Department of Defense Legacy Initiative and Bat Conservation in Utah

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Introduction

A total of 18 species of bat are known to occur in Utah; 6 are considered Utah Species of Concern or Tier II State Wildlife Action Plan (WAP) species. Very little information is known about the distribution or population status of bats in the state. Prior to this project, bat inventory data for Utah was scattered within private, state, and federal holdings and were not collectively available for resource managers. Lack of such information makes it difficult to identify and address statewide management issues related to the conservation of bats. With five Department of Defense (DoD) facilities in Utah, whose management authority extends over 1.8 million acres, it was crucial to identify distribution and frequency of occurrence to prevent encroachment and listing issues related to the lack of conservation management of bat species in Utah. The Legacy Initiative, in three phases, seeks to create a collaborative platform for comprehensive management of bat species on DoD lands and throughout Utah through the implementation of the DoD Integrated Natural Resources Management Plans (INRMPs) and the State WAP. This three year effort led by U.S. Army Dugway Proving Ground (DPG) and the Utah Division of Wildlife Resources (UDWR) partnered with 14 different state, federal, and private stakeholders through the Utah Bat Conservation Cooperative to proactively and sustainably manage bats into the foreseeable future.

Legacy I

Data Consolidation

Conducted an exhaustive search for Utah bat records (federal and state agencies, universities, local contractors, private researchers, and non-profit groups). Entered all data sets into the Utah BatBase database (see example below). Completed database is housed and maintained by the UDWR's Utah Natural Heritage Program (UNHP) and has expanded current bat knowledge from **just over 2,300 records to currently over 28,000 bat records, a 1000% increase**.

Table 1. Number of individual bats and events recorded by each of 16 collection entity types.

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U.S. Forest Service (USFS)	286	586
Utah State University	6	34
Weber State University	34	10
Unknown	19	37
Total	13895	28629

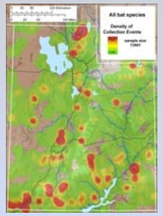


Fig 1. Distribution of Utah bat species. Red = high density while green = low. Density is a result of sampling intensity across 103 years. Spatial representation of data was obtained from the BatBase.

Web-Based Geodatabase

The database data entry page was designed around the existing Utah Bat Conservation Cooperative (UBCC) data sheet and a bat monitoring protocol data sheet described in Legacy III. The webpage portion of the project is in continuous development. The web portion meets project lead's design requirements and is the instrument for web-based entry and retrieval.

Fig 2 . The BatBase home page, above, can be found at https://www.utahbats.org/**.** A multitude of queries can be conducted once approval is given for access by the UBCC and UNHP.

Important Bat Habitat Model

With five DoD facilities in Utah, it remains crucial to prioritize efforts to identify important bat habitat to direct conservation management within DoD installations. As a critical element of a statewide Bat Conservation Strategy, UDWR and The Nature Conservancy (TNC) developed an expert-opinion-algorithmic - based habitat suitability model to identify important bat habitat. This model:

- Identifies distribution, quantity, and quality of suitable bat habitat.
- Allows federal, state, and military land managers to identify landscape characteristics that promote or limit potential use by bats.
- Serves as a foundation for future cooperative bat research and management efforts in the state.
- Provides a process template other Western states can use to identify, implement and manage important bat habitat.

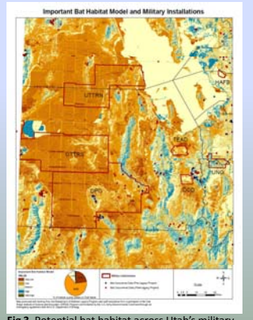


Fig 3. Potential bat habitat across Utah's military installations.

Legacy II

Bat Occurrence

To evaluate occurrence of sensitive bat species, a frequency distribution was created using the number of capture events recorded in Utah by species. By defining the current status of bat distributions, a new stage in bat monitoring and research has begun. This data set provides a basis for protocol development, species habitat modeling, and sensitive species monitoring. Habitat associations are present with Utah's sensitive species and were detected through this bat occurrence analysis.

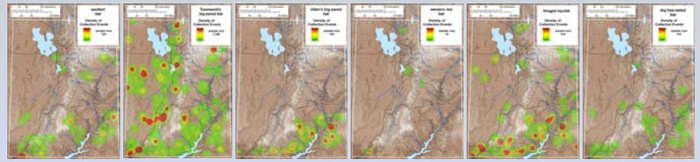


Fig 4. Density of bat data collection events in Utah. Each data point has a 5 km radius of activity. A continuum of event densities from high (red) to low (green) areas indicates the magnitude of data collection.

Bat Diversity

Bat diversity was measured in two ways: 1) number of species events, and 2) a diversity and evenness index in each of the 6 scales and associated 116 classes (described below).

Events were defined as the number of times a species was captured within each of the scales and associated classes. The most diverse and evenly represented Ecoregion and Physiographic Province was the Colorado Plateau. DoD managed lands had a high diversity and evenness. The Southern UDWR Region had the highest diversity index score followed by the Central, Northeastern, Southeastern, and Northern Regions. Colorado Plateau Pinyon-Juniper woodlands had the highest diversity score and Invasive annual forblands had the lowest.

