DoD Natural Resources Program

Enabling the Mission, Defending the Resources

DoD Wildfire Hazard Assessment

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DoD Wildfire Hazard Assessment

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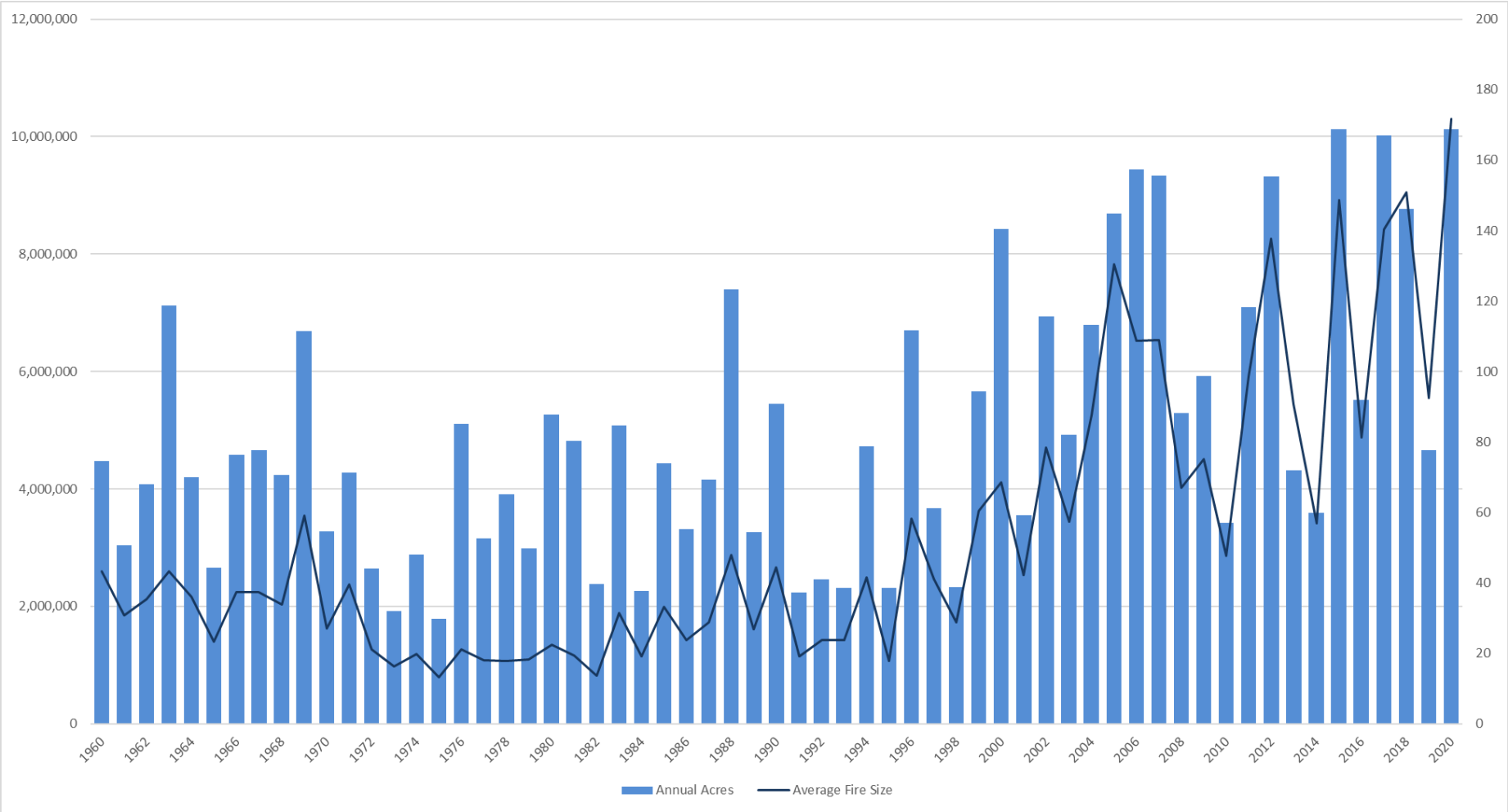Center for Environmental Management of Military Lands

Legacy Project #16-788

Overview

- ▶ Brief National and Military Wildfire Trends Background

- ▶ Purpose of the Study

- ▶ Methodology

- ▶ Results

- ▶ Conclusions

- ▶ Questions

National Wildfire Occurrence

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Military Context

▶ Within the military, no reliable wildfire data exists. Fire data collected by installations varies in completeness, quality, and variables tracked.

