

STATEMENT OF OBJECTIVES

Bat Diet Characterization at Arnold Air Force Base
Article III, (D) of the Southern Appalachian Mtns / Great Rivers
Cooperative Ecosystems Studies Units (CESU)

1. PURPOSE

This Scope of Objectives (SOO) provides the details of technical support to be performed for Arnold Air Force Base (AFB) through a cooperative agreement (CA). The objective of this CA is to characterize the diet of bat species identified at Arnold AFB using genetic analysis of guano collected from the Elk River Dam gray bat colony, harp trapping at Beth Page Bridge, mist net surveys conducted by Arnold AFB, and independent mist netting to be conducted by the Non-Federal Entity (NFE) for this study.

The Air Force seeks specialized, technical support to conduct analyses at the level of individual guano pellet for mist net/harp trap techniques and a combination of individual pellet and a pool of pellets for guano collected at the dam.

Background:

Nine species of bats have been documented from Arnold AFB all of which are insectivores. Two bat species at Arnold AFB are listed as “Endangered” by the United States Fish and Wildlife Service (USFWS). The Indiana bat (*Myotis sodalis*) was listed on 11 March 1967 and the gray bat (*M. grisescens*) was listed on 28 April 1976. A third, the Northern long-eared bat (*M. septentrionalis*), was listed as “Threatened” on 4 May 2014. Additional species identified on the installation include the evening bat (*Nycticeius humeralis*), Eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), big brown bat (*Eptesicus fuscus*), tricolored bat (*Perimyotis subflavus*), and little brown bat (*Myotis lucifugus*).

Previous studies at Arnold AFB have included examinations of aquatic and terrestrial arthropod communities, and a broad scale examination of forest arthropods is currently ongoing. The bat community is well studied including inventory efforts across the installation and telemetry studies of roosting and foraging habits. Five sites on Arnold AFB are under continuous acoustic monitoring with mist netting at each site twice per year. Additionally, a gray and little brown bat roost site that is just off base at Beth Page Bridge is harp trapped annually. Finally, annual monitoring is conducted at a colony of gray bats that roosts in the Elk River Dam.

2. AUTHORITY

- 2.1 In accordance with the Sikes Act (Sec. 103A [16 USC 670c-1]) “the Secretary of a military department may enter into cooperative agreements with States, local governments, Indian Tribes, non-governmental organizations, and individuals...” This project is in support of the Integrated Natural Resources Management Plan (INRMP), as directed in the Sikes Act.
- 2.2 In agreement with the above stated goals, the recipient/cooperator agrees to provide the necessary personnel, equipment, and materials required to implement, in part, the Air

Force responsibilities pursuant to the Endangered Species Act (16 USC 1531 et seq.), the Sikes Act Improvement Act, the Migratory Bird Treaty Act (16 USC 1361 et seq.), the National Environmental Policy Act (42 U.S.C. 4321 et seq.), and applicable implementing regulations, such as Air Force Instruction 32-7064, *Integrated Natural Resources Management*.

- 2.3 In accordance with section 6305 □ *Using cooperative agreements* of the *Federal Grant and Cooperative Agreements Act of 1977* (31 U.S.C. § 6301 et seq.), all CESU projects must carry out a public purpose of support or stimulation, instead of acquiring goods or services for the exclusive direct benefit of the United States Government. Examples of carrying out a public purpose may include, but are not limited to, the following:
- Project results are made available to a wide audience (including nonfederal entities)
 - Project results/outputs add to the scientific literature/knowledge base, with applicability and utility beyond the scope of the project footprint/study area
 - Academic and other nonfederal partner institutions (and their personnel) gain professional experience, increase knowledge, and develop skills and abilities
 - Students benefit from direct interaction with federal scientists, program and technical staff, and field unit managers
- 2.4 In accordance with section 6305 – Using cooperative agreements of the Federal Grant and Cooperative Agreements Act of 1977 (31 U.S.C. § 6301 et seq.), substantial involvement is expected between the Department of Defense and the recipient when carrying out the activity contemplated by the cooperative agreement. The DoD agrees to participate at a national level in support of the CESU program as accepted in the Master MOU for the establishment and continuation of the CESU program Article II 1-4 and Article VI 1-7.
- 2.5 The installation further (hence DoD) agrees to provide substantial involvement as directed under Article II (A) CESU Master Agreements to include, but are not limited to, the following:
- INSTALLATION is involved in development of study methodology, data gathering, analysis, and/or report writing
 - INSTALLATION actively participates and collaborates in carrying out the project plan of work, reviews and approves activities, helps train or select project staff or trainees
 - INSTALLATION incurs in-kind or direct expenditures in carrying out the activities specified in the project agreement.

