

**Results of Bat Inventories at
Chattahoochee River National Recreation Area
and
Kennesaw Mountain National Battlefield
2015-2016**

National Battlefield Park Piedmont
South Atlantic Cooperative Ecosystems Studies Unit
(PSAC-CESU Cooperative Agreement Number P13AC00443)

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Project Objective: To cooperate with the University of Georgia to conduct an updated bat inventory at Chattahoochee River National Recreation Area and to conduct a baseline bat inventory at Kennesaw Mountain National Battlefield Park.

BACKGROUND AND SCOPE OF WORK

White-nose Syndrome (WNS) is a disease in bats caused by the fungus *Pseudogymnoascus destructans* (Pd). Since its discovery in 2006, WNS has killed millions of bats in the eastern United States (Frick et al. 2010, Langwig et al. 2012). The disease was first confirmed in Georgia in February 2013, and in 2014 Pd was confirmed in the county adjacent to the one in which Chattahoochee River National Recreation Area (CHAT) and Kennesaw Mountain National Battlefield (KEMO) occur. WNS has had a well-documented, devastating impact on bat populations as counted in winter hibernacula. What is less certain, is the resulting impact the disease has on bat presence on the landscape during the summer months.

Three species susceptible to WNS were documented in CHAT during the summer of 2004 and 2005: little brown bat (*Myotis lucifugus*), big brown bat (*Eptesicus fuscus*), and tricolored bat (*Perimyotis subflavus*). No bat inventories have occurred at KEMO, but the same three species are expected to occur there based on habitat similarity. Additionally, both parks are within the southernmost extent of the ranges of two federally-endangered bat species that are known to be susceptible to WNS: Northern long-eared bat (*M. septentrionalis*) and Indiana bat (*M. sodalis*).

This project involved implementing summer bat inventories to document presence and an index of relative abundance of bat species two years after WNS confirmation in the state and one year after Pd documentation in a county adjacent to the parks' county. Survey results will provide park managers with important information on bat distribution and the impacts of threats like WNS. This project also involved establishing monitoring routes to be included in routine bat monitoring efforts being conducted by the state.

Table 1. Bats of Georgia including species codes and state and federal status.

CODE	Scientific Name	Common Name	US Status	GA Status
CORA	<i>Corynorhinus rafinesquii</i>	Rafinesque's big-eared bat		Rare
EPFU	<i>Eptesicus fuscus</i>	big brown bat		
LANO	<i>Lasionycteris noctivagans</i>	silver-haired bat		
LABO	<i>Lasiurus borealis</i>	Eastern red bat		
LACI	<i>Lasiurus cinereus</i>	hoary bat		
LAIN	<i>Lasiurus intermedius</i>	Northern yellow bat		Species of Concern
LASE	<i>Lasiurus seminolus</i>	seminole bat		
MYAU	<i>Myotis austroriparius</i>	Southeastern myotis		Species of Concern
MYGR	<i>Myotis grisescens</i>	gray myotis	Endangered	Endangered
MYLE	<i>Myotis leibii</i>	Eastern small-footed myotis		Species of Concern
MYLU	<i>Myotis lucifugus</i>	little brown myotis		Species of Concern
MYSE	<i>Myotis septentrionalis</i>	Northern long-eared myotis	Threatened	Threatened
MYSO	<i>Myotis sodalis</i>	Indiana myotis	Endangered	Endangered
NYHU	<i>Nycticeius humeralis</i>	evening bat		
PESU	<i>Perimyotis subflavus</i>	tri-colored bat		Species of Concern
TABR	<i>Tadarida brasiliensis</i>	Brazilian free-tailed bat		

METHODS AND RESULTS

Mist netting

Mist netting is the most commonly used method for capturing bats traveling and foraging across the landscape, and can provide useful demographic parameters along with confirmation of species-presence in an area (Loeb et al. 2015). Standard mist netting techniques (Gardner et al. 1989) were used throughout the survey. Sites were selected in areas where a high level of bat activity was expected with mist nets placed over roads, trails, streams and other corridors. In general, nets were erected around sunset and taken down before 2 A.M EST. Captured bats were identified, weighed, measured and checked for signs of WNS. At CHAT, mist netting was completed over 3 nights in 2015 and over 6 nights in 2016. At KEMO, mist netting was completed over 2 nights in 2015 and over 7 nights in 2016. A summary of the capture locations and results are below (see Figs 1 – 4).