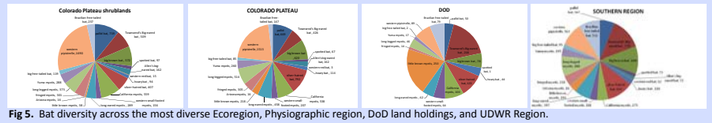


Fig 5. Bat diversity across the most diverse Ecoregion, Physiographic region, DoD land holdings, and UDWR Region.

Observation Type

To interpret bat activity type, activity records in the database were evaluated. Bat activity type was categorized as: day, night, hibernaculum, maternity roosts, or foraging activity. Cavern roosting species, Townsend's big-eared bat and fringed myotis, were observed across multiple roost types due to the high intensity of cavern surveys in Utah. The other 4 species were observed primarily while foraging.

Fig 6. Bat activity type each of Utah's 6 Tier II bat species were observed across.

Elevational Association

To evaluate elevation as a total model, each bat event was categorized into one of six elevation classes: <1000 m, 1001-1500 m, 1501-2000 m, 2001-2500 m, 2501-3000 m and >3000 m to represent variation on the landscape. Three bat species (Townsend's big-eared bat, Allen's big-eared bat and western red bat) occurred predominately at middle elevations. Only the spotted bat was found across all elevation classes while the fringed myotis and the big free-tailed bat were found primarily at low elevation.

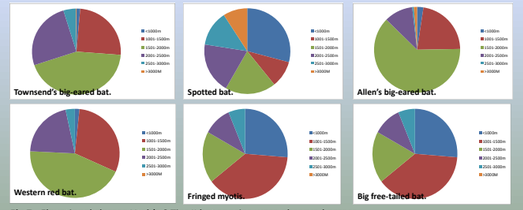


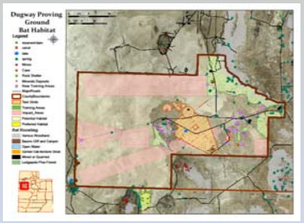
Fig 7. Elevational classes Utah's 6 Tier II bat species were observed across.

Legacy III

Risk Assessment

DoD facilities provide a wide array of bat habitat including roosting, foraging, watering, and migration corridors. These types allow for continued stability of bat populations and communities within the area.

- Bat roosting habitat was found across Utah DoD installations. These actual and potential roosts provide critical bat habitat and should be managed for stability.
- Bats were also observed foraging across DoD facilities. Foraging densities were highest above or near open water. Because bats require daily water these sites should be managed for continued use.
- While no documented bat migration corridors occur on DoD facilities, actual and potential migration habitat exists within mines, caves, buildings, trees, and foliage. Migration roosts can be protected for potential use.



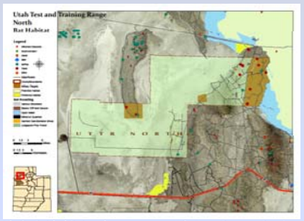


Fig 8. Bat habitat and range use on U.S. Army Dugway Proving Ground and U.S. Air Force Utah Test and Training Range.

Species Specific Habitat Models

Overall the presence/absence models performed well within context. Of the 6 models, 5 performed at or above 70% accuracy. In complex ecological systems such as bat communities, a model prediction rate above 50% is often the norm. The models consistently performed better at absence prediction than presence with the exception of Townsend's big-eared bat and fringed myotis. Both of these species are strongly associated with geologic cover types that are characterized by natural caves and abandoned mines making model predictions for absence more accurate.

Fig 9. Random forest analysis model results mapped using ArcGIS 9.2. Actual bat captures are overlaid to illustrate model fit.

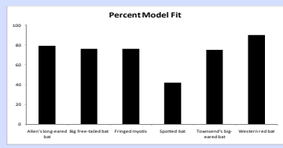


Fig 10. Percent model fit for Utah's 6 Tier II bat species.

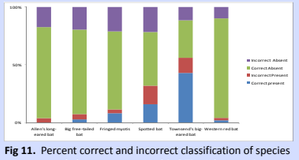


Fig 11. Percent correct and incorrect classification of species presence and absence across Utah's 6 Tier II bat species.

Utah Bat Monitoring Protocol

Table 2. Summary of Utah bat species Akaike's Information Criterion (AIC) weights used in monitoring protocol. Observed occupancy is based on the number of occupied cells divided by the total number of cells sampled. Estimated occupancy is based on the occupancy estimate calculated within the software package MARK. Detection probability was also estimated within program MARK.

Species	Species code	Observed Occupancy	Estimated Occupancy (ψ)	SE (ψ)	Detection probability (p)	SE (p)
Pallid Bat	ANPA	0.292	0.337	0.060	0.569	0.102
Big brown bat	EPFU	0.375	0.400	0.060	0.351	0.103
Hoary bat	LACI	0.203	0.236	0.063	0.222	0.140
Silver-haired bat	LANO	0.406	0.442	0.069	0.565	0.101
California myotis	MYCA	0.219	0.278	0.079	0.375	0.133
Western small-footed myotis	MYCI	0.328	0.436	0.099	0.359	0.109
Long-eared myotis	MYEV	0.406	0.496	0.087	0.420	0.100
Little brown bat	MYLU	0.344	0.593	0.173	0.250	0.097
Fringed myotis	MYTH	0.188	0.329	0.140	0.241	0.130
Long-legged myotis	MYVO	0.453	0.546	0.082	0.473	0.203
Yuma myotis	MYYU	0.281	0.440	0.129	0.284	0.111
Western pipistrelle	PIHE	0.297	0.311	0.061	0.636	0.113

These findings can be used to better allocate resources to monitor bat taxa on a landscape scale. By calculating the detectability of these 12 bat species, the sampling intensity required to create a complete picture of biodiversity at a sampling site can be estimated. By estimating occupancy, the distribution of bat species in relationship to the landscape and site characteristics in Utah can be better understood. Repeating these surveys every three years will produce a population stability estimate; are they stable, increasing, or decreasing?

