CAMP RIPLEY
SENTINEL LANDSCAPE

Parcel-Level Resilience Assessment Using GIS: A Sentinel Landscape Case Study at Camp Ripley

Kayli Overland: Camp Ripley Sentinel Landscape Coordinator
Destiny McDonald: Easement Coordinator
Raenah Bailey, Ph.D.: Midwest Resilience Specialist

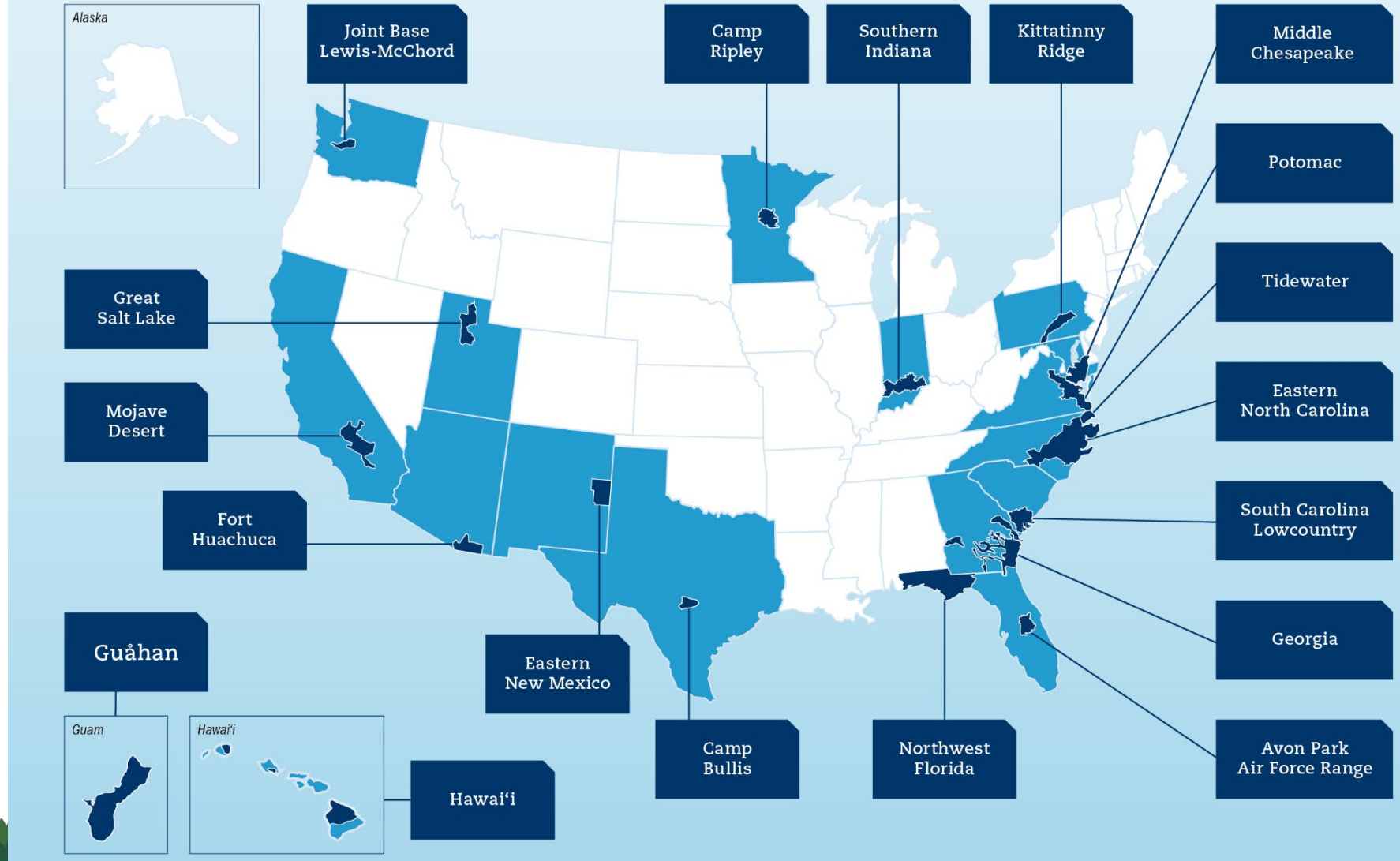
SENTINEL LANDSCAPES

CAMP RIPLEY
SENTINEL LANDSCAPE

Sentinel Landscapes Mission Statement

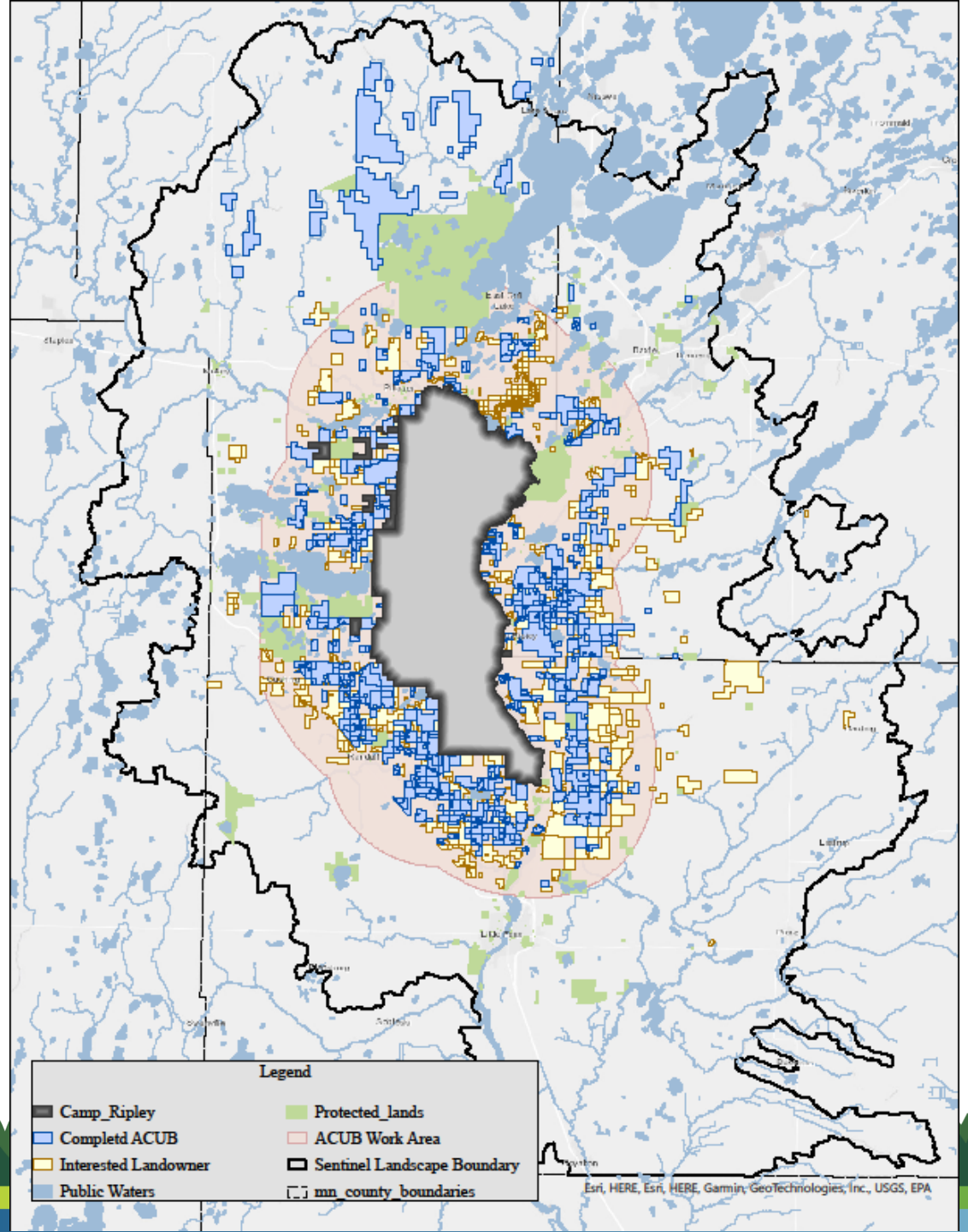
Sentinel Landscapes are working or natural lands important to the Nation's defense mission–places where preserving the working and rural character of key landscapes strengthens the economies of farms, ranches, and forests; conserves habitat and natural resources; and protects vital testing and training missions conducted on those military installations that anchor such landscapes.

