FINAL

Task Summary Report

For

Task Order N4008018F5125 Task 9F

Bat Survey

At

Naval Support Activity Annapolis

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Prepared for
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Prepared by
Marstel-Day, LLC
and
Conservation Management Institute

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EXECUTIVE SUMMARY

Over the past decade, bat conservation has become one of the most important topics in natural resource management due to severe population declines. It is important for Department of Defense natural resource managers to have a comprehensive picture of how bats utilize specific installations in order to maintain healthy populations and comply with environmental regulations.

An acoustic and capture bat survey was conducted at the Naval Support Activity Annapolis, Annapolis MD, from 17-21 June 2019. Six locations were surveyed acoustically across four nights, for a total of 24 detector nights. Two of these locations were also surveyed via mist-net for two nights each over 19-21 June 2019. Six bat species were confirmed to occur on the installation: big brown bat (*Eptesicus fuscus*), eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), silver-haired bat (*Lasionycteris noctivagans*), little brown bat (*Myotis lucifugus*), and evening bat (*Nycticeius humeralis*). Big brown bats and eastern red bats were captured via mist-net. The eastern red bats showed signs of reproduction, with the presence of lactating females. These findings are complementary to other surveys in the region. No federally threatened or endangered species were detected over the duration of this study.

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NAVAL SUPPORT ACTIVITY ANNAPOLIS BAT SURVEY

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDICES

ABBREVIATIONS AND ACRONYMS

Acronym	Definition
BCID	Bat Call Identification
CMI	Conservation Management Institute
EPTFUS	*Eptesicus fuscus* (big brown bat)
ESA	Endangered Species Act
KaPRO	Kaleidoscope Pro
LASBOR	*Lasiurus borealis* (eastern red bat)
LASCIN	*Lasiurus cinereus* (hoary bat)
LASNOC	*Lasionycteris noctivagans* (silver-haired bat)
MLE	maximum likelihood estimate
MYOAUS	*Myotis austroriparius* (southeastern myotis)
MYOLUC	*Myotis lucifugus* (little brown bat)
MYOSEP	*Myotis septentrionalis* (northern long-eared bat)
MYOSOD	*Myotis sodalis* (Indiana bat)
NAVFAC Washington	Naval Facilities Engineering Command, Naval District Washington
NSA	Naval Support Activity
NYCHUM	*Nycticeius humeralis* (evening bat)
PERSUB	*Perimyotis subflavus* (tri-colored bat)
USFWS	U.S. Fish and Wildlife Service

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1 INTRODUCTION

Over the past decade, bat conservation has become one of the most important topics in natural resource management. North American bat species are major consumers of nocturnal insects, and the ecological top-down trophic control of insects that these bats provide has significant ecological and economic impacts (Kunz et al. 2011). These and other potentially far-reaching trophic cascading effects emphasize the ecological importance of bat communities and their conservation. Economically, the control of crop and forest pests by bats in North America is estimated to have an approximate value of $3.7 billion annually based on potential losses and increased pesticide requirements in their absence, a practice that would likely bear many of its own ecological consequences (Boyles et al. 2011).

North American bat species have been experiencing severe population declines, including bats in the Mid-Atlantic region (Powers et al. 2015; O'Shea et al. 2016; Reynolds et al. 2016). Declines of up to 95 percent have occurred in some species across their range (Turner et al. 2011). Various factors are contributing to the decline. The invasive fungal pathogen, *Pseudogymnoascus destructans*, which causes the infectious and fatal disease known as white-nose syndrome, has decimated cave dwelling bats during hibernation periods through eastern and mid-western North America (Ford et al. 2011; USFWS 2018b). In addition, high-mortality events from wind energy development have resulted in heavy population declines of migratory and forest dwelling bats (Arnett et al. 2008). Habitat loss and fragmentation from urban development and deforestation is another factor negatively affecting bat populations. Bats rely on forested landscapes for their summer reproductive habitat, with several species primarily utilizing standing snags. For this reason, urban development and deforestation pose a threat to this already vulnerable taxon (Silvis et al. 2016). Furthermore, these factors often act synergistically to negatively affect bat populations. Therefore, conservation of bat species at any level will help preserve these imperiled and beneficial animals from further population declines.