3. DESCRIPTION OF OBJECTIVES

Field work for this project will occur over two years of field seasons (June through September 2022 and June through September 2023). Analysis will be conducted at the level of individual guano pellet for mist net/harp trap techniques. For guano collected at the dam, a combination of individual pellet and a pool of pellets will be used.

The NFE will be responsible for state and Federal permits required to enter the Woods Dam gray bat colony, mist netting, and any other proposed activities. Arnold AFB personnel will escort entries into the dam.

The contractor shall perform the following work elements for the project:

A. Study Plan Preparation:

Prepare a draft study plan that presents the detailed study approach, GIS mapping procedures, guano collection methods, genetic analysis techniques, and proposed data analysis techniques. After approval of draft by Arnold AFB, produce and submit a final study plan.

B. Field Surveys and Genetic Analysis:

In order to collect guano needed for dietary analysis, this project will:

- Provide sampling equipment to Arnold AFB for collection of guano at annual mist net locations
- Attend annual harp trapping at Beth Page Bridge to collect guano
- Collect guano from the Elk River Dam by positioning clean plastic sheet(s) under the roost
- Collect guano from independent mist net locations at a duration of at least 10 nights at a minimum of 5 sites per year on the installation. Specific points to be used for mist netting will be selected in consultation with Arnold AFB Natural Resources personnel.

Captured bats of all species will be banded with either 2.9 mm uniquely numbered aluminum lipped bands (Porzana Ltd, Icklesham, East Sussex, UK) provided by Arnold AFB or, in the case of tri-colored bats, with Tennessee Wildlife Resources Agency (TWRA) 2.4 mm bands.

Genetic analysis will identify prey species to the lowest taxonomic classification possible using the barcode of life data system (BOLD), GenBank, and/or other genetic database(s). Species accumulation curves will be used to indicate the completeness of dietary sampling.

Comparisons will be made between bat species and years utilizing the lowest operational taxonomic units (OTU) possible (e.g., family, genus, species). Comparisons should include differences in composition, richness, and evenness of prey OTUs. Significant dietary OTUs, if they exist, should be identified for each species of bat for which samples are collected. Within-species variation in diet will be assessed for species where multiple individuals were sampled. Relate prey species composition to previous bat and arthropod studies in addition to foraging habitat quality (forest, lentic and lotic waters) using available reports and data provided by the Base. Specific statistical analyses will be identified in the study plan, but may include:

- Bipartite networks created to visualize dietary connections between each bat species and their dietary components (community interactions and

associations), and between bat species and their insect prey at the level of taxonomic Family (species associations).

- An adjacency matrix to visualize possible modules within the Arnold AFB bat community.
- Non-metric multidimensional scaling or other distance-based techniques

C. Reporting:

The NFE shall compile all data and findings of the project into a scientifically formatted report for the Arnold AFB Natural Resources Manager's review and comment. The report shall include a summary and interpretation of the data with spreadsheets listing all prey species detected for each bat species and the location(s) from which they were collected.

Upon review (and subsequent return) of the draft reports, comments will be addressed, and the final reports will be submitted to Arnold AFB. All government comments should be addressed in a response to comments matrix and provided within 14 days of receipt of comments. Once the government approves the NFE responses, the NFE can finalize the report and distribute.