SENTINEL LANDSCAPES

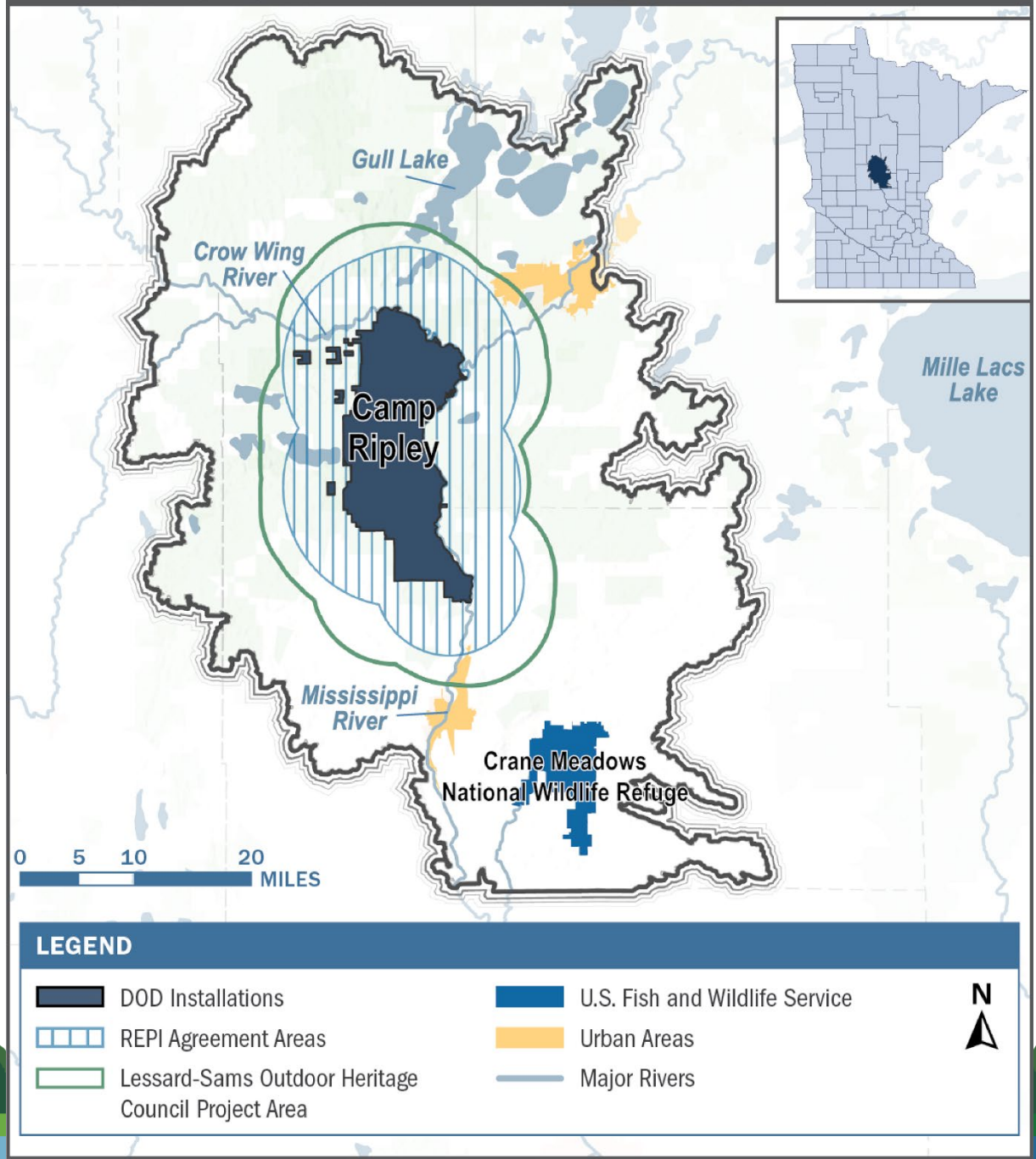


CAMP RIPLEY
SENTINEL LANDSCAPE

- *The term "resilience" means the capability to avoid, prepare for, minimize the effect of, adapt to, and recover from extreme weather events, flooding, wildfire, or other anticipated or unanticipated changes in environmental conditions*



Camp Ripley Sentinel Landscape Map



Our Story

2004

The creation of Camp Ripley's Army Compatible Use Buffer (ACUB) Program

2006

Board of Water and Soil Resources (BWSR) begins ACUB Reinvest in Minnesota (RIM) Easement program

2011

First State funded match contribution by Lessard-Sams Outdoor Heritage Council (LSOHC)

2015

State Sentinel Landscape Designation

2016

Federal Sentinel Landscape Designation

Coordination

Thank You

- **Kayli Overland**
- Camp Ripley Sentinel Landscape Coordinator
- (c) 218-820-4561
- Kayli@legacyworksgroup.com