Military readiness requires that military installations provide training areas and live fire ranges in support of the military mission. All Department of Defense administered installations are also required to abide by all national environmental laws, including the Endangered Species Act (ESA). ESA Section 7(a) requires federal agencies to ensure that their actions are "not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species," and mandates that "each agency shall use the best scientific and commercial data available" to fulfill these requirements (USFWS 2016; Virginia Department of Game and Inland Fisheries 2016; USFWS 2017). These mandates can lead to conflicts when training activities change in response to

evolving mission requirements. The presence of federally threatened or endangered bat species within a proposed action area can mean heightened regulatory scrutiny on resource utilization and development, with the potential need for consultation with the U.S. Fish and Wildlife Service (USFWS) under ESA Section 7. Therefore, it is necessary for installation natural resource managers to have the best information available to act proactively in avoiding conflicts between military training and environmental compliance.

For land managers to effectively conserve bat populations and maintain environmental compliance, they must have the most current and robust estimations of species occurrence on properties under their purview. The objective of this study is to determine which species of bats are present on Naval Support Activity (NSA) Annapolis, Annapolis, MD, and to measure the relative nightly activity levels of those species. This information will assist natural resource managers at NSA Annapolis to make informed decisions to help effectively manage their lands. This report summarizes the 2019 acoustic and mist-net bat surveys conducted at NSA Annapolis under Task Order N4008018F5125 Task 9F for Naval Facilities Engineering Command, Naval District Washington (NAVFAC Washington). Marstel-Day, LLC (Marstel-Day) managed the bat surveys in consultation with the NAVFAC Washington project manager and installation point of contact. Conservation Management Institute at Virginia Tech (CMI), of Blacksburg, Virginia, was contracted by Marstel-Day to conduct the field surveys and analyze the acoustic data.

2 METHODS

2.1 Project Area Description

NSA Annapolis is approximately 1,500 acres (6.07 square kilometers) and is located in Anne Arundel County, Maryland approximately 30 miles east of Washington, DC and 20 miles southeast of Baltimore (Figure 2-1). Anne Arundel County is in the Western Shore Region of Maryland and is bordered to the east by the Chesapeake Bay. NSA Annapolis and the U.S. Naval Academy are divided by the Severn River, with the U.S. Naval Academy to the west and North Severn, including Greenbury Point, Possum Point, and the U.S. Naval Academy Golf Course, to the east. Bat surveys were conducted on North Severn.