▶ Wildfires impact installation infrastructure, training resources, natural and cultural resources, and neighboring communities. Impacts sometimes lead to lost training time and/or capability.

▶ National fire statistics for the military are lacking making data-driven decision about the distribution of limited fire management resources difficult.

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Purpose

▶ Help fill the data gap.

▶ Provide information to regional and national level fire managers with which to inform decisions about funding and resourcing installation wildland fire programs.

▶ Triage installations, both within each military branch and across all of DoD, based on their exposure to historical wildfires.

▶ Intended as one factor within a larger decision-making framework.

▶ This study is not a 'risk' assessment, it does not account for the values that could potentially be impacted by a fire.

General Approach

- Use 11 years of Landsat differenced normalized burn ratio (dNBR) to identify wildland fires at Air Force, Army, Navy, and Marine Corps installations.

- Analyzed 145 installations chosen based on perceived fire exposure and discussion with military branch representatives.

Number of installations included in the analysis from each DoD Service Branch

Air Force	Army	Navy	Marine Corps	Total
40	54	37	14	145

- Defined a study area including the installation and a 5-mile buffer around it to account for the potential for off-installation fires to impact the installation.

- Use a decision tree approach to separate prescribed fires from wildfires with >80% accuracy. Prescribed fires were removed from the analysis.

- Utilize a set of 10 metrics to establish the characteristics of fires occurring at each installation.

- Use normalized measures of these metrics to compare installations and triage them within each military branch, as well as across all four branches.

Landsat Fire Detection

- dNBR is routinely used to delineate wildland fires. We largely followed the methods of the national Monitoring Trends in Burn Severity (MTBS) program with two key differences.

  - We did not restrict our fire detection to reported fires as the MTBS program does.

  - We did not restrict our fire detection to the acreage limits of the MTBS program.

- Automated a process to carry out initial detection and perimeter delineation of fires. A Remote Sensing Analyst reviewed these and edited, added, or deleted perimeters as necessary.

- Fires were attributed with their detection date, whether they were inside, outside, or crossed the installation boundary, and the fire type (prescribed or wildfire).

Landsat Detection Limitations

- Small fires, low severity fires, and fires under dense canopy can go undetected.

- Cloud cover can mask fires if it is present for multiple satellite passes (once every 16 days).

- Our data is therefore effectively a sample of fires at each installation with a known bias towards larger and more severe fires. The intent was not to detect every fire, or even most fires, but to create a consistent and comparable sample set of data across all installations representative of fire activity.

Landsat Data Example – Camp Pendleton

Fire Detections

► Detected 20,912 fires, of which 5,291 were determined to be wildfires.

► 1,046 were entirely outside the installation boundary, but at least partially within the 5-mile buffer.

► 113 fires were transboundary.

► 4,132 fires were detected that were entirely within installation boundaries.

► Again, the purpose was not to detect all fires, but to create a sample of fires that is consistent and comparable across installations.

Hazard Metrics

We defined 10 metrics used to characterize wildfire activity at each installation.

- Total count of all wildfires inside the installation.

- Median count per year of wildfires inside the analysis area

- Total count of large wildfires inside the installation

- Proportion of all wildfires inside the installation that are large

- Total count of wildfires inside the installation close to the boundary

- Total count of transboundary wildfires

- Median fire size across the analysis area

- 90th percentile fire size across the analysis area

- Total wildfire acreage within the installation boundary

- Overall proportion of installation area burned by wildfire

Analysis

- Identified outliers for each metric in each dataset independently (each of the service branches and DoD-wide) to avoid skewing the results, which are dependent on proportionate relationships. Outliers were assessed subjectively.