LEGACYWORKS GROUP

CAMP RIPLEY SENTINEL LANDSCAPE | USDA

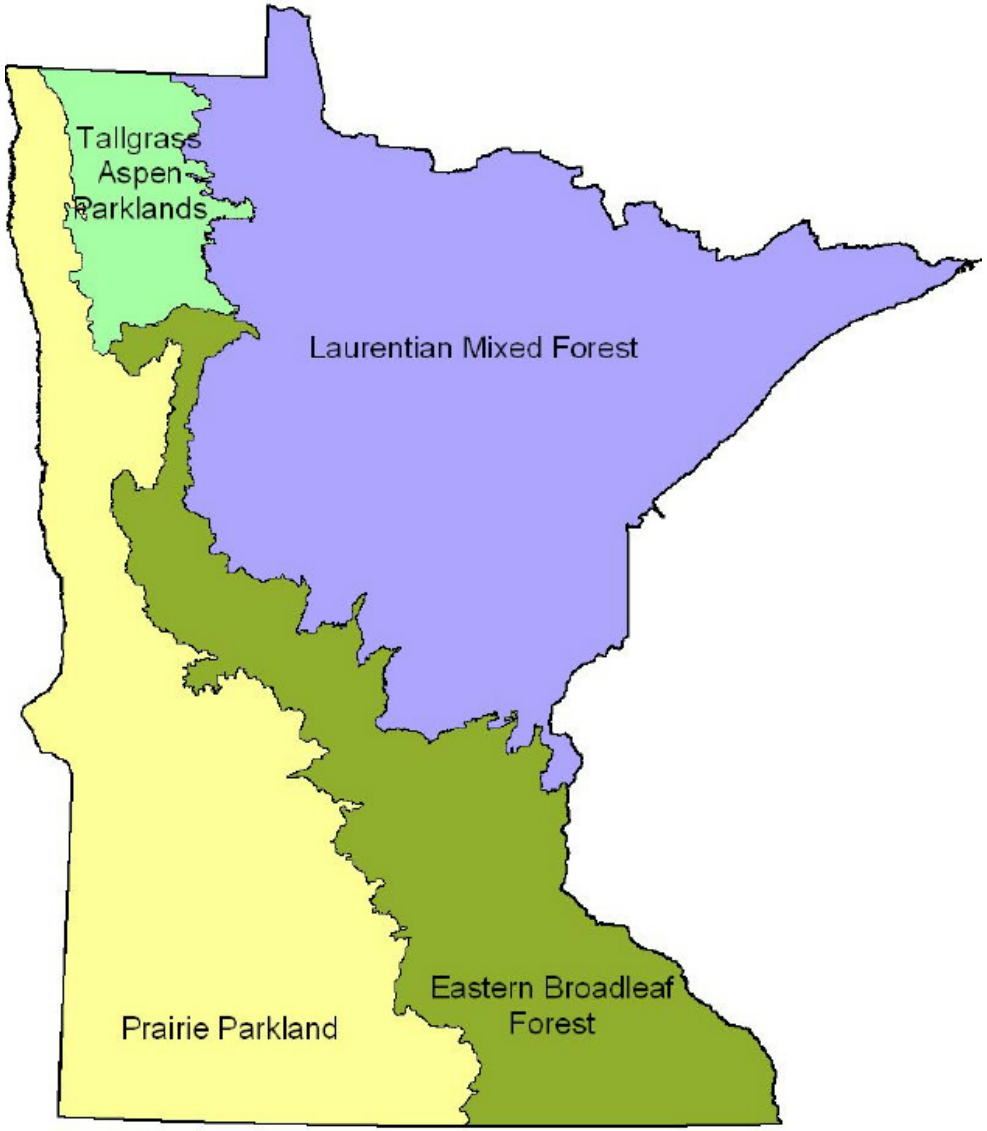
Army Compatible Use Buffer (ACUB)

PRESERVING FARMS AND PROTECTING FORESTS

Unique and Diverse Landscape

The Camp Ripley Sentinel Landscape is home to many species, including:

- Federal Endangered (1)
- Federal Threatened (1)
- State Endangered (6)
- State Threatened (13)
- State Special Concern (36)

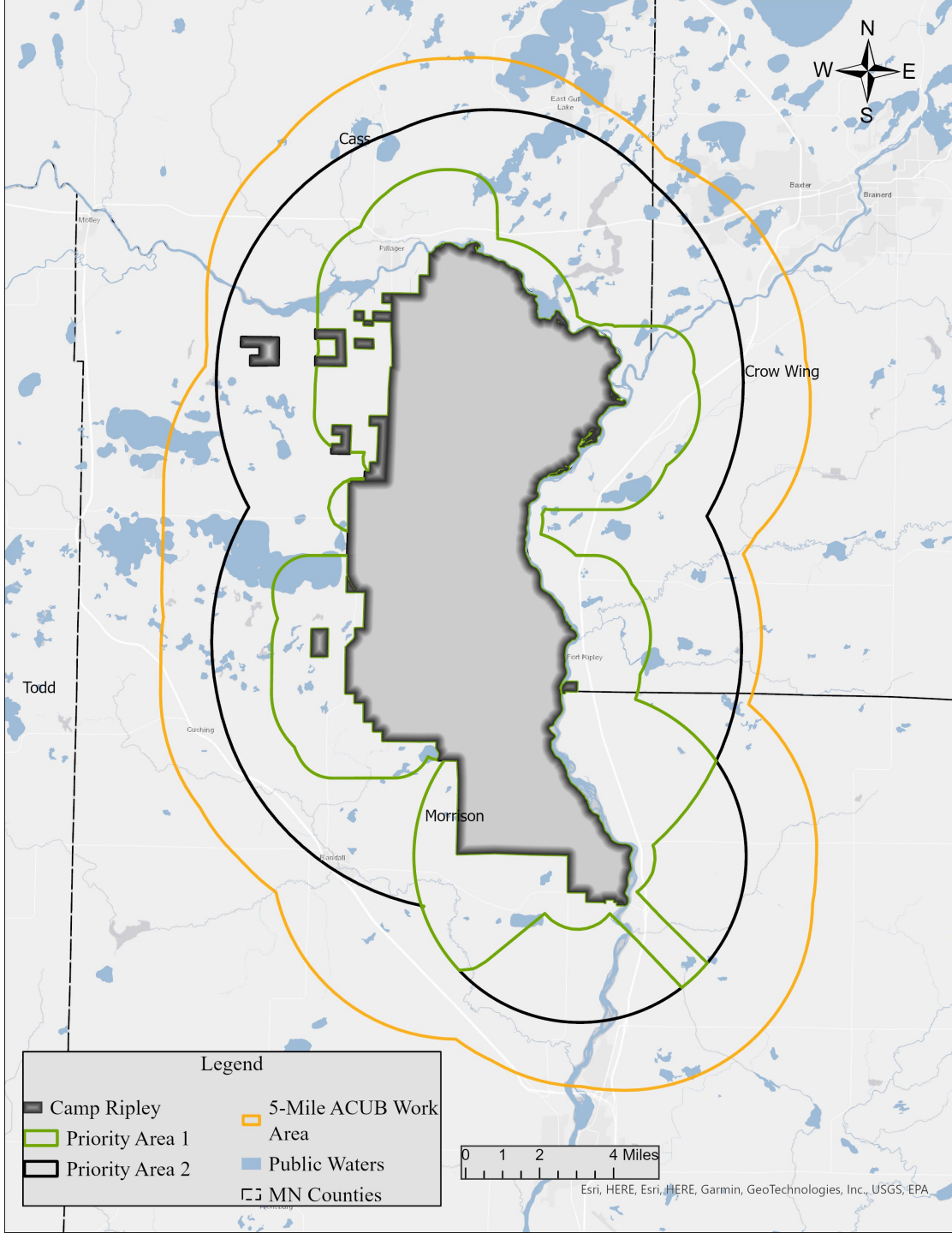


1 Program
2 Easement Types

- Federally funded ACUB easements protect working lands. This allows agricultural lands to remain in production, while maintaining the area's rural character.
- State funded ACUB easements are focused on quality habitat protection, with a goal to create habitat corridors and connectivity across the landscape.

Authorized Work Areas

- Priority Area 1 (Green) was created based on firing range noise contour zones and training flight paths
- Priority Area 2 (Black) an approximate 3-mile buffer around the base.
- The State Funding Work Area (Gold) is an approximate 5-mile buffer around the base



Ranking Process

Because of the difference in funding source and priorities, each type has its own ranking system.