This protocol was only able to determine occupancy and detectability (and ultimately measure population changes over time) for 12 of the 18 bat species in Utah. This is a result of low capture and/or detection rates for rare species. The protocol will need to be modified to increase detection of rare species (e.g. through targeted surveys or increased roost surveys). Specifically a cavern and cliff roosting site survey is needed to increase detectability of Townsend's big-eared bat and the big free-tailed bat, two of Utah's rare species. As expected, this protocol was not capable of creating occupancy estimates for Utah's three rarest species; Allen's big-eared bat, spotted bat, and western red bat have only been recorded 166, 120, and 19 times across 103 years in Utah.

In summary, this protocol was capable of estimating occupancy for 12 bat species and with small adjustments may be capable of providing estimates for three more bat species. The Utah Bat Conservation Cooperative is in the process of evaluating the use of this method for future management.

Department of Defense Legacy I Initiative and Bat Conservation in Utah

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Overall Introduction

A total of 18 species of bat are known to occur in Utah; 6 are considered Utah Species of Concern or Tier II State Wildlife Action Plan (WAP) species. Very little information is known about the distribution or population status of bats in the state. Prior to this project, bat inventory data for Utah was scattered within private, state, and federal holdings and were not collectively available for resource managers. Lack of such information makes it difficult to identify and address statewide management issues related to the conservation of bats. With five Department of Defense (DoD) facilities in Utah, whose management authority extends over 1.8 million acres, it was crucial to identify distribution and frequency of occurrence to prevent encroachment and listing issues related to the lack of conservation management of bat species in Utah. The Legacy Initiative, in three phases, seeks to create a collaborative platform for comprehensive management of bat species on DoD lands and throughout Utah through the implementation of the DoD Integrated Natural Resources Management Plans (INRMPs) and the State WAP. This three year effort led by U.S. Army Dugway Proving Ground (DPG) and the Utah Division of Wildlife Resources (UDWR) partnered with 14 different state, federal, and private stakeholders through the Utah Bat Conservation Cooperative to proactively and sustainably manage bats into the foreseeable future.

Legacy I (07-346): Data Consolidation and Modeling

This phase focuses on consolidation of bat data collected throughout Utah with two primary goals as follows:
1) Identify what is already known in Utah.
2) Create a web-based geodatabase to allow entry, storage, and queries of all old, new, and future data.

Data Consolidation

Methods

- Conducted an exhaustive search for Utah bat records (federal and state agencies, universities, local contractors, private researchers, and non-profit groups).
- Entered all data sets into the Utah BatBase database (see example below).
- Database is characterized by data masks and filters to ensure data quality, has customizable user queries to facilitate data sorting and extraction, and is web enabled.
- Completed database is housed and maintained by the UDWR's Utah Natural Heritage Program.

Results

Table 1. Number of individual bats and events recorded by each of 16 collection entity types.

Data Source	Events	Individual Bats
Bureau of Land Management (BLM)	2	2
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Utah State University	6	34
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Unknown	37	37
Total	**13,895**	**28,629**

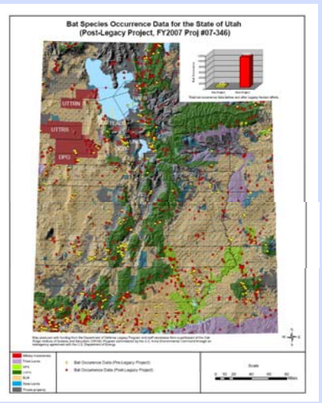

Fig 1. Number of bat data points before and after BatBase data consolidation project.

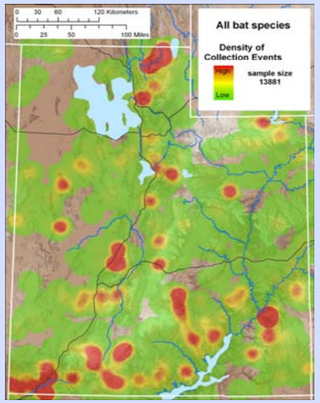

Fig 2. Distribution of all bat species in Utah. Red represents high density while green is low. Density is also a result of sampling intensity across 103 years. Spatial representation of data was obtained from the BatBase data consolidation project.

Discussion

- Expanded current bat knowledge from **just over 2,300 records to currently over 28,000 bat records, a 1000% increase**.
- Data from 16 federal, state, and private stakeholders creates a unique opportunity for bat management in Utah.
- BatBase, the web-based data management system, allows for the consolidation of past, present and future data.
- Provides a foundation for future bat conservation efforts in Utah and a context for historical datasets collected across a diversity of temporal and spatial scales.
- Will allow for large scale management of Utah bat species and foster a greater understanding of species distribution.

Web-Based Geodatabase

Methods

The web-based geodatabase, while in the process of going through several revisions, is in final draft form. The data entry portion of the database was designed around the existing Utah Bat Conservation Cooperative data sheet. A second data entry portion of the web-based database was created around a bat monitoring protocol described in Legacy III.