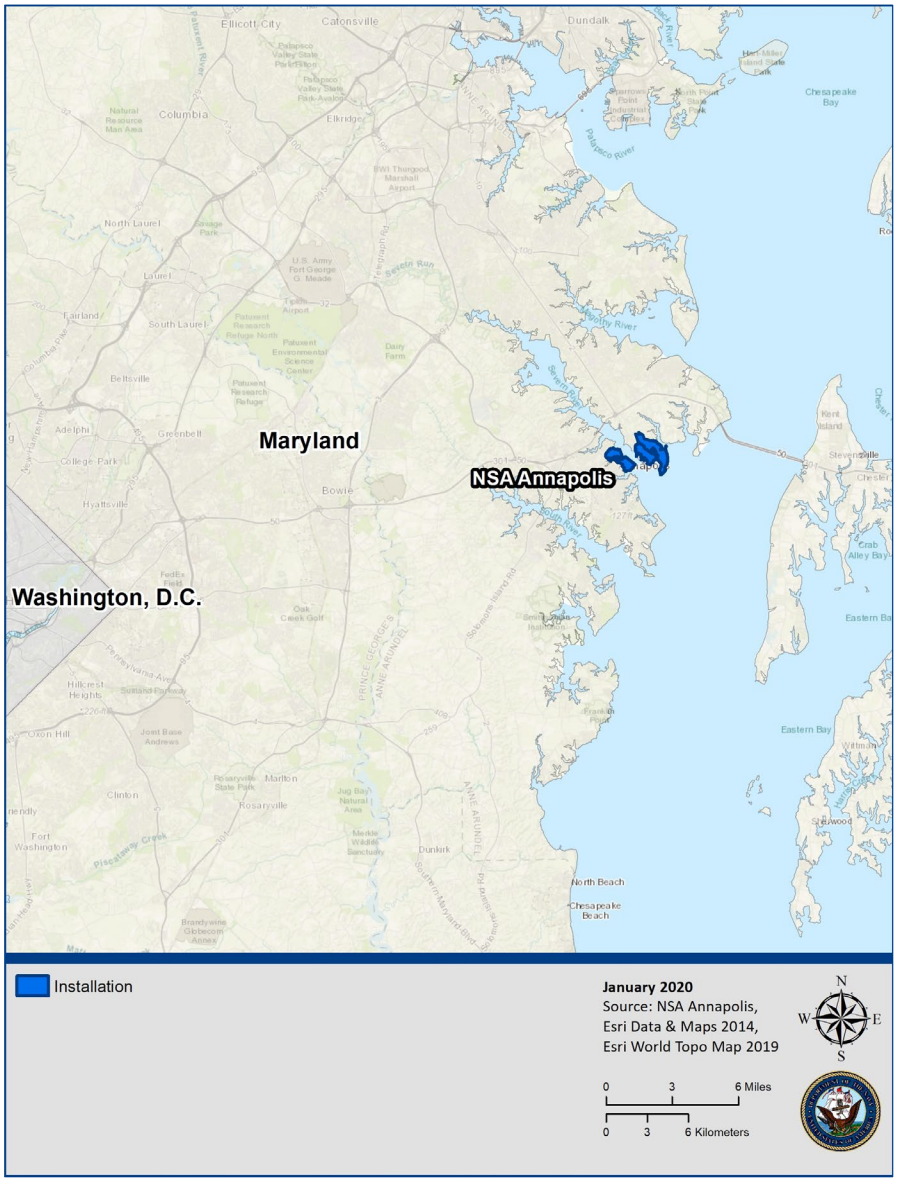

Figure 2-1. Project Location

2.2 Survey Protocol Approach

The survey and analytical approach and protocols followed the "Range-wide Indiana Bat Summer Survey Guidelines," (USFWS 2018a) which includes "Northern Long-eared Bat Survey Guidelines" (USFWS 2014; USFWS 2017). To obtain species presence, ultrasonic acoustic detectors were used to determine which species were occupying and utilizing the installation (Corben 2002; St. Germain et al. 2017). Planning level capture surveys were conducted in accordance with USFWS protocols (USFWS 2017).

2.3 Survey Site Locations

Acoustic and capture surveys were conducted in suitable bat habitat identified within the installation (Figure 2-2). These sites represented higher probabilities of detecting bats and areas of interest to the installation natural resources manager. Surveys targeted areas where bat activity is likely highest (Kunz and Kurta 1988). These areas included flight corridors created by perennial road ruts and old road right of ways, creeks, ponds, or other waterways, as well as potential foraging areas (e.g. forest clearings) (Murray et al. 1999). A minimum spacing of 200 meters between sampling locations was used, where possible.

2.4 Survey Protocol

One Songmeter SM4 or SongmeterZC acoustic detector was deployed at each survey location. Detectors used the SM-UU1 omni-directional microphone (Wildlife Acoustics, Maynard, Massachusetts). Units remained at each location for four consecutive calendar nights. Six locations (Figure 2-2) were sampled for a total of 24 detector nights, beginning on 17 June and concluding on 21 June 2019.

Mist-net capture surveys took place at two locations (ANO_n09, ANO_n15) near acoustic site ANO_09 and ANO_15 respectively, for two consecutive nights each over 19-21 June 2019. Three mist-net configurations were used at each site for a total of 12 complete net nights. Site ANO_n09 was along a wooded unimproved road adjacent to the golf course; Net A was a double high 6-meter, Net B was a double high 6-meter, and Net C was a single high 6-meter. Site ANO_n15 was along an improved path behind the nature center; Net A was a double high 9-meter, Net B was a double high 9-meter, and Net C was a single high 6-meter.

Figure 2-2. NSA Annapolis Overview Map with Survey Sites

2.5 Data Analysis

The collected acoustic data was screened for 10 species, based on the geographic location of NSA Annapolis and other species observations in the region (Kalen et al. 2017; St. Germain 2017; St. Germain et al. 2017; Marstel-Day and Conservation Management Institute 2018). Quantitative analysis of the acoustic data was conducted using USFWS-approved software Kaleidoscope Pro (KaPro) v4.2.0 (Wildlife Acoustics 2018) and Bat Call Identification (BCID) v2.7d (Allen 2014) using the balanced setting (0) and a 95 percent confidence threshold for the maximum likelihood estimator (MLE) ($\alpha \leq 0.05$). MLE is a method of estimating the parameters of a statistical model that can be used to determine species presence or probable absence at a site on a particular night by means of a classification matrix. The probability values provided in the guidelines (95 percent) from the MLE is a measure of the probability that the call parameters recorded match the distribution of the known or established call parameters of a species. In this case, the MLE represents the probability of misidentification; therefore, a value of ≤ 0.05 has met the criteria for likelihood of correct classification.