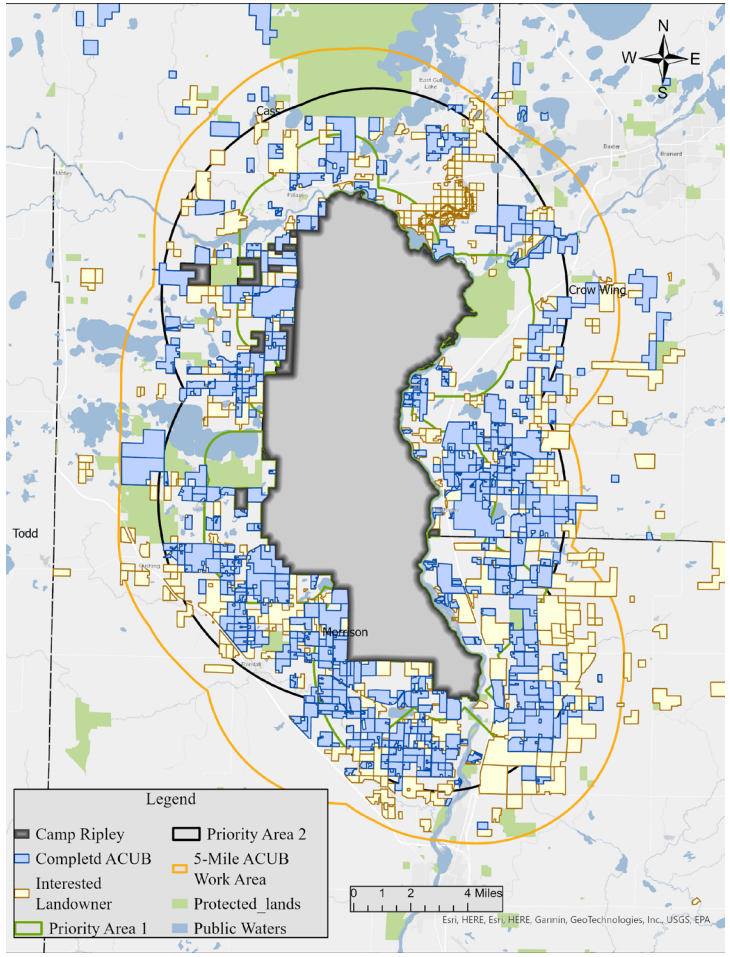
Federal ACUB parcels are ranked by installation staff based on criteria like:

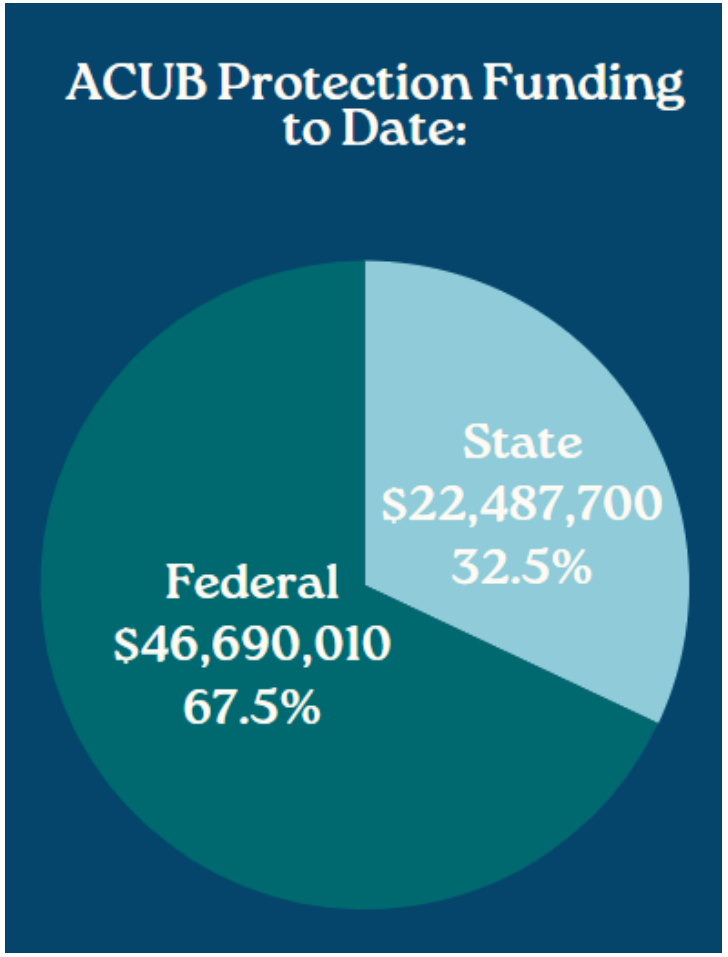
- Proximity
- Parcel size
- Flight operations
- Noise Contours
- And some land use criteria

State funded parcels are ranked by SWCD staff using a weighted scoresheet with criteria like:

- Biological significance
- Adjacency to protected lands
- Habitat value
- Cultural resources present
- And percent of tract developable

Program Success





April 2025

- Easements Completed: **368**
- Acres Protected: **37,736.1**
- Interested Landowners awaiting funding: **399**

New funding & New Opportunity

This money provides the opportunity to fund parcels that have been historically overlooked with the other ranking systems. Particularly:

- Smaller farming operations
- Wetland and water storage parcels
- Mixed land use types

We knew we needed a tool that would rank parcels in the landscape for resiliency criteria and provide justification for selection.

Thank you!

Destiny McDonald (Mankowski)
Easement Coordinator
(320) 631-3558
destiny.mcdonald@morrisonswcd.org
16776 Heron Rd. Little Falls, MN 56345
morrisonswcd.org

MORRISON SOIL & WATER

Mission: To provide leadership and direct assistance for conservation management of soil and water

CAMP RIPLEY
SENTINEL LANDSCAPE

Parcel-Level Resilience Assessment Using GIS: A Sentinel Landscape Case Study at Camp Ripley

Overview

- The Camp Ripley Sentinel Landscape Resilience Project applies GIS-based modeling to assess parcel-level vulnerabilities and strengths across five climate hazards.
- Supports the REPI mission to enhance military installation resilience and conservation outcomes.

Resilience Scoring Framework

Adaptation of the DoD Extreme Conditions Assessment Tool for parcel-scale analysis.

Integration of multiple geospatial indicators into weighted composite scores per hazard.

Why GIS? From Data to Resilience

- Integrates land cover, hydrology, soils, topography, and climate into one analysis
- Enables parcel-level insight for transparent, repeatable scoring
- Translates complex science into clear, mappable action
- Supports resilience planning that is place-based and scalable
- Bridges the gap between data, decisions, and storytelling