Results

Fig 3. The BatBase home page, above, can be found at https://www.utahbats.org/

Fig 4. Accessing BatBase queries page on website can only be done when logged in.

Fig 5. Data use agreement form for BatBase access. Persons are granted access by permission of the Utah Bat Conservation Cooperative only and must sign these forms.

Discussion

This database, although a functional product on its own, can serve a much greater function with an analysis of its content [funded Fiscal Year (FY) 2008 Legacy Proposal project]. This analysis will provide direction to bat management and allow for the greater use and applicability of the database. The webpage portion of the project is in continuous development. The web page portion will ultimately meet Legacy project lead's design requirements and be the instrument for web-based entry and retrieval.

Important Bat Habitat Model

Methods

With five DoD facilities in Utah, it remains crucial to prioritize efforts to identify important bat habitat to direct conservation management within DoD installations. As a critical element of a statewide Bat Conservation Strategy, UDWR and The Nature Conservancy (TNC) developed an algorithmic-based habitat suitability model to identify important bat habitat in Utah. Experts from the Utah Bat Conservation Cooperative were integral parts of this process.

Results

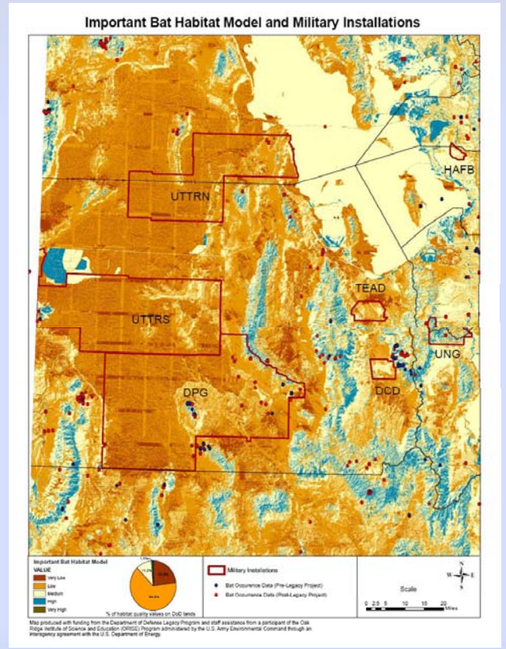

Fig 6. Utah military installation habitat.

Discussion

This model:
- Identifies distribution, quantity, and quality of suitable bat habitat in Utah.
- Allows federal, state, and military land managers to identify landscape characteristics that promote or limit potential use by bats.
- Serves as a foundation for future cooperative bat research and management efforts in the state.
- Provides a process template other Western states can implement to identify and manage their important bat habitat.

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Joel Diamond


Lauren Wilson


Ryan Swan


Ryan Swan

Legacy II (08-346): Data Analysis

BatBase allows for analysis of bat use across space and time within the State. DoD land managers use INRMPs to guide sustainable management practices to ensure that testing and training areas continue to function sustainably without restrictions. This regional approach to managing bats within Utah and specifically understanding regional trends and patterns on DoD lands directly supports stewardship objectives and goals fundamental to sound land management policies within the DoD.

Bat Occurrence

Methods

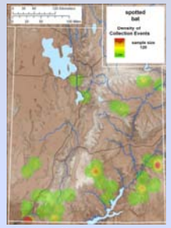
To evaluate occurrence of sensitive species, a frequency distribution was created across species using the number of capture events recorded in Utah by species and analyzed for 6 scales:

- Ecoregion
- Physiographic Province
- Land Cover Classification
- Land Owner
- UDWR Region
- County

Analysis was conducted using PROCFREQ in SAS® and visual analysis in Excel®. The occurrence data were then used to create a diversity analysis.

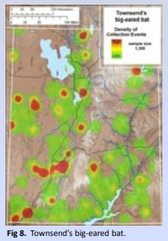
Results

Density of bat data collection events in Utah was calculated. Each data point has a 5 km radius of activity zone. A continuum of event densities from high (red) to low (green) areas indicates the magnitude of data collection.



- 3 Ecoregions
- 3 Physiographic Provinces
- 23 Land Cover Classifications
- 6 Land Owners
- 4 UDWR Regions
- 12 Counties

Fig 7. Spotted bat.

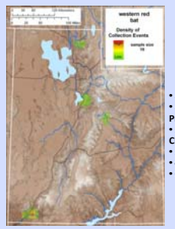


- 4 Ecoregions
- 4 Physiographic Provinces
- 44 Land Cover Classifications
- 11 Land Owners
- 5 UDWR Regions
- 27 Counties

Fig 8. Townsend's big-eared bat.

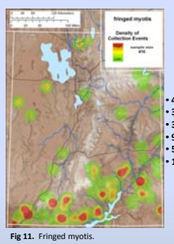
- 3 Ecoregions
- 2 Physiographic Provinces
- 18 Land Cover Classifications
- 5 Land Owners
- 2 UDWR Regions
- 6 Counties

Fig 9. Allen's big-eared bat.



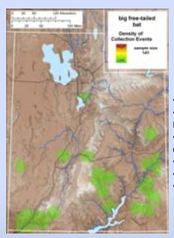
- 3 Ecoregions
- 3 Physiographic Provinces
- 2 Land Cover Classifications
- 2 Land Owners
- 4 UDWR Regions
- 6 Counties

Fig 10. Western red bat.