In addition to using quantitative outputs from the approved software packages, representative calls for each species were followed up using qualitative measures, including individual review and verification by Michael St. Germain and then cross-validated with agreement by both Kaleidoscope and BCID programs. This qualitative analysis was additionally conducted for all calls from both state and federally listed threatened or endangered species.

For the capture data, individuals were identified to species, and standard morphometric measurements were recorded with specific attention to reproductive condition.

3 RESULTS

A total of 2,652 call files were recorded, of which 498 were bat calls, 341 could not be identified, and 1,813 were classified as noise, according to results from the KaPro quantitative analysis. From these calls, six bat species were identified as occurring on the installation: big brown bat, eastern red bat, hoary bat, silver-haired bat, little brown bat, and evening bat (Table 3-1, Table 3-2).

For each species screened with the Kaleidoscope output, MLE p-values were provided to show the probability of misidentification (Table 3-3) for each night. With correct classifications, the data were summarized into an average nightly activity index at each sampling location/night (i.e., activity = [# calls / nights surveyed]) (Table 3-4).

Nine bats were captured during the survey period (Table 3-5). Captures included big brown bat (n=3) and eastern red bat (n=6). Four of the eastern red bat females were lactating, suggesting successful reproduction on or in the vicinity of NSA Annapolis.

Table 3-1. Species Presence Results[1]

			Number of Calls	
Species Code	Common Name	Scientific Name	Total (6 sites)	Average (24 nights)
EPTFUS	big brown bat	*Eptesicus fuscus*	193	8.0
LASBOR	eastern red bat	*Lasiurus borealis*	26	1.1
LASCIN	hoary bat	*Lasiurus cinereus*	31	1.3
LASNOC	silver-haired bat	*Lasionycteris noctivagans*	104	4.3
MYOAUS	southeastern myotis	*Myotis austroriparius*		
MYOLUC	little brown bat	*Myotis lucifugus*	44	1.8
MYOSEP*	northern long-eared myotis	*Myotis septentrionalis*		
MYOSOD**	Indiana bat	*Myotis sodalis*		
NYCHUM	evening bat	*Nycticeius humeralis*	38	1.6
PERSUB	tri-colored bat	*Perimyotis subflavus*		
		Number of Species	**6**	
* Denotes federally threatened species				
** Denotes federally endangered species				

[1] Each species was screened for analysis with potential occurrence at NSA Annapolis, Annapolis MD, 17-21 June 2019, and detection record based upon USFWS survey guidelines. Detections are based on agreement between Kaleidoscope Pro v 4.2.0, BCID v2.7, and hand verifications (qualitative analyses).

Table 3-2. Acoustic Detections and Average Number of Calls Collected per Night at Each Site[1]

			Average Number of Calls / Night (n=4)					
Species Code	Common Name	Scientific Name	ANO_05	ANO_06	ANO_09	ANO_11	ANO_15	ANO_38
EPTFUS	big brown bat	*Eptesicus fuscus*			39.3	9.0		
LASBOR	eastern red bat	*Lasiurus borealis*			6.5			
LASCIN	hoary bat	*Lasiurus cinereus*			1.0	6.8		
LASNOC	silver-haired bat	*Lasionycteris noctivagans*			13.3	12.8		
MYOAUS	southeastern myotis	*Myotis austroriparius*						
MYOLUC	little brown bat	*Myotis lucifugus*			11.0			
MYOSEP*	northern long-eared myotis	*Myotis septentrionalis*						
MYOSOD**	Indiana bat	*Myotis sodalis*						
NYCHUM	evening bat	*Nycticeius humeralis*			8.0	1.5		
PERSUB	tri-colored bat	*Perimyotis subflavus*						
* Denotes federally threatened species								
** Denotes federally endangered species								

[1] Number and percent of calls collected that met the maximum likelihood estimation (α≤0.05) for each species with potential occurrence at NSA Annapolis, Annapolis MD, 17-21 June 2019, derived from Kaleidoscope Pro (KaPro) v4.2.0, and hand verification (qualitative analysis).