The Anatomy of a Resilience Tool

1. Select hazards to assess

2. Choose metrics linked to resilience

3. Use zonal statistics for parcel scoring

4. Combine scores into composite indices

5. Map patterns to guide decisions

Hazards Evaluated

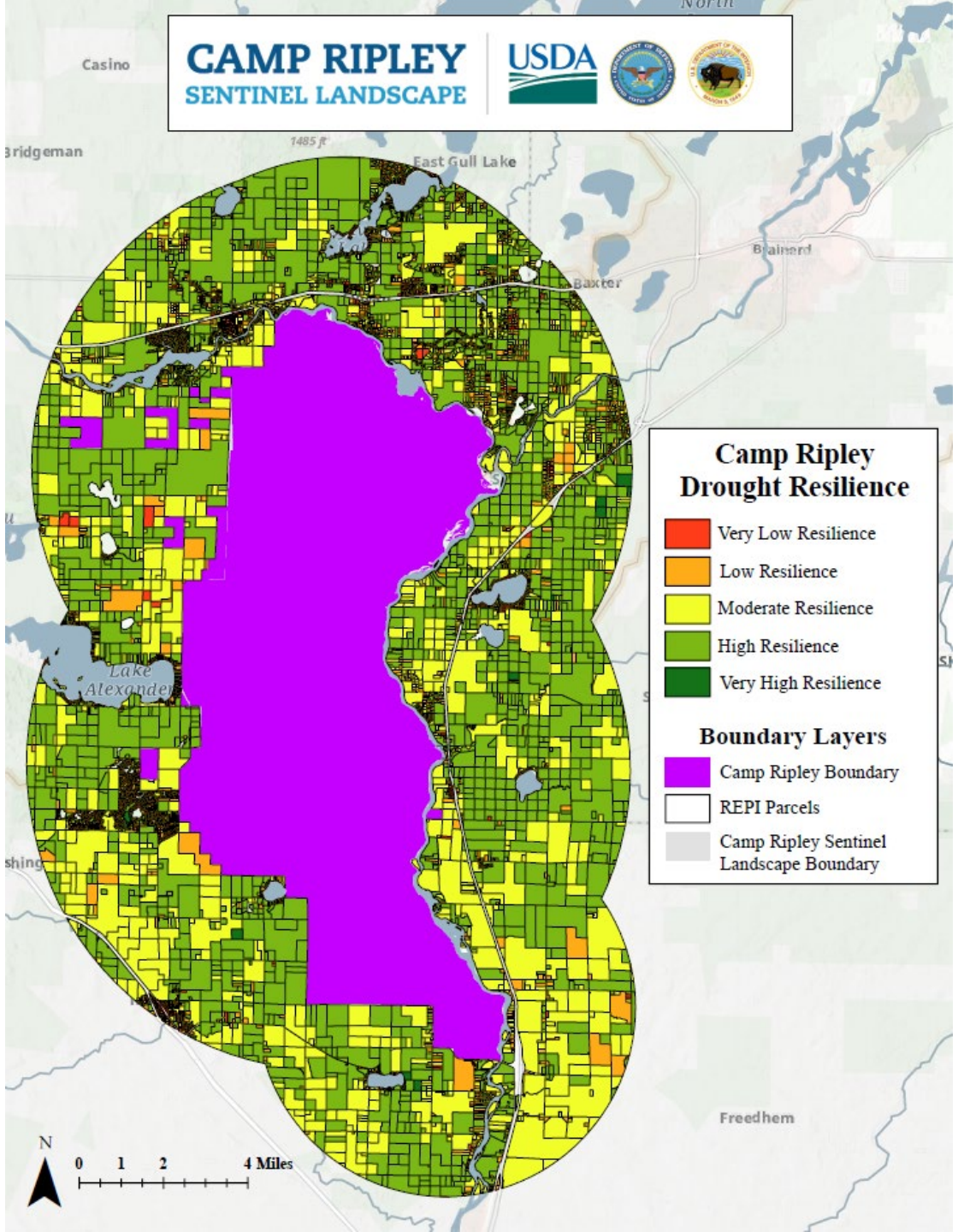
- Drought
- Extreme Temperature
- Riverine Flooding
- Wildfire
- Land Degradation

Drought Resilience – Methods

METRIC	WEIGHT	RATIONALE
Proximity to Wetlands	10%	Parcels closer to wetlands benefit from hydrologic buffering that reduces vulnerability to drought stress.
Wetland Restorable Index	5%	Areas suitable for wetland restoration provide opportunities to expand water storage capacity on the landscape.
Dominant Hydrological Soil Group	30%	Soils with higher infiltration rates enhance groundwater recharge and sustain soil moisture, directly improving a parcel's ability to withstand prolonged dry periods.
Drought-Tolerant Vegetation	25%	Drought-tolerant species such as native grasses and deep-rooted woody plants reduce evapotranspiration losses and maintain ecosystem function under water stress.

Drought Resilience – Methods

METRIC	WEIGHT	RATIONALE
Proximity to High Recharge Areas	10%	Parcels near high recharge zones are more likely to benefit from subsurface water movement.
Groundwater Recharge Rate	15%	High-recharge areas help sustain baseflows and aquifers during droughts, providing a reliable water source for ecosystems and human use.
Land Cover Conversion	5%	Conversion from natural vegetation to impervious or intensively managed land reduces infiltration, canopy interception, and evapotranspiration regulation.
Streamflow Permanence	Multiplier	Watersheds with higher permanence are better able to buffer ecological and water supply impacts during extended dry periods.



Drought Resilience – Results

Higher Resilience:

- Clusters along the Mississippi River corridor, extending beyond the floodplain
- Concentrated around large wetland complexes inside and near the boundary

Lower Resilience:

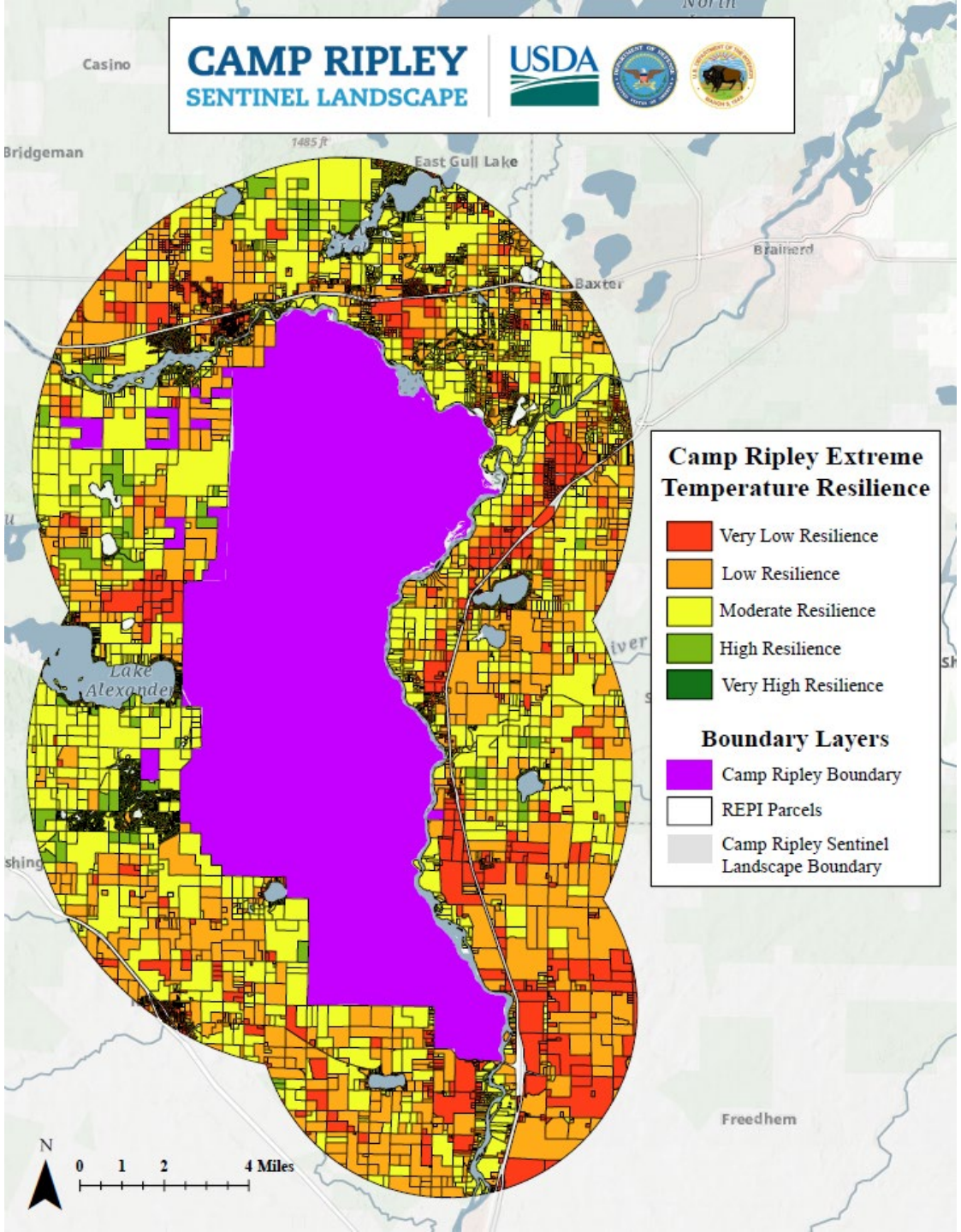
- Scattered low-resilience parcels on the outer edges of the landscape
- Hotspots along developed corridors, transportation routes, and urban edges
- Agricultural areas near towns