- Metrics for the remaining installations were normalized on a scale of 0-1.

  - Within each dataset, the maximum installation value observed was assigned the value of 1 with all others proportionately tiered off of that value.

  - The intent is to compare installations relative to one another on a proportionate scale.

  - Normalizing the data also allows us to compare metrics with different units.

- Some metrics could be sensitive to installation size. A linear correlation analysis was used to test this and no metrics were found to be strongly correlated with installation size, though there was moderate correlation in several cases.

Results – Example of Proportionate Measures of Two Metrics
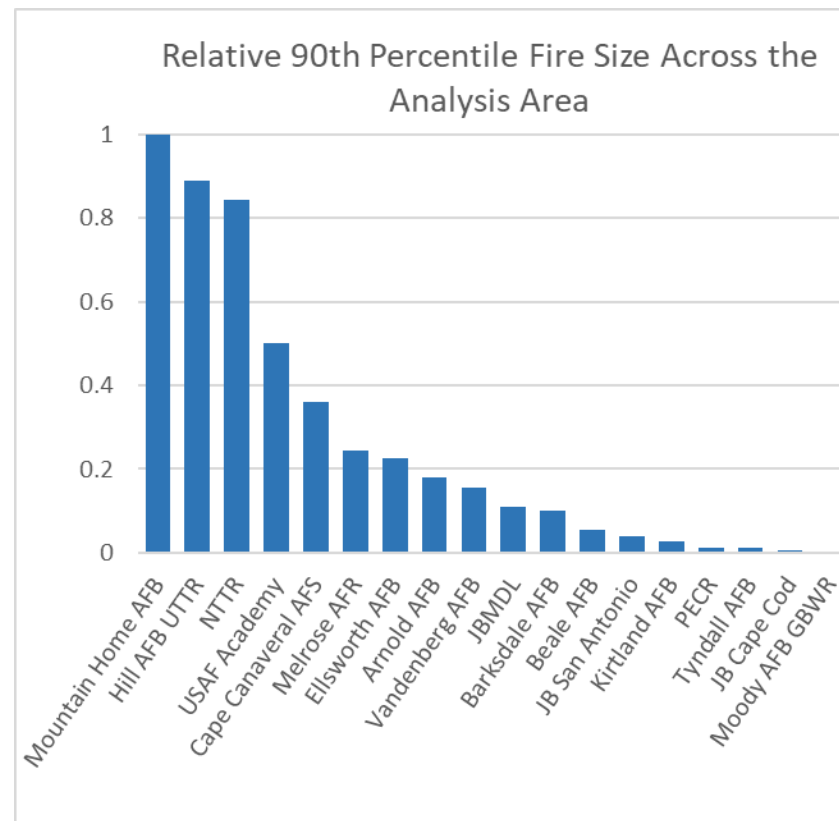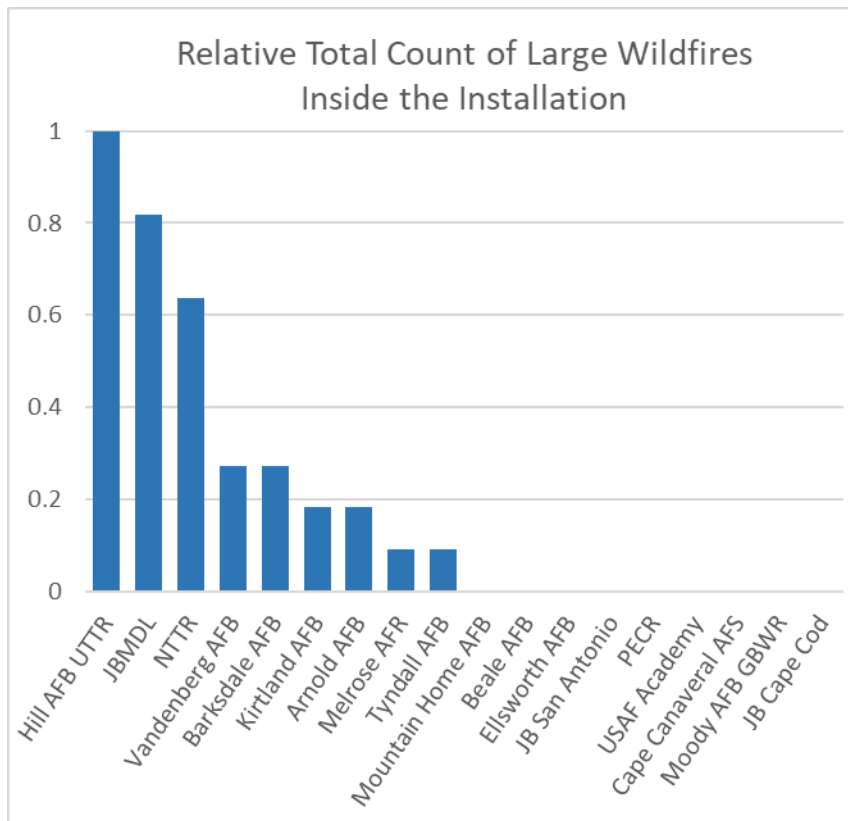
Analysis

