includes analysis of heat stress during wildfire management activities and training, seasonal changes in fitness experienced by hand crews, and the risk of lung cancer and cardiovascular disease mortality due to smoke exposure. Several of these studies have manuscripts that are under peer review at this time—we expect them to be published at the end of 2019. Additionally, a website called “The Black” has been developed to serve as a centralized location for health and safety information for wildland firefighters (WLFFs) (<http://theblackperformance.net/>).

Budget

Under the direction of the U.S. Department of Agriculture's Forest Service, Fire and Aviation Management, NTDP allocated \$960,000 for wildland firefighter health and safety projects in fiscal year 2019. A large portion of this funding went to partnerships with various universities through agreements to conduct the research. The field evaluations scheduled to occur during the summer of 2019 include, as follows:

- Wildland Firefighter Exposure and Health Effects Evaluation (3-Year Duration). This is a cooperative effort with the National Institute of Occupational Safety and Health (NIOSH).
- Critical Training Physiological Stress Evaluation (2-Year Duration). This project documents the demands of training for an interagency hotshot crew.
- Evaluation of the current revision to the nutritional components of the Large Fire Food Contract. This project focuses on the nutritional needs of wildland firefighters assigned to long-duration incidents.
- Evaluation of the electrolyte needs of wildland firefighters during wildfire management activities.



Planned Research and Budget

Project Area	Budget
Continued development of content and user access to the website, "The Black." This consists of dynamic updates to this central location of resources and content catered to wildland firefighters to reduce injury rates during physical training and support physical and nutritional needs.	\$375,000
Continued evaluation of electrolyte needs of wildland firefighters.	\$106,000
Continued evaluation of hydration strategies during exercise in the heat.	\$61,000
Development of educational tools for employee health and WLFF feeding strategies.	\$37,000
Physiological adaptations to smoke exposure.	\$65,000

Research Opportunities and Knowledge Gaps

Current knowledge gaps and research needs consist of long-term health studies to document the cumulative effects of wildland firefighter activities such as fatigue, stress, smoke exposure, and level of fitness. A multitude of baseline studies have provided significant clarification on the demands of the occupation; however, the long-term effects on the employee are relatively unknown. Sound science will shape policies to improve and maintain wildland firefighters' health and safety.

Published Literature

Smoke Exposure

- Adetona O, Hall DB, Naeher LP. Lung function changes in wildland firefighters working at prescribed burns. *Inhal Toxicol*. 2011;23(13):835-841.
- Adetona O, Simpson CD, Onstad G, Naeher LP. Exposure of wildland firefighters to carbon monoxide, fine particles, and levoglucosan. *Ann Occup Hyg*. 2013;57(8):979-991.
- Broyles G. Wildland Firefighter Smoke Exposure. *US Forest Service*. 2013.
- Ferguson MD, Semmens EO, Dumke C, Quindry JC, Ward TJ. Measured Pulmonary and Systemic Markers of Inflammation and Oxidative Stress Following Wildland Firefighter Simulations. *J Occup Environ Med*. 2016;58(4):407-413.
- Peters B, Ballmann C, Quindry T, et al. Experimental Woodsmoke Exposure During Exercise and Blood Oxidative Stress. *J Occup Environ Med*. 2018;60(12):1073-1081.
- Reinhardt TE, Ottmar RD. Baseline measurements of smoke exposure among wildland firefighters. *J Occup Environ Hyg*. 2004;1(9):593-606.

Physical Demands

- Coker RH, Murphy CJ, Johannsen M, Galvin G, Ruby BC. Wildland Firefighting: Adverse Influence on Indices of Metabolic and Cardiovascular Health. *J Occup Environ Med*. 2019;61(3):e91-e94.
- Cuddy JS, Slivka DR, Tucker TJ, Hailes WS, Ruby BC. Glycogen levels in wildland firefighters during wildfire suppression. *Wilderness Environ Med*. 2011;22(1):23-27.
- Gaskill SE, Ruby BC, Lankford DE, Heil DP, Sharkey BJ. Effect of Submaximal VO₂ at the Ventilatory Threshold on Self-Selected Work Rate during Wildland Firefighting in Missoula, MT: USDA, USFS, National Technology and Development Program; 2003.
- Ruby BC, Shriver TC, Zderic TW, Sharkey BJ, Burks C, Tysk S. Total energy expenditure during arduous wildfire suppression. *Med Sci Sports Exerc*. 2002;34(6):1048-1054.



Sol J, Ruby B, Gaskill S, Dumke C, Fomitrovich J. Metabolic Demand of Hiking in Wildland Firefighting. *Wilderness Environ Med.* 2018;Sep(29(3)):304-314.

Heat Stress

Cuddy JS, Ruby BC. High work output combined with high ambient temperatures caused heat exhaustion in a wildland firefighter despite high fluid intake. *Wilderness Environ Med.* 2011;22(2):122-125.

Cuddy JS, Sol JA, Hailes WS, Ruby BC. Work patterns dictate energy demands and thermal strain during wildland firefighting. *Wilderness Environ Med.* 2015;26(2):221-226.

Nutrition

Cuddy JS, Slivka DR, Tucker TJ, Hailes WS, Ruby BC. Glycogen levels in wildland firefighters during wildfire suppression. *Wilderness Environ Med.* 2011;22(1):23-27.

Cuddy JS, Gaskill SE, Sharkey BJ, Harger SG, Ruby BC. Supplemental feedings increase self-selected work output during wildfire suppression. *Med Sci Sports Exerc.* 2007;39(6):1004-1012.

Hydration

Cuddy JS, Ham JA, Harger SG, Slivka DR, Ruby BC. Effects of an electrolyte additive on hydration and drinking behavior during wildfire suppression. *Wilderness Environ Med.* 2008;19(3):172-180.

Ruby BC, Schoeller DA, Sharkey BJ, Burks C, Tysk S. Water turnover and changes in body composition during arduous wildfire suppression. *Med Sci Sports Exerc.* 2003;35(10):1760-1765.