All geographic data will be provided for entry into the Arnold AFB GIS database. Format will be in SDSFIE 3.1 or determined in consultation with GIS specialist.

At 20.5 months after award of agreement, the NFE shall submit a draft final report for two-week inspection and feedback period by government. Final report due at 23 months after award of agreement. Duration of project is expected to be 24 months.

4. QUALIFICATIONS

The NFE should meet the minimum qualifications necessary to perform tasks described in the project work statement. The principal investigator should have experience directing the efforts of the project team. NFE personnel shall have the technical experience, the field implementation experience, any required state and federal certifications, and any required state or federal handling or application permits likely to be used in this project, specifically a Section 10 Permit from US Fish and Wildlife Service and a Scientific Collection Permit from Tennessee Wildlife Resources Agency. The NFE shall furnish all labor, materials, equipment, supplies, technical expertise, and supervision needed to perform all field efforts.

5. GOVERNMENT FURNISHED MATERIALS OR PROPERTY

- 5.1 Physical Data: Arnold AFB shall provide access to any necessary data, existing reports, recent studies, and any other information necessary to complete the objectives of this scope.
- 5.2 Equipment: Government-furnished materials or property is governed by 2 C.F.R. Part 200.312 which states that a) Title to federally-owned property remains vested in the Federal government. The non-Federal entity must submit annually an inventory listing of federally-owned property in its custody to the Federal awarding agency. Upon

completion of the Federal award or when the property is no longer needed, the non-Federal entity must return the property to the Federal awarding agency for further Federal agency utilization.

6. PERIOD OF PERFORMANCE

24 months for support, from date of agreement award. There are no option periods.

7. COORDINATION

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8. DELIVERABLES

Table 1. Project Schedule

The project shall be implemented according to the following schedule:

Task	Date
Study Plan/Equipment Preparation	March – April 2022
Field Surveys	June – September 2022 and 2023
Lab work and Prey Species Identification	October 2022 – December 2023
Report Preparation	January - March 2024

Table 2. Deliverables Schedule

Deliverable	Schedule	Distribution
Quarterly Progress Reports/Weekly Meetings: The NFE shall provide quarterly comprehensive progress reports. The NFE shall set up a weekly progress meeting with the AF PM and USACE PM to discuss progress, issues, and plans for the upcoming schedule.	Quarterly reports are to be delivered on the 10th day of each month via email.	Submission by email to Installation POC and USACE PM
Draft / Final Study Plan: Prepare and submit draft plan for government review and comment. Address government comments, and upon approval of comment responses, prepare and submit final report.	Draft Study Plan is due within 60 after award of agreement. Government shall be provided 30 days for review and comment. Comment responses and final report to be due within 21 days after government response.	Submit electronic copy to the Arnold AFB PM and USACE PM.
Draft Report: Prepare and submit draft report with all data collected. This shall include a summary and interpretation of data and spreadsheets listing all prey species detected from each bat species and the location(s) from which they were collected.	Draft report is due 60 days prior to the end of the period of performance.	Submit electronic copy to the Arnold AFB PM and USACE PM.
Final Report: Prepare and submit final report addressing government comments.	Submit draft final report for two-week inspection and feedback period by government. Final report due at 23 months after award of agreement.	Submit final report in electronic and hard copy to Arnold AFB and electronic copy only to USACE PM.
GIS Final Deliverables: Delivery of GIS data to be coordinated with the Arnold AFB GIS staff.	Submit with final report, or as determined through coordination with Arnold AFB.	Data to be submitted in SDSFIE 3.1 format (or latest version).