- 4 Ecoregions
- 3 Physiographic provinces
- 35 Land Cover Classifications
- 9 Land Owners
- 5 UDWR Regions
- 16 Counties

Fig 11. Fringed myotis.



- 4 Ecoregions
- 2 Physiographic Provinces
- 26 Land Cover Classifications
- 8 Land Owners
- 4 UDWR Regions
- 9 Counties

Fig 12. Big free-tailed bat.

Discussion

By defining the current status of bat distributions in Utah, a new stage in bat monitoring and research has begun. This data set provides a base for protocol development, species-specific habitat modeling, and sensitive species monitoring. Habitat associations are present with Utah sensitive species and was detected through this bat occurrence analysis.

Diversity

Methods

- Bat diversity was measured in two ways:
  1. Number of species events.
  2. A diversity and evenness index in each of the 6 scales (see list at left) and associated 116 classes (described below).
- Events: The number of times a species was captured within each of the scales and associated classes.
- Events were used to reduce the influence of 19 high magnitude capture events on species evenness.
- Six scales were analyzed using a frequency distribution across classes within scales. The Shannon-Weiner Diversity Index was used with each class across all scales. These classes were then compared within each of the six scales.
- Analysis was conducted with PROCFREQ in SAS® and Excel®.

Results

Ecoregion

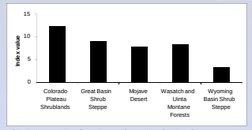


Fig 13. Bat species diversity, as determined using the Shannon-Weiner Diversity Index across Utah's Ecoregions.

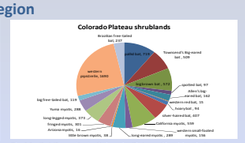


Fig 14. Bat Diversity in Colorado Plateau Shrublands Ecoregion.

Physiographic Province

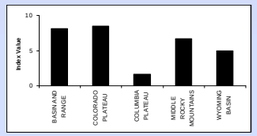


Fig 15. Bat species diversity, as determined using the Shannon-Weiner Diversity Index across Utah's Physiographic Provinces

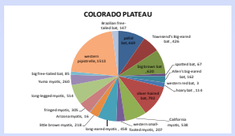


Fig 16. Bat Diversity in the Colorado Plateau.

Land Owner

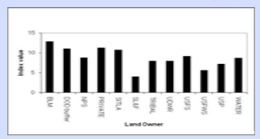


Fig 17. Bat species diversity, as determined using the Shannon-Weiner Diversity Index across Utah's land owner types

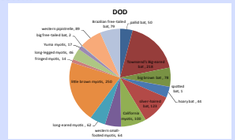


Fig 18. Bat Diversity on DoD Lands.

UDWR Region

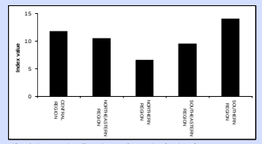


Fig 19. Bat species diversity, as determined using the Shannon-Weiner Diversity Index across Utah's UDWR Regions.

Fig 20. Bat Diversity in the Southern UDWR Region.

Discussion

- **Ecoregion:** The most diverse and evenly represented is the Colorado Plateau shrublands followed by the Great Basin Shrub Steppe; the Wyoming Basin is the least diverse.
- **Physiographic Province:** Trends mirror that of the ecoregion diversity.
- **Land Owner:** BLM managed lands account for more area than all other types and these lands are characterized by the high diversity land cover types discussed above. DoD had the second highest bat diversity though it has much less habitat diversity and land area than BLM lands.
- **UDWR Region:** The Southern region had the highest diversity index score followed by the Central, Northeastern, Southeastern, and Northern regions.
- **Land Cover:** Colorado Plateau Pinyon-Juniper Woodlands had the highest diversity score and Invasive Annual Forblands had the lowest.
- **County:** Garfield County had the highest diversity score. Its location in Wasatch and Uinta Montane Forests and Colorado Plateau ecoregions and the high diversity of land cover type in this county account for the high diversity. Kane County also had high diversity scores that is likely due to the Southern location and a mixing of ecoregions.
- **Project Deliverables**: Fact Sheet, Status of Bats Report, Utah Bat Conservation Plan, and Utah Bat Monitoring Protocol (a dynamic document). Copies are available from any POC listed under the title.

Elevational Associations

Methods

- To evaluate elevation as a total model, each bat event was categorized into one of six elevation classes: <1000 m, 1001-1500 m, 1501-2000 m, 2001-2500 m, 2501-3000 m, and >3000 m to represent variation on the landscape.
- A frequency analysis (PROCFREQ) was conducted in SAS® and Excel®.

Results

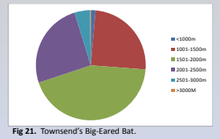


Fig 21. Townsend's Big-Eared Bat.

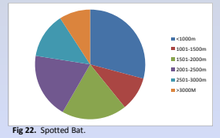


Fig 22. Spotted Bat.

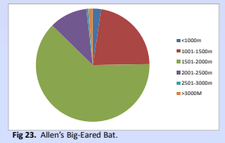


Fig 23. Allen's Big-Eared Bat.

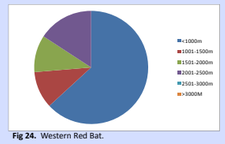


Fig 24. Western Red Bat.

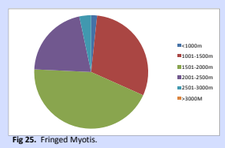


Fig 25. Fringed Myotis.