METRIC	WEIGHT	RATIONALE
Combined Topographic Factor Score	10%	Elevation, slope, and aspect regulate solar radiation and airflow. Higher elevations and north/northeast slopes remain cooler due to reduced sun exposure, while moderate slopes improve drainage.
Tree Canopy Cover	35%	Tree canopy is the strongest parcel-scale driver of cooling, reducing heat stress by providing shade, lowering surface temperatures, and mitigating the urban heat island effect. Through evapotranspiration, trees cool the air & enhance soil moisture retention, stabilizing local microclimates.
Available Water Storage	25%	Soils with higher AWS retain moisture that sustains evapotranspiration, cools the air, and stabilizes vegetation. Drier soils amplify heat extremes, while wetter soils dampen them, making AWS a critical factor in resilience to temperature extremes.

Extreme Temperature Resilience – Methods

Extreme Temperature Resilience – Methods

METRIC	WEIGHT	RATIONALE
Proximity to Water Bodies	10%	Water bodies moderate extreme temperatures by absorbing heat during the day and releasing it at night, creating stable microclimates. Evaporation from lakes, rivers, and wetlands cools surrounding areas, but the influence is distance-limited.
Percent Impervious Surface	15%	Impervious surfaces directly drive local heating by storing and re-radiating solar energy while suppressing infiltration and evapotranspiration. The strong positive correlation between impervious fraction and heat makes this a key factor, second only to canopy and soil moisture, and complementary to the cooling role of vegetation.
Land Cover Conversion	5%	Land cover transitions (e.g., forest → developed) intensify heating by removing vegetation and introducing impervious surfaces.



Extreme Temperature Resilience – Results

Higher Resilience:

- North-facing forested slopes remain cooler with canopy shade
- Parcels near water & wetlands benefit from localized cooling
- Dense, mature forest canopy reduces heating & buffers extremes

Lower Resilience:

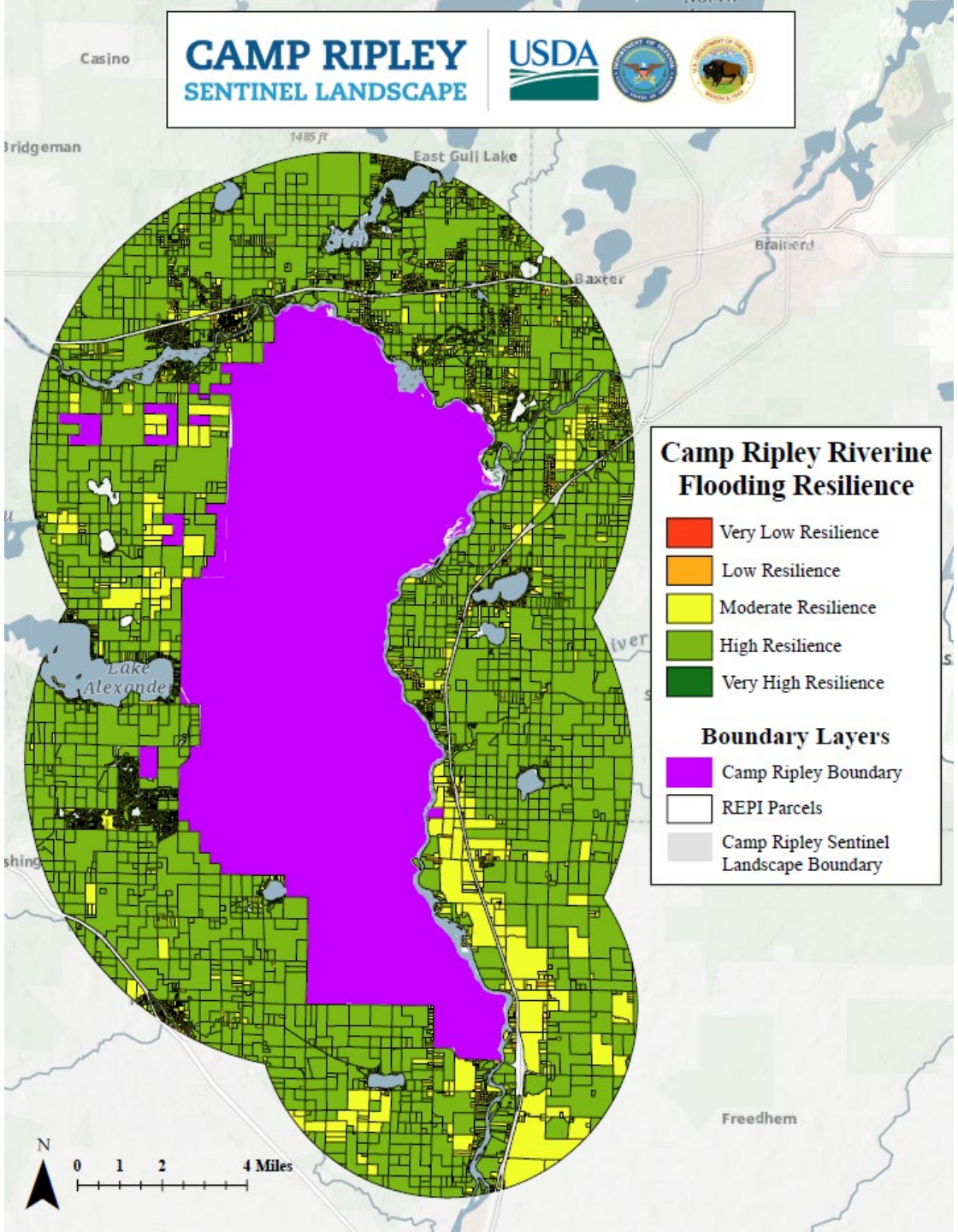
- Agricultural fields with exposed soils and low vegetation diversity
- Open grasslands and recently converted lands with limited shade
- Parcels farther from lakes and wetlands lacking microclimate buffering
- Edges & fragmented areas with reduced canopy and land conversion

Riverine Flooding Resilience – Methods

METRIC	WEIGHT	RATIONALE
Proximity to Wetlands	20%	Parcels close to wetlands directly benefit from these hydrologic functions, reducing flood peaks and buffering extreme runoff events.
Wetland Restorable Index	10%	Restorable wetlands represent future opportunities to increase floodwater storage and reconnect hydrology at the parcel scale.
Dominant Hydrological Soil Group	15%	Parcels with highly permeable soils reduce flood risk by absorbing rainfall and sustaining baseflow, while poorly infiltrating soils amplify surface flooding.
Riparian Connectivity	15%	Intact riparian corridors store floodwater, slow flow velocities, dissipate erosive energy, and provide pollutant filtering and critical habitat linkages along waterways.