Table 3-3. KaPro Acoustic Software MLE Results[1]

		Species Code and MLE Value									
Site	Date	EPTFUS	LASBOR	LASCIN	LASNOC	MYOAUS	MYOLUC	MYOSEP	MYOSOD	NYCHUM	PERSUB
ANO_05	20190617	1	1	1	0.176664	1	1	1	1	1	1
ANO_05	20190618	1	1	1	1	1	1	1	1	1	1
ANO_05	20190619	1	1	1	0.176664	1	1	1	1	1	1
ANO_05	20190620	1	1	1	0.176664	1	1	1	1	1	1
	Global MLE	**1**	**1**	**1**	**0.005514**	**1**	**1**	**1**	**1**	**1**	**1**
ANO_06	20190617	1	1	1	1	1	1	1	1	1	1
ANO_06	20190618	1	1	1	1	1	1	1	1	1	1
ANO_06	20190619	1	1	1	1	1	1	1	1	1	1
ANO_06	20190620	1	1	1	1	1	1	1	1	1	1
	Global MLE	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
ANO_09	20190617	0	1	1	0.61759	1	0	1	1	0.000857	0.409448
ANO_09	20190618	0	0	1	0	1	5E-07	1	1	0.782472	0.836758
ANO_09	20190619	0.031326	7.6E-06	0.000937	1	1	0.594129	1	1	0.873321	1
ANO_09	20190620	2.02E-05	8E-07	1	0.01194	1	0.00264	1	1	1.3E-06	1
	Global MLE	**0**	**0**	**1**	**0**	**1**	**0**	**1**	**1**	**4E-07**	**0.908446**
ANO_11	20190617	4.4E-06	1	0.032881	0.010548	1	1	1	1	1	1
ANO_11	20190618	0.013823	1	0	2.34E-05	1	1	1	1	0.072623	1
ANO_11	20190619	0.02297	1	0.01431	0.000221	1	1	1	1	0.072623	1
ANO_11	20190620	0.019379	1	1	0.000761	1	1	1	1	0.000378	1
	Global MLE	**0**	**1**	**0**	**0**	**1**	**1**	**1**	**1**	**0.000002**	**1**
ANO_15	20190617	0.138881	1	1	1	1	1	1	1	1	1
ANO_15	20190618	1	1	1	1	1	1	1	1	1	1
ANO_15	20190619	1	1	1	1	1	1	1	1	1	1
ANO_15	20190620	1	1	1	1	1	1	1	1	1	1
	Global MLE	**0.138881**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
ANO_38	20190617	1	1	1	1	1	1	1	1	1	1
ANO_38	20190618	1	1	1	1	1	1	1	1	1	1
ANO_38	20190619	1	1	1	1	1	1	1	1	1	1
ANO_38	20190620	1	1	1	1	1	1	1	1	1	1
	Global MLE	**0.138881**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

[1] Maximum likelihood estimation (α≤0.05, probability of misidentification) for each species with potential occurrence at NSA Annapolis, Annapolis MD, 17-21 June 2019. Output is from Kaleidoscope Pro v4.2.0.

Table 3-4. Average Nightly Activity Index[1]