▶ Used K-means clustering to group installations by metric similarity.

▶ Used Kruskal-Wallis and Dunn's post hoc tests to determine the statistical validity of each metric for separation among clusters.

▶ Each group was then assigned a low, moderate, or high hazard classification based on the metric values of the group.

▶ Installations where no fires were detected anywhere in the study area were assigned to a negligible category as were installations with fires inside the 5-mile buffer but completely outside the installation boundary.

▶ Reviewed each installation against their group's classification and subjectively refined the classifications. Outlier installations were assessed in a similar manner.

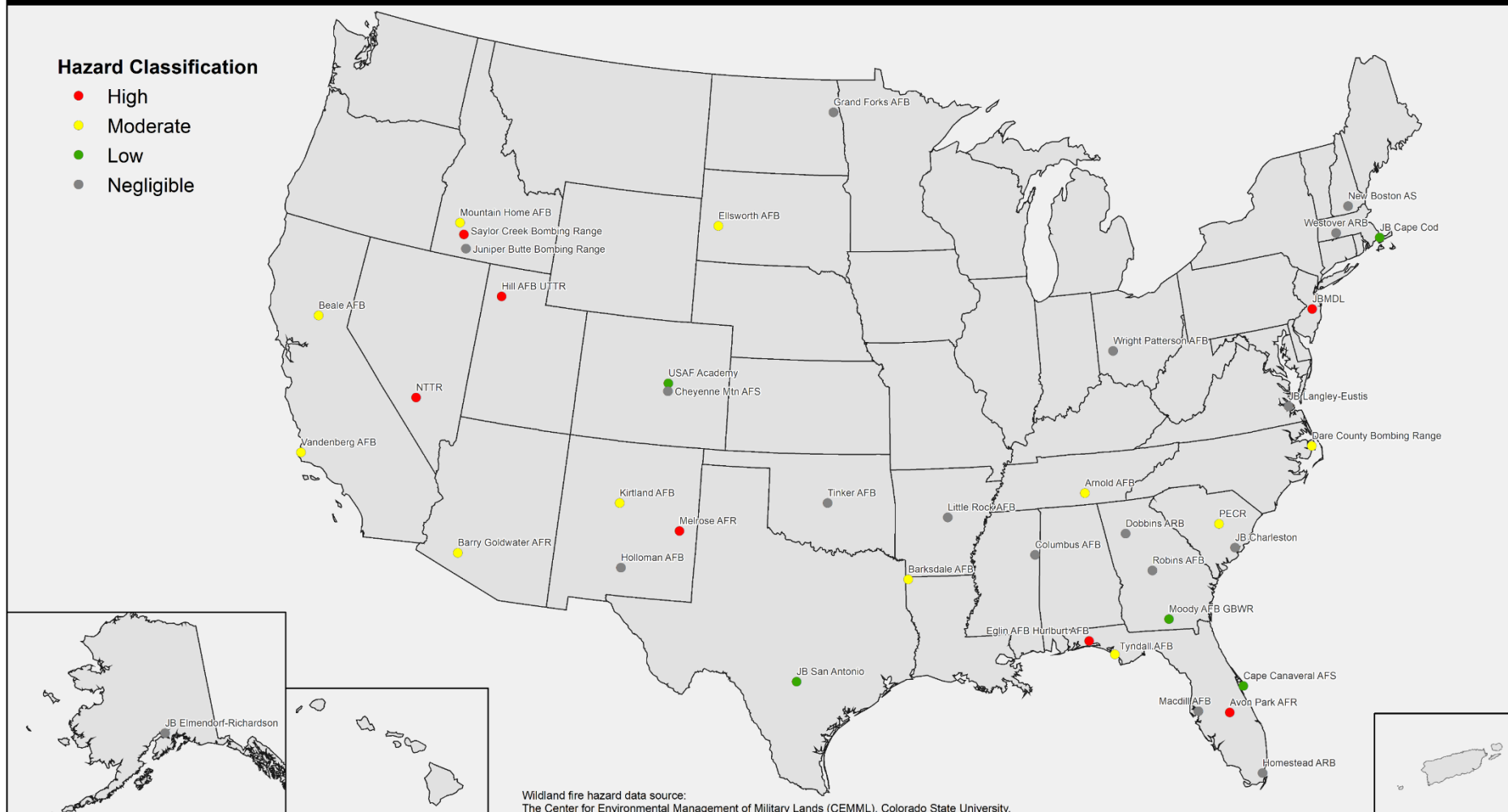# Results – Example K-Means Clusters for Two Metrics
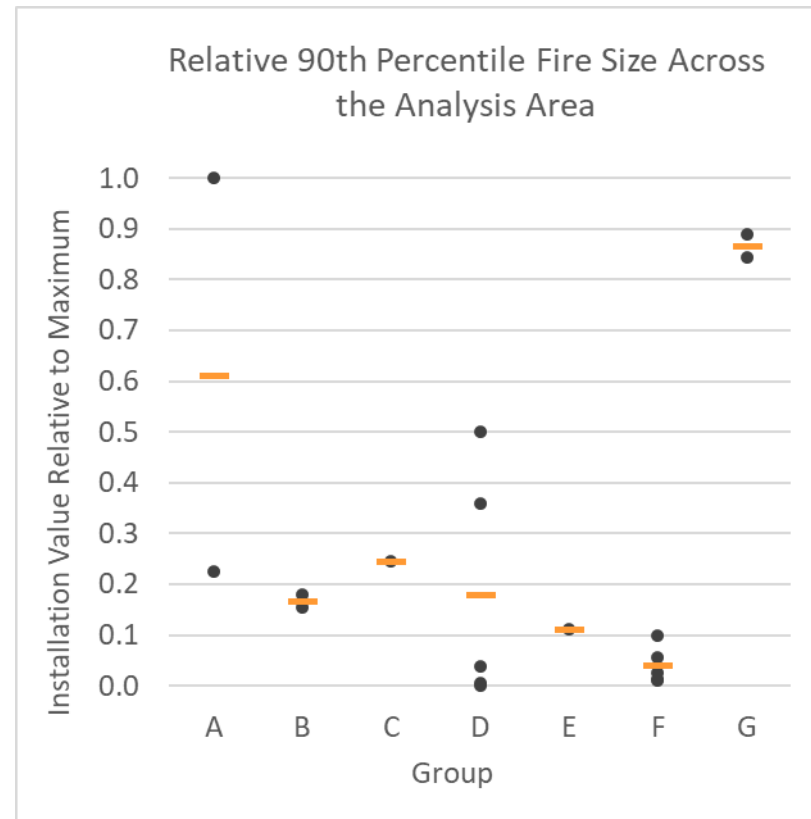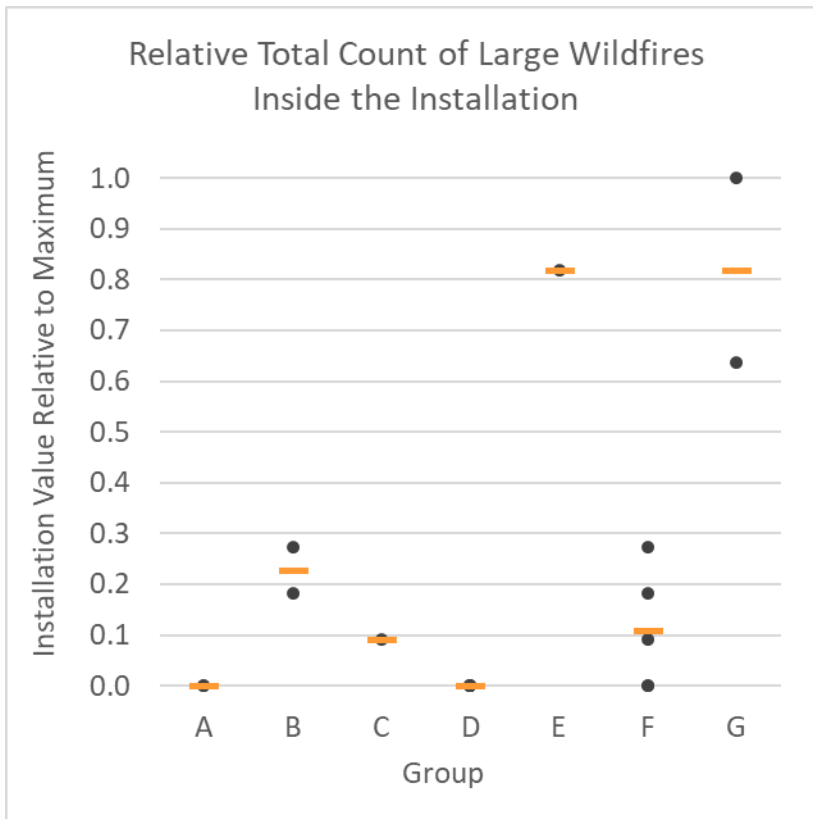
Results – Example of Air Force Triage