Riverine Flooding Resilience – Methods

METRIC	WEIGHT	RATIONALE
Topographic Wetness Index	10%	The Topographic Wetness Index identifies areas most prone to saturation and surface flooding.
Percent Impervious Surface	15%	Impervious cover eliminates infiltration pathways and rapidly converts rainfall into runoff, intensifying flood peaks.
Land Cover Conversion	5%	Land cover change highlights recent disturbances such as forest-to-agriculture or agriculture-to-urban transitions. While related to imperviousness, it provides unique insight into trends of disturbance and future risk, rather than static conditions.
Floodplain Extent	10%	FEMA 100-year and 500-year floodplain boundaries capture exposure to mapped flood hazards. Parcels within these zones face greater risk of inundation.



Riverine Flooding Resilience – Results

Higher Resilience:

- Strong clusters along the Crow Wing River corridor and Upper Mississippi tributaries
- Parcels near wetlands and riparian floodplains consistently resilient
- Camp Ripley core and conservation lands support intact forested floodplain corridors

Lower Resilience:

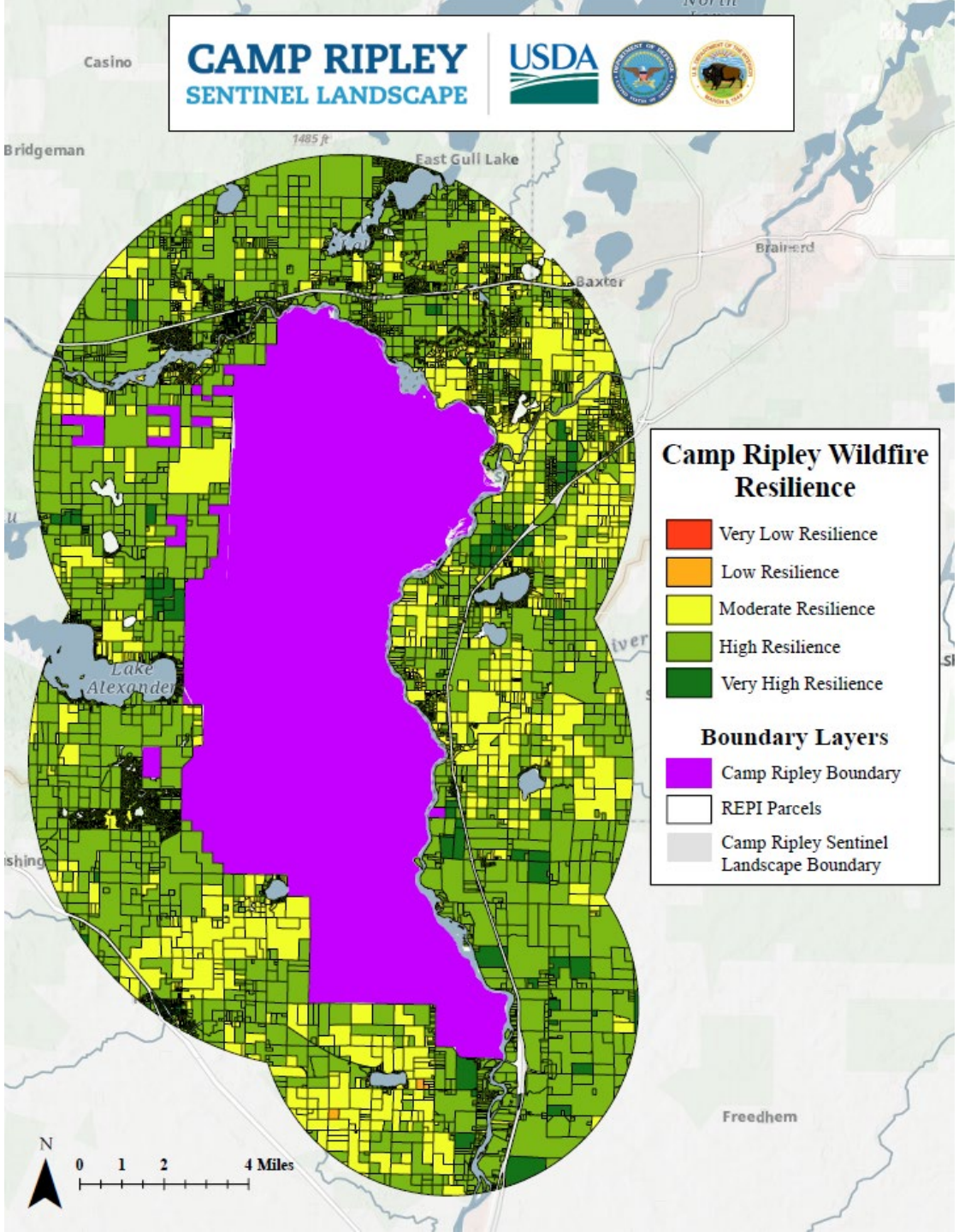
- Urbanizing zones around Little Falls with impervious surfaces and drainage alteration
- Downstream tributary channels show lower resilience from channelization and land conversion
- Fragmented edge parcels near ag & developed lands with reduced vegetative buffers

Wildfire Resilience – Methods

METRIC	WEIGHT	RATIONALE
Risk to Potential Structures	20%	Directly reflects the combined fire likelihood, intensity, and structural consequence. High predictive value for parcel vulnerability.
Conditional Risk to Structures	15%	Reflects potential damage if a fire occurs. Useful in locations where fire is infrequent but potentially severe.
Exposure Type	12%	Indicates whether the parcel is in the path of direct/indirect fire spread. Essential for understanding how fire enters developed areas.
Burn Probability	15%	Quantifies fire likelihood using simulated long-term burn patterns. Crucial for hazard-based prioritization.

Wildfire Resilience – Methods

METRIC	WEIGHT	RATIONALE
Conditional Flame Length	10%	Represents fire intensity at the parcel. Higher flame length increases suppression difficulty and potential damage.
Flame Length Exceedance > 4 ft	8%	Exceeding 4 ft implies that handcrew suppression is ineffective; used as a moderate intensity threshold.
Flame Length Exceedance > 8 ft	8%	Indicates extremely intense fires requiring mechanical or aerial suppression—directly tied to management difficulty.
Wildfire Hazard Potential	12%	Captures cumulative hazard characteristics, useful for fuel treatment prioritization and landscape-scale decision-making.