		Species Code and Number of Call Files Collected									
Site	Date	EPTFUS	LASBOR	LASCIN	LASNOC	MYOAUS	MYOLUC	MYOSEP	MYOSOD	NYCHUM	PERSUB
ANO_05	20190617	0	0	0	0	0	0	0	0	0	0
ANO_05	20190618	0	0	0	0	0	0	0	0	0	0
ANO_05	20190619	0	0	0	0	0	0	0	0	0	0
ANO_05	20190620	0	0	0	0	0	0	0	0	0	0
	subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	average	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
ANO_06	20190617	0	0	0	0	0	0	0	0	0	0
ANO_06	20190618	0	0	0	0	0	0	0	0	0	0
ANO_06	20190619	0	0	0	0	0	0	0	0	0	0
ANO_06	20190620	0	0	0	0	0	0	0	0	0	0
	subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	average	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
ANO_09	20190617	105	0	0	0	0	19	0	0	8	0
ANO_09	20190618	38	12	0	44	0	16	0	0	0	0
ANO_09	20190619	3	5	4	0	0	0	0	0	0	0
ANO_09	20190620	11	9	0	9	0	9	0	0	24	0
	subtotal	**157**	**26**	**4**	**53**	**0**	**44**	**0**	**0**	**32**	**0**
	average	**39.3**	**6.5**	**1.0**	**13.3**	**0.0**	**11.0**	**0.0**	**0.0**	**8.0**	**0.0**
ANO_11	20190617	13	0	5	11	0	0	0	0	0	0
ANO_11	20190618	10	0	17	19	0	0	0	0	0	0
ANO_11	20190619	7	0	5	12	0	0	0	0	0	0
ANO_11	20190620	6	0	0	9	0	0	0	0	6	0
	subtotal	**36**	**0**	**27**	**51**	**0**	**0**	**0**	**0**	**6**	**0**
	average	**9.0**	**0.0**	**6.8**	**12.8**	**0.0**	**0.0**	**0.0**	**0.0**	**1.5**	**0.0**
ANO_15	20190617	0	0	0	0	0	0	0	0	0	0
ANO_15	20190618	0	0	0	0	0	0	0	0	0	0
ANO_15	20190619	0	0	0	0	0	0	0	0	0	0
ANO_15	20190620	0	0	0	0	0	0	0	0	0	0
	subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	average	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
ANO_38	20190617	0	0	0	0	0	0	0	0	0	0
ANO_38	20190618	0	0	0	0	0	0	0	0	0	0
ANO_38	20190619	0	0	0	0	0	0	0	0	0	0
ANO_38	20190620	0	0	0	0	0	0	0	0	0	0
	subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	average	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

[1] Number of calls collected that met the maximum likelihood estimation ($\alpha \leq 0.05$) for each species with potential occurrence at NSA Annapolis, Annapolis MD, 17-21 June 2019, derived from Kaleidoscope Pro v4.2.0.

Table 3-5. Bat Capture Results[1]

Site	Date (yyyymmdd)	Species Code	Time	Net	Sex	Weight (g)	Forearm (mm)	Age	Reproductive Condition	Wing Score
AN0_n09	20190619	EPTFUS	2139	B	male	15	44	adult	non-reproductive	0
		LASBOR	2220	A	male	12	40	adult	non-reproductive	
		LASBOR	2400	A	female	14	40	adult	lactating	
AN0_n09	20190620	LASBOR	2215	B	female	13	40	adult	lactating	
ANO_n15	20190619	LASBOR	2145	B	female		39	adult	lactating	
		EPTFUS	2200	B	male		43	adult	non-reproductive	0
		EPTFUS	2215	B						
		LASBOR	2330	B	male			adult	non-reproductive	0
		LASBOR	2330	B	female		40	adult	lactating	0
ANO_n15	20190620	NO CAPTURES								

[1] Bat capture results at NSA Annapolis, Annapolis MD, 19-21 June 2019.

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4 DISCUSSION

No federally threatened or endangered species were detected during the duration of this study. The results from this acoustic study are consistent with other regional surveys (Kalen et al. 2017; St. Germain 2017; Marstel-Day and Conservation Management Institute 2018). The most commonly detected bats were the big brown bat, silver-haired bat, and eastern red bat. Calls of the hoary bat, little brown bat, and evening bat were also collected. There were several captures of both male and female big brown bats and eastern red bats. All the female eastern red bats were lactating. This evidence suggests that the eastern red bat is successfully reproducing on or near NSA Annapolis. The variation between detections and captures is in part due to inherent sampling biases with each approach and an amalgamation of many outside factors. The combination of sampling techniques used in this study provided a more comprehensive picture of the bat species assemblage on NSA Annapolis. These data can serve as baseline information to monitor species trends over time or to compare the relative activity for each species among sites and nights.

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6 LIST OF CONTRIBUTORS

This project was conducted collaboratively between the Navy and contractor contributors.