HIGH	MODERATE	LOW	NEGLIGIBLE
AVON PARK AFR*	ARNOLD AFB	CAPE CANAVERAL AFS	CHEYENNE MTN AFS
EGLIN AFB HURLBURT AFB*	BARKSDALE AFB	ELLSWORTH AFB	COLUMBUS AFB
HILL AFB UTTR	BARRY GOLDWATER AFR*	JB CAPE COD	DOBBINS ARB
JB MCGUIRE DIX LAKEHURST	BEALE AFB	JB SAN ANTONIO	GRAND FORKS AFB
MELROSE AFR	DARE COUNTY BOMBING RANGE*	MOODY AFB GRAND BAY	HOLLOMAN AFB
NTTR	KIRTLAND AFB	USAF ACADEMY	HOMESTEAD ARB
SAYLOR CREEK BOMBING RANGE*	MOUNTAIN HOME AFB		JB CHARLESTON
	PECR		JB ELMENDORF RICHARDSON
	TYNDALL AFB		JB LANGLEY FORT EUSTIS
	VANDENBERG AFB		JUNIPER BUTTE BOMBING RANGE
			LITTLE ROCK AFB
			MACDILL AFB
			NEW BOSTON AS
			ROBINS AFB
			TINKER AFB
			WESTOVER ARB
			WRIGHT PATTERSON AFB

Cross-Branch High Hazard Installations

Avon Park AFR

Camp Pendleton

Eglin AFB/Hurlburt AFB

Fort Benning

Fort Bliss

Fort Bragg

Fort Campbell

Fort Hood

Fort Polk

Fort Sill

Fort Wainwright

Saylor Creek BR

Yakima Training Center

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▶ These represent installations from the Air Force, Army, and Marine Corps, with the bulk from the Army.