Wildfire Resilience – Results

Higher Resilience:

- Most parcels moderate–high resilience, reflecting intact vegetation and low burn probabilities
- Large interior forest blocks score high due to limited fragmentation and ignition risk

Lower Resilience:

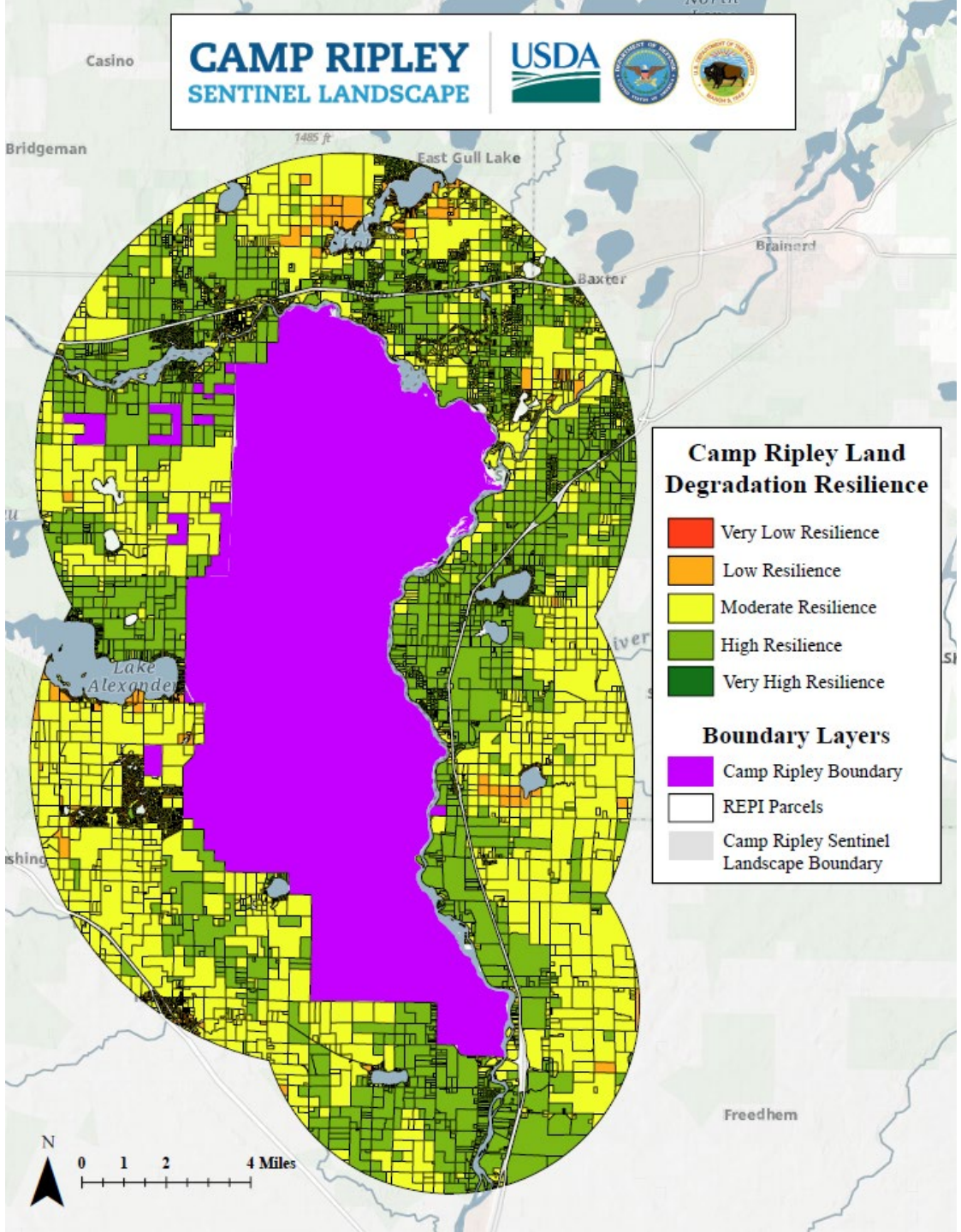
- Consistent low resilience along the wildland-urban interface (WUI) near residential developments
- Fragmented edge zones between developed, agricultural, and forested areas show reduced resilience
- Scattered vulnerable pockets along roads, access routes, and developing corridors

Land Degradation Resilience – Methods

METRIC	WEIGHT	RATIONALE
Aridity Index	15%	Aridity is the foundational climatic driver of degradation, directly limiting vegetation growth and soil moisture availability. Persistent water deficits reduce recovery after disturbance and make landscapes more vulnerable to wind and water erosion.
Vegetation Stability	25%	Vegetation provides the first line of defense against degradation. Stable, perennial cover reduces runoff, protects soils, and sustains infiltration. Declines in NDVI or perennial vegetation signal active degradation processes such as erosion or desertification.
Land Cover Conversion	5%	Recent land cover transitions (e.g., forest-to-agriculture or agriculture-to-urban) capture acute human-driven disturbances. While important as indicators of change, they function more as stress signals than as long-term drivers.

Land Degradation Resilience – Methods

METRIC	WEIGHT	RATIONALE
Soil Erodibility	25%	Sandy outwash soils across central Minnesota are especially prone to both wind and water erosion. Soil erodibility strongly governs baseline vulnerability regardless of land use.
Percent Impervious Surface	10%	Impervious surface and human modification reflect cumulative land disturbance.
Slope	20%	Steeper slopes accelerate runoff & increase soil detachment, compounding erosion risks. Moderate slopes can be critical when combined with erodible soils or low vegetation cover.
Drought Frequency	Multiplier	Repeated droughts intensify degradation by depleting soil moisture, reducing vegetation cover, and amplifying erosion risk.



Land Degradation Resilience – Results

Higher Resilience:

- Large intact forest cores within and around Camp Ripley boundary
- Scattered native prairie remnants and natural grasslands resist degradation
- Interior lands with low road density and minimal fragmentation

Lower Resilience:

- Agricultural frontiers at forest–agriculture edges with soil disturbance
- Recently developed residential areas with impervious surfaces and fragmentation
- Converted forest or prairie to cropland/development consistently low resilience

Applications to Camp Ripley

- Parcel-level resilience scoring directs investments to lands that buffer training ranges from drought, flooding, wildfire, and degradation.
- Supports restoration and protection projects that stabilize natural infrastructure and sustain long-term mission readiness.
- Builds regional resilience by aligning military, ecological, and community priorities.

Applications for Conservation Planning

- Identify high-priority parcels for conservation easements.
- Focus restoration efforts in vulnerable, restorable zones.
- Enhance habitat corridors and landscape connectivity.
- Justify land protection with science-backed parcel scores.
- Communicate value to landowners and partners.
- Inform funding applications and land protection strategies.
- Replicate methods across other landscapes and project areas.

Resilience Scoring Dashboard

Step 1: Choose a Hazard

Drought | Extreme Temperature | Riverine Flooding | Wildfire | Land Degradation

- Step 2: Boundary Layer
- Step 3: Data Inputs
- Step 4: Analyses
- Step 5: Metric Weights
- Step 6: Review

▶ Run

Thank you!

Raenah Bailey
Midwest Resilience Specialist
(c) 317-495-5622
Raenah@legacyworksgroup.com

LEGACYWORKS GROUP

CAMP RIPLEY SENTINEL LANDSCAPE

SOUTHERN INDIANA SENTINEL LANDSCAPE

Thank You to Our Partners

LEGACYWORKS GROUP

CLEAN WATER LAND & LEGACY AMENDMENT

CAMP RIPLEY SENTINEL LANDSCAPE

Camp Ripley
"The Warrior's Choice"

MORRISON SOIL & WATER

USDA

REPI
READINESS AND ENVIRONMENTAL PROTECTION INTEGRATION PROGRAM

BOARD OF WATER AND SOIL RESOURCES