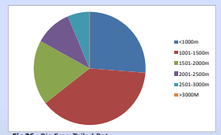


Fig 26. Big Free-Tailed Bat.

Discussion

- More species (19) were observed between 1501-2000 m elevation than all other elevations.
- 18 species at 2001-2500 m and 1001-1500 m (Arizona myotis was absent).
- 14 species at <1000 m (silver-haired bat, long-eared myotis, little brown myotis, Arizona myotis, and long-legged myotis were absent), and at 2501-3000 m (pallid bat, western red bat, Arizona myotis, western pipistrelle and Brazilian free-tailed bat were absent).
- 6 species were observed at >3000 m (spotted bat, Allen's big-eared bat, hoary bat, western small-footed myotis, long-eared myotis and long-legged myotis).

Utah Bat Monitoring Protocol

Introduction

- A landscape level bat monitoring protocol was developed to meet DoD and UDWR bat management goals (SIKES ACT, UDWR 2005; Oliver et al. 2009).
- Studies in Montana, Oregon, Washington, California, West Virginia, and Hawaii indicate that occupancy based models provided good estimates of bat species and community distribution.
- Studies such as these indicate that monitoring bats at a landscape level requires ecological stratification with at least 15 sample units per strata, and that using acoustic and mist netting methods in combination increases detection probabilities and the accuracy of occupancy estimates.

Methods

Protocol Designed to Determine the Status of Utah Bat Populations by Measuring:

- Geographic Extent, Species Distribution, Metapopulation Behavior, Species Richness, and Disease Movement.

Sampling Cell Selection

- 65 randomly selected 20 X 20 km hexagonal cells using Utah's existing Tesselated Grid allows for data comparison across other taxa monitoring programs (Fig 27).

Survey Site Selection

- Capture Survey (Primary Survey): Observer selected water site (within each sample cell) with 4 to 400 m^2 of standing or flowing water on less than a 4 degree slope.
- Acoustic Survey (Secondary Survey): Observer selected site greater than 500 m from the Primary Survey site.

Survey Schedule

- Three visits per sample cell per year (3 Acoustic and 3 Capture Surveys) encompassing reproductive conditions.
  - Gravid (May/June).
  - Lactating (June/July).
  - Volancy (July/August).
- Survey protocol repeats every three years (2009, 2012, etc...).

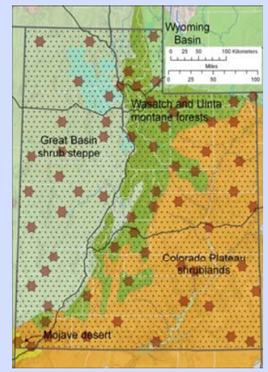


Fig 27. Sampling cell locations randomized throughout Utah using the existing Tesselated Grid and stratified by Utah's 5 ecoregions.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Department of Defense Legacy III Initiative and Bat Conservation in Utah

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Legacy III (09-346): Protocol Implementation

This final phase is crucial to ensuring that the extensive efforts and achievements realized through the first two phases becomes integrated into an established state-wide bat management effort that will remain self-sustaining across agencies long after this project concludes. The three main objectives of this phase were to: 1) write a DoD specific Risk Assessment for bat and military mission interaction, 2) create species-specific habitat models, and 3) implement the Utah Bat Monitoring Protocol state-wide. These actions directly ensure that the WAP, INRMPs, and the Utah Bat Conservation Plan goals and objectives are implemented throughout the state.

DoD Risk Assessment

Introduction

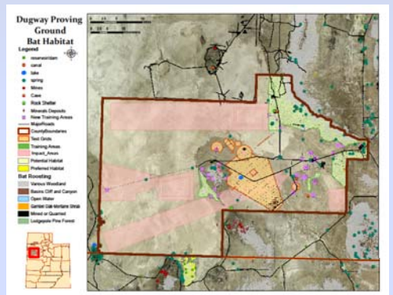
- Consolidate, understand, and apply data and knowledge gained from the Legacy project to military mission activity and land management.
- The plan includes bat monitoring on all 5 DoD facilities.
- Land use will include bat use and military testing and training activities and will ensure an extensive look at bat and military mission interaction.

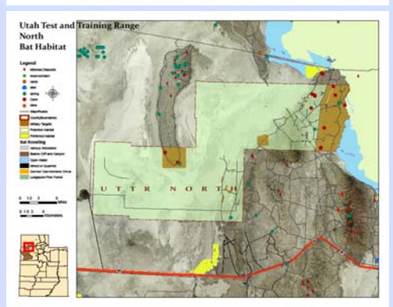
Methods

- Actionable management guidelines for each base will be outlined for improvement and/or sustainment of bat populations and mitigation for bat habitat loss due to critical mission use areas.
- Surrounding lands will be assessed for potential improvement or protection of habitat to ensure that military testing and training capabilities throughout Utah remain sustainable and unrestricted.
- Mitigation measures (if needed) can be implemented at little to no cost to DoD facilities because of the extensive work put into interagency cooperation through this Legacy initiative.

Results/Discussion

Fig 28. Bat habitat and range use on U.S. Army Dugway Proving Ground and U.S. Air Force Utah Test and Training Range North.





DoD facilities provide a wide array of bat habitat including roosting, foraging, watering, and migration corridors. These types allow for continued stability of bat populations and communities within the area.

Bat roosting habitat was found across Utah DoD installations. These actual and potential roosts provide critical bat habitat and should be managed for stability.