- 8.1 Study Plan (Draft and Final): The draft and final study plan shall include the following sections: Introduction; Methods, including lab techniques, genetic analysis protocols, GIS mapping procedures, and data analysis; and schedule for project implementation.
- 8.2 Progress Reports: The contractor will provide minutes from weekly phone updates. The contractor shall prepare quarterly progress reports to include a summary of progress and results in all phases of the project, including any anticipated schedule alterations and a summary of resources consumed. Invoices for partial payment shall be submitted to coincide with receipt of the quarterly progress reports. No partial payment will be approved unless the government has received all progress reports.
- 8.3 Draft and Final Reports: Draft report shall be submitted in electronic format, and the final report shall be submitted in both electronic and hard formats. Reports shall include, but not be limited to:

- Introduction describing the basis for the project and overall study approach
- Methods section including maps and descriptions of the study areas, lab techniques, genetic analysis protocols, GIS mapping procedures, and data analysis
- Results section providing details of the study including data analysis
- Discussion section interpreting the study findings
- Management Recommendations section
- Recommendations for Future Study section detailing potential projects

8.4 Electronic data delivered in SDSFIE 3.1 format (or latest version) coordinated early in the project with Arnold AFB GIS staff to ensure integration into Arnold AFB's GIS.

9. ADMINISTRATION

9.1 This cooperative agreement may be administered through a CESU only upon mutual agreement and official authorization by both parties of the acceptance of the application of the CESU Network IDC rate (17.5%).

9.2 Any resulting cooperative agreement will be subject to and recipient/cooperator shall comply with 2 CFR 200.313 "Equipment", 200.314 "Supplies", and 200.315 "Intangible Property" which includes use of research data.

10. SELECTED LITERATURE

Bernard, R. F., E. V. Willcox, R. T. Jackson, V. A. Brown, and G. F. McCracken. 2021.

Feasting, not fasting: winter diets of cave hibernating bats in the United States. *Frontiers in Zoology* 18:48.

Clare, E. L., E. E. Fraser, H. E. Braid, M. B. Fenton, and P. D. Hebert. 2009. Species on the menu of a generalist predator, the eastern red bat (*Lasiurus borealis*): using a molecular approach to detect arthropod prey. *Molecular Ecology* 18, 2532–2542

Clare, E. L., B.R. Barber, B.W. Sweeny, P.D. Hebert, and M.B. Fenton. 2011. Eating local: influences of habitat on the diet of little brown bats (*Myotis lucifugus*). *Molecular Ecology* doi: 10.1111/j.1365-294X.2011.05040.x.

Clare, E. L., W. O. C. Symondson, H. Broders, F. Fabianek, E. E. Fraser, A. Mackenzie, A. Boughen, R. Hamilton, C. K. R. Willis, F. Martinez-Nunez, A. K. Menzies, K. J. O. Norquay, M. Brigham, J. Poissant, J. Rintoul, R. M. R. Barclay, and J. P. Reimer. 2013. The diet of *Myotis lucifugus* across Canada: assessing foraging quality and diet variability. *Molecular Ecology. Special Issue: Molecular Detection of Trophic Interactions*. doi: 10.1111/mec.12542

Clare, E. L., W. O. C. Symondson, and M. B. Fenton. 2014. An inordinate fondness for beetles? Variation in seasonal dietary preferences of night-roosting big brown bats (*Eptesicus fuscus*). *Molecular Ecology* 23, 3633–3647

- Dodd, L.E., E.G. Chapman, J.D. Harwood, M.J. Lacki, and L.K. Rieske. 2012. Identification of prey of *Myotis septentrionalis* using DNA-based techniques. *Journal of Mammalogy* 93(4): 1119–1128.
- Feldhamer, G.A., T.C. Carter, and J.O. Whitaker Jr. 2009. Prey Consumed by Eight Species of Insectivorous Bats from Southern Illinois. *The American Midland Naturalist* 162(1):43-51.
- Ulyshen, M.D. 2011. Arthropod vertical stratification in temperate deciduous forests: Implications for conservation-oriented management. *Forest Ecology and Management* 261: 1479–1489.
- Wray, A.K., M.Z. Peery, M.A. Jusino, J.M. Kochanski, M.T. Banik, J.M. Palmer, D.L. Lindner, and C. Gratton. 2021. *Molecular Ecology* 30(3), 855-873.

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