U.S. Department of the Navy

Adrian Dascalu, NAVFAC Washington (NAVFAC Project Manager)

Katharine Seguin, NSA Annapolis (Installation Project Manager)

Contractors

Dr. Sean Donahoe, Marstel-Day (Partner-in-Charge)

Jennifer Allen, Marstel-Day (Task Order Project Manager)

John Cannon, Marstel-Day (Project Lead)

Michael St. Germain, Conservation Management Institute (Project Manager, Lead Author)

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APPENDIX A. REPRESENTATIVE BAT SURVEY PHOTOGRAPHS

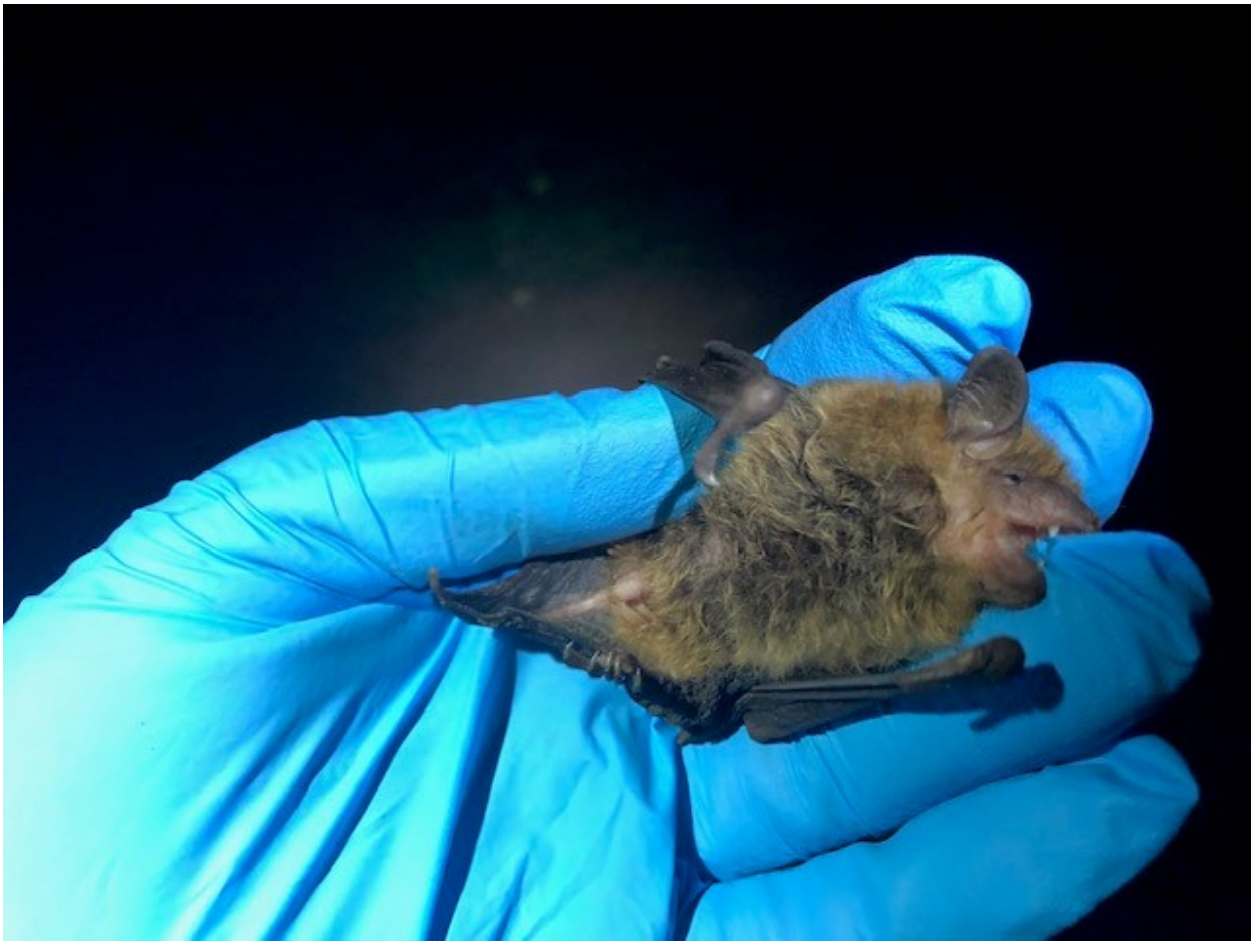

Figure A-1. Captured Big Brown Bat (*Eptesicus fuscus*) on NSA Annapolis, Annapolis MD, 17-21 June 2019, Photograph by Michael St. Germain

Figure A-2. Captured Eastern Red Bat (*Lasiurus borealis*) on NSA Annapolis, Annapolis MD, 17-21 June 2019, Photograph by Michael St. Germain