Bats were also observed foraging across DoD facilities. Foraging densities were highest above or near open water. Because bats require daily water these sites should be managed for continued use.

While no documented bat migration corridors occur on DoD facilities, actual and potential migration habitat exists within mines, caves, buildings, trees, and foliage. Migration roosts can be protected for potential use.

Species Specific Habitat Models

Introduction

- Species specific models have been created for DoD lands and the state of Utah based on occurrence and habitat needs.
- Habitat models are coveted components of impact analyses and assessments completed by state and federal agencies.
- Species models will be integrated quickly into existing impact analysis infrastructure. Models will be incorporated into the standardized sampling framework to prioritize future survey efforts and balance the needs and desires of partner agencies.

Methods

- Assign each species data point to a spatially explicit 3 km area (Legacy I BatBase data set).
- Each species was evaluated as "present" within every area they were detected.
- "Pseudo-absence" was estimated in every area a species was not found. A site could not be selected as a pseudo-absence site unless the bat species in question had not been capture/observed during at least nine sampling events.
- The associated land form, land cover, geology, and climate (135 total variables) were then used to create a presence/pseudo-absence framework within R[®] statistical software.
- Data were analyzed using the Random Forest package within R statistical software. Ten random forest models were run. Each model consisted of 250 iterations. The outputs were averaged to create a percent fit of each model.

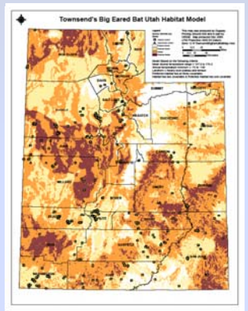


Fig 29. Random forest analysis model results mapped using ArcGIS 9.2. Actual bat captures are overlaid to illustrate model fit. Map courtesy of Teresa Langley, GIS Specialist, DPG.

Results

- 200 classification trees were run to compile a random forest analysis for Utah's 6 sensitive bat species.
- This analysis was then used to calculate a model error rate.

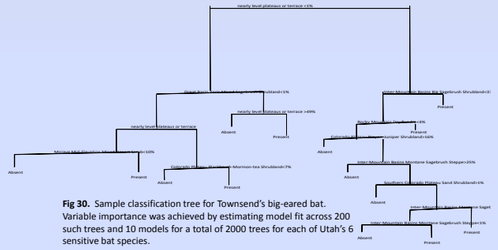


Fig 30. Sample classification tree for Townsend's big-eared bat. Variable importance was achieved by estimating model fit across 200 such trees and 10 models for a total of 2000 trees for each of Utah's 6 sensitive bat species.

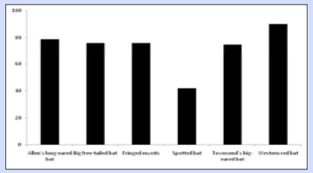


Fig 31. Percent model fit for Utah's 6 bat species of concern.

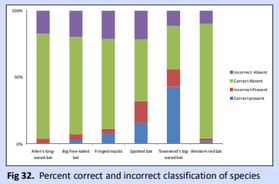


Fig 32. Percent correct and incorrect classification of species presence and absence across Utah's 6 species of concern.

- The Allen's big-eared bat model correctly categorized presence/absence in 79% of model iterations. The model was poor at predicting presence, while excelling in predicting absence.
- The big free-tailed bat model correctly categorized presence/absence in 76% of model iterations. This model correctly predicted presence in 50% of iterations and absence in 79% of iterations.
- The fringed myotis model correctly categorize presence/absence in 76% of model iterations. The model correctly predicted 71% of present and 77% of absent iterations.
- The spotted bat model only correctly categorized presence/absence in 42% of model iterations. This model correctly predicted presence in 50% and absence in 68% of iterations.
- The Townsend's big-eared bat model correctly predicted presence/absence events in 75% of iterations. This model correctly predicted presence in 77% of iterations.
- The western red bat model correctly categorized presence/absence in 90% of model iterations. This model correctly predicted presence in 50% and absence in 90% of iterations.

Discussion

Overall the presence/absence models preformed well within context. Of the 6 models, 5 performed at or above 70% accuracy. In complex ecological systems such as bat communities, a model prediction rate above 50% is often the norm. The models consistently performed better at absence prediction than presence with the exception of Townsend's big-eared bat and fringed myotis. Both of these species are strongly associated with geologic cover types that are characterized by natural caves and abandoned mines making model predictions for absence more accurate. This association of Townsend's big-eared bat and the fringed myotis with cavern habitat is well documented.

Utah Bat Monitoring Protocol Implementation

Results

Overall

Table 2. Summary of Utah bat species Akaike's Information Criterion (AIC) weights used in monitoring protocol. Observed occupancy is based on the number of occupied cells divided by the total number of cells sampled. Estimated occupancy is based on the occupancy estimate calculated within the software package MARK. Detection probability was also estimated within program MARK.