▶ These installations had some of the highest individual metric values in the study as well as numerous metrics that were high or moderate.

▶ These installations were the most likely to experience:

  ▶ Numerous wildfires

  ▶ Large wildfires

  ▶ Transboundary wildfires

  ▶ Some combination thereof

Cross-Branch Moderate Hazard Installations

Aberdeen Proving Ground

Barry Goldwater AFR

Camp Lejeune

Camp Parks

Dare County BR

Dugway Proving Ground

Ellsworth AFB

Fort AP Hill

Fort Carson

Fort Drum

Fort Gordon

Fort Huachuca

Fort Hunter Liggett

Fort Jackson

Fort Riley

Fort Rucker

Fort Stewart

Hill AFB/UTTR

JBLM

Melrose AFR

Mountain Home AFB

NAWS China Lake

NTTR

NWS Seal Beach Det. Fallbrook

NWSTF Boardman

Pinecastle Range

Pinon Canyon

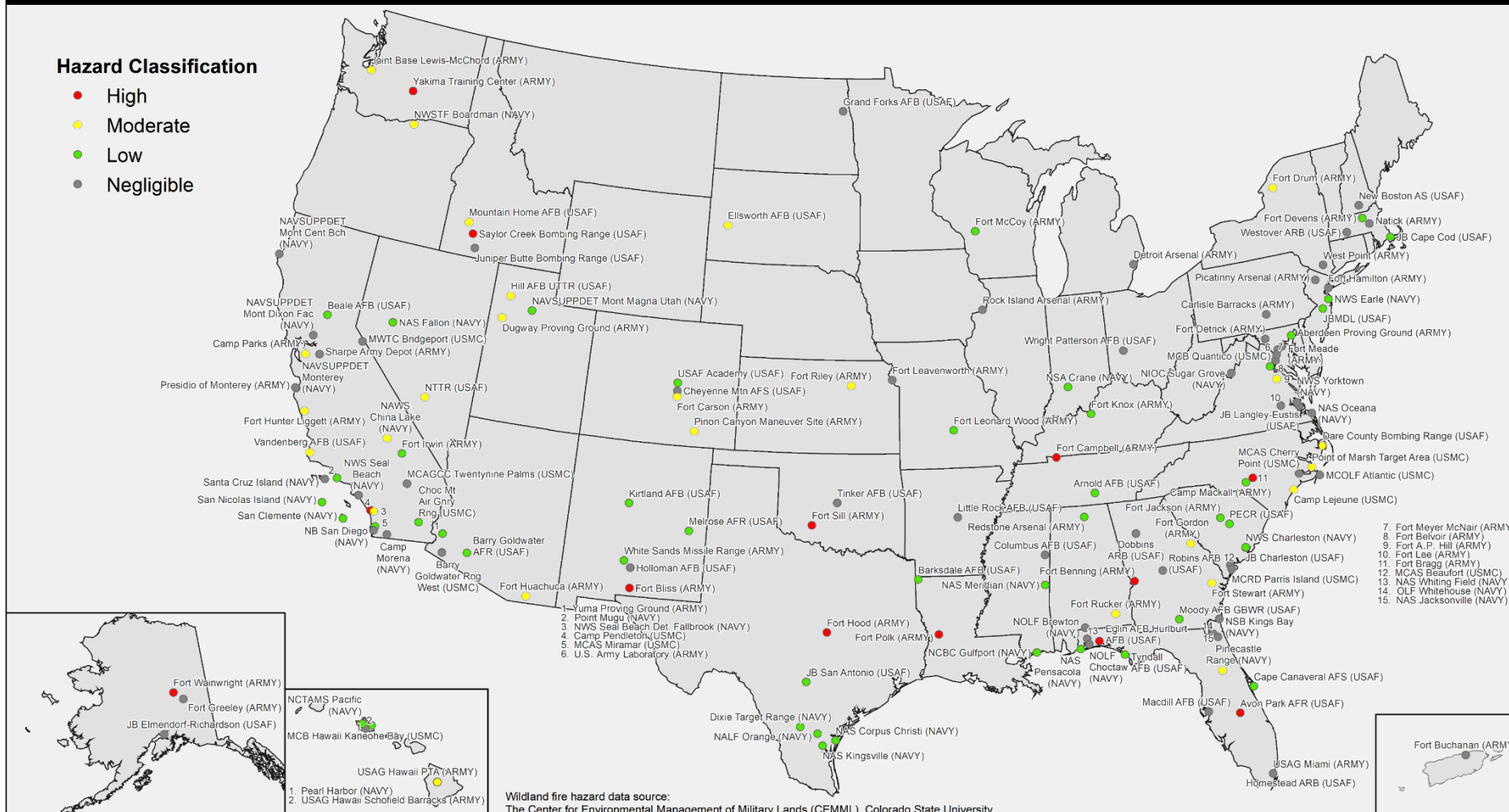Point of March Target Area

USAG Hawaii PTA

Vandenberg AFB

White Sands Missile Range

▶ These represent installations from every branch.

▶ Elevated values for multiple metrics

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Cross-Branch

Wildfire Hazard Classification

Hazard Classification
- High
- Moderate
- Low
- Negligible

Wildland fire hazard data source:
The Center for Environmental Management of Military Lands (CEMML), Colorado State University.

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Cross-Branch Comparisons

		Army	Air Force	Navy	Marine Corps
Proportion of All Installations		0.37	0.28	0.26	0.10
Cross-Branch Proportion	High	0.69	0.23	0.00	0.08
	Moderate	0.55	0.26	0.13	0.06
	Low	0.23	0.30	0.38	0.10
	Negligible	0.31	0.28	0.30	0.11

▶ All else being equal, the proportion of each branch's installations in each category should equal the proportion of the branch's installations in the entire analysis.

▶ Deviations indicate a disproportionate level of wildfire hazard.

Conclusions

- The Army contains a disproportionate number of installations categorized as high or moderate hazard.

- Navy installations were disproportionately categorized as low or negligible.

- In every analysis in this study, more installations fell into the negligible category than into any other category – from 35% to 46%.