Figure A-3. Captured Eastern Red Bat (*Lasiurus borealis*) on NSA Annapolis, Annapolis MD, 17-21 June 2019, Photograph by Michael St. Germain

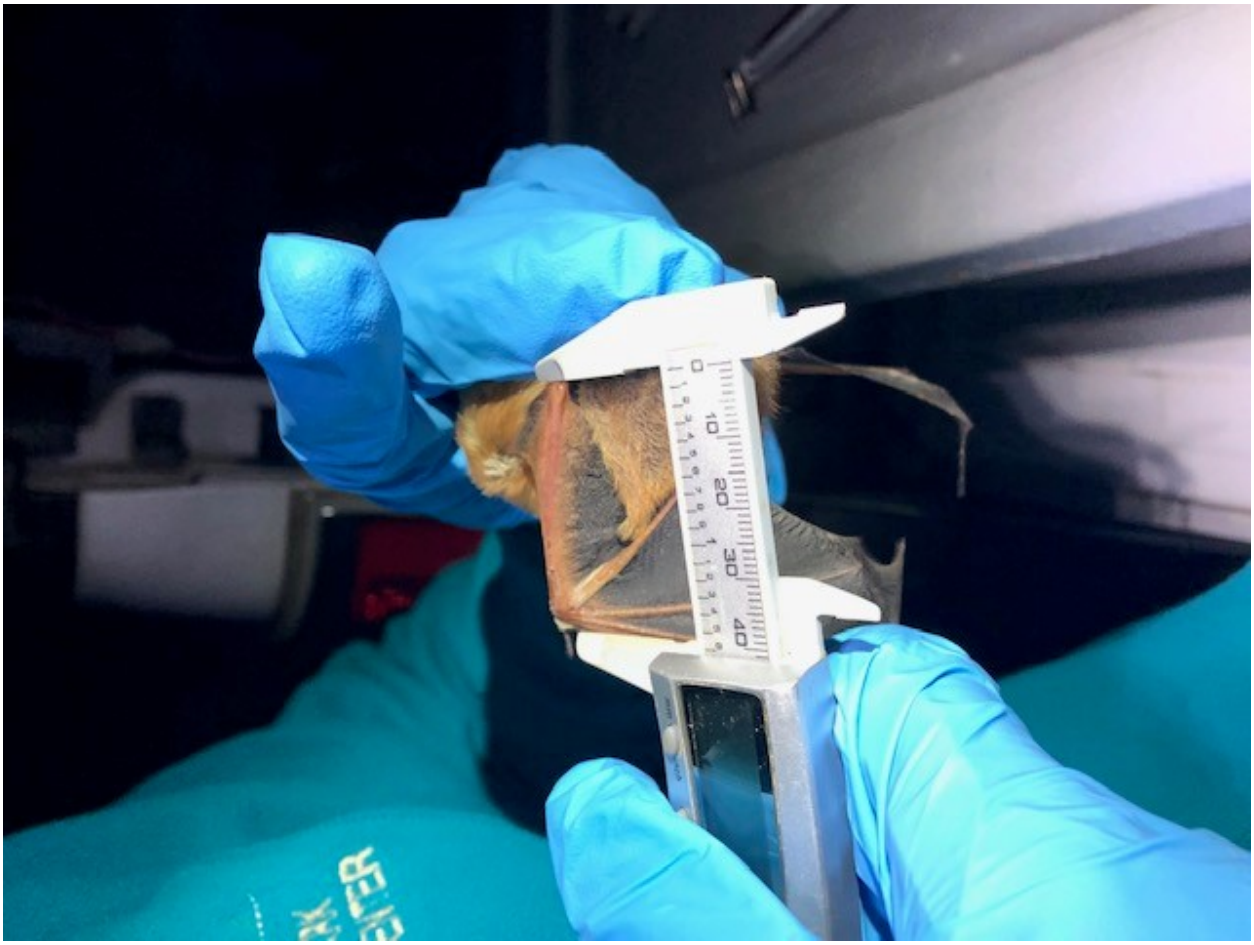

Figure A-4. Measuring the Forearm of an Eastern Red Bat (*Lasiurus borealis*) on NSA Annapolis, Annapolis MD, 17-21 June 2019, Photograph by Michael St. Germain