Species	Species code	Observed Occupancy	Estimated Occupancy (ψ)	SE (ψ)	Detection probability (p)	SE (p)
Pallid Bat	ANPA	0.292	0.337	0.060	0.569	0.102
Big brown bat	EPFU	0.375	0.400	0.060	0.351	0.103
Hoary bat	LACI	0.203	0.236	0.063	0.222	0.140
Silver-haired bat	LANO	0.406	0.442	0.069	0.565	0.101
California myotis	MYCA	0.219	0.278	0.079	0.375	0.133
Western small-footed myotis	MYCI	0.328	0.436	0.099	0.359	0.109
Long-eared myotis	MYEV	0.406	0.496	0.087	0.420	0.100
Little brown bat	MYLU	0.344	0.593	0.173	0.250	0.097
Fringed myotis	MYTH	0.188	0.329	0.140	0.241	0.130
Long-legged myotis	MYVO	0.453	0.546	0.082	0.473	0.203
Yuma myotis	MYYU	0.281	0.440	0.129	0.284	0.111
Western pipistrelle	PIHE	0.297	0.311	0.061	0.636	0.113

Species Specific

Table 3. Covariate relationships for the 12 Utah bat species with an observed occupancy of >18%. Each AIC model is based on the relationship between occupancy and covariates. The top 3 to 4 models for each species are displayed here.

Pallid Bat

Model	K	AIC	ΔAIC
Ecoregion, UTMN, Elevation, Wstype	4	138.786	0
Ecoregion, UTMN, Elevation, Wstype, Canopy	5	139.115	0.329
Ecoregion, Elevation, Wstype	3	140.837	2.051
Elevation	1	164.097	25.311

California Myotis

Model	K	AIC	ΔAIC
Ecoregion UTMN Elevation WSPerimeter	4	160.779	0.000
UTMN Elevation WSPerimeter	3	161.572	0.793
Ecoregion UTMN Elevation	3	162.134	1.355
UTMN	1	163.167	2.388

Silver-haired bat

Model	K	AIC	ΔAIC
UTME Elevation NetArea WSWidth	4	207.15	0.000
Elevation NetArea WSWidth	3	210.53	3.38
UTME Elevation NetArea	3	215.74	8.59
Elevation	1	219.798	12.648

Western Small-footed Myotis

Model	K	AIC	ΔAIC
Ecoregion WSWidth Moonphase WSType	4	167.613	0.000
Ecoregion Elevation WSWidth Moonphase WSType	5	167.892	0.279
Ecoregion Moonphase WSType	3	168.129	0.516
MoonPhase	1	170.933	3.320

Long-eared Myotis

Model	K	AIC	ΔAIC
UTMN Elevation WSPerimeter	3	198.96	0.000
Elevation WSPerimeter	2	198.977	0.017
Ecoregion UTMN Elevation WSPerimeter	4	200.096	1.136
Elevation	1	204.531	5.571

Fringed Myotis

Model	K	AIC	ΔAIC
UTMN WSType	2	113.512	0.000
UTMN Elevation WSType	3	114.269	0.757
Ecoregion UTMN Elevation WSType	4	115.133	1.621
WSType	1	116.033	2.521

Little Brown Bat

Model	K	AIC	ΔAIC
UTMN WSWIDTH	2	162.341	0.000
UTMN	1	163.097	0.756
UTMN NetArea WSWidth	3	163.356	1.015
Ecoregion UTMN NetArea WSWidth	4	165.077	2.736

Yuma Myotis

Model	K	AIC	ΔAIC
Ecoregion UTMN Understory	3	130.428	0.000
Ecoregion UTMN Elevation Understory	4	131.872	1.444
Ecoregion UTMN	2	132.858	2.43
Ecoregion	1	133.674	3.246

Long-legged Myotis

Model	K	AIC	ΔAIC
Elevation	1	204.481	0.000
Elevation UTME	2	206.201	1.72
UTME	1	221.765	17.284

Western Pipistrelle

Model	K	AIC	ΔAIC
Ecoregion UTMN Elevation WSType Canopy Understory	6	111.168	0.000
Ecoregion UTMN Elevation WSType Canopy	5	112.899	1.731
UTMN Elevation WSType Canopy	4	112.947	1.779
Elevation	1	159.088	47.920

Discussion

These findings can be used to better allocate resources to monitor bat taxa on a landscape scale. By calculating the detectability of these 12 bat species, the sampling intensity required to create a complete picture of biodiversity at a sampling site can be estimated. By estimating occupancy, the distribution of bat species in relationship to the landscape and site characteristics in Utah can be better understood. Repeating these surveys every three years will produce a population stability estimate; are they stable, increasing, or decreasing?

This protocol was only able to determine occupancy and detectability (and ultimately measure population changes over time) for 12 of the 18 bat species in Utah. This is a result of low capture and/or detection rates for rare species. The protocol will need to be modified to increase detection of rare species (e.g. through targeted surveys or increased roost surveys). Specifically a cavern and cliff roosting site survey is needed to increase detectability of Townsend's big-eared bat and the big free-tailed bat, two of Utah's rare species. As expected, this protocol was not capable of creating occupancy estimates for Utah's three rarest species; Allen's big-eared bat, spotted bat, and western red bat have only been recorded 166, 120, and 19 times across 103 years in Utah.

In summary, this protocol was capable of estimating occupancy for 12 bat species and with small adjustments may be capable of providing estimates for three more bat species. The Utah Bat Conservation Cooperative is in the process of evaluating the use of this method for future management.

Acknowledgments

The Nature Conservancy, Tooele Army Depot, National Guard Utah, Utah DNR Oil, Gas & Mining, American Bird Conservancy, UBCC Utah Bat Conservation Cooperative, Forest Service USDA, Utah DNR Wildlife Resources, SWCA Environmental Consultants, UtahState University, U.S. Army, U.S. Fish & Wildlife Service, ORISE Oak Ridge Institute for Science & Education