- At every installation in the low through high categories, at least one fire had burned on the installation, representing a realized fire hazard. At least a minor wildfire hazard exists at all of these installations.

- Installations in the same category may be categorized as such for very different reasons – e.g. many small to moderate size fires versus large but rare fires. The mitigation measures necessary, their effectiveness, and their cost are likely to vary as well.

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Additional Context

- This study presents a starting point for additional investigation into those installations in the high and moderate categories. This initial ranking, allows a data-driven focus on those installations that are likely most deserving of additional attention.

- Installations in the low and negligible categories may not require additional fire mitigation measures, but may also be in these categories because of existing successful fire mitigation programs.

- Mitigating the hazards at moderate rated installations without major disruptions to the mission may be more straightforward, and possibly more cost-effective, than mitigation at high-hazard installations where interrupting the connection between the mission and fires may require extensive intervention.

- There are elements beyond wildfire hazard to consider when determining the level of wildland fire support an installation may require, particularly prescribed fire needs that may reduce the hazard, but are often implemented to support INRMP objectives.

The Big Picture

- Wildfire mitigation resources and funding are finite.

- Wildfire is inherent in the military mission.

- Protecting the military mission requires applying those limited resources as efficiently as we can.

- These results are intended to be utilized as one component in decisions regarding the distribution of those resources.

Special Thanks

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- CEMML Staff:
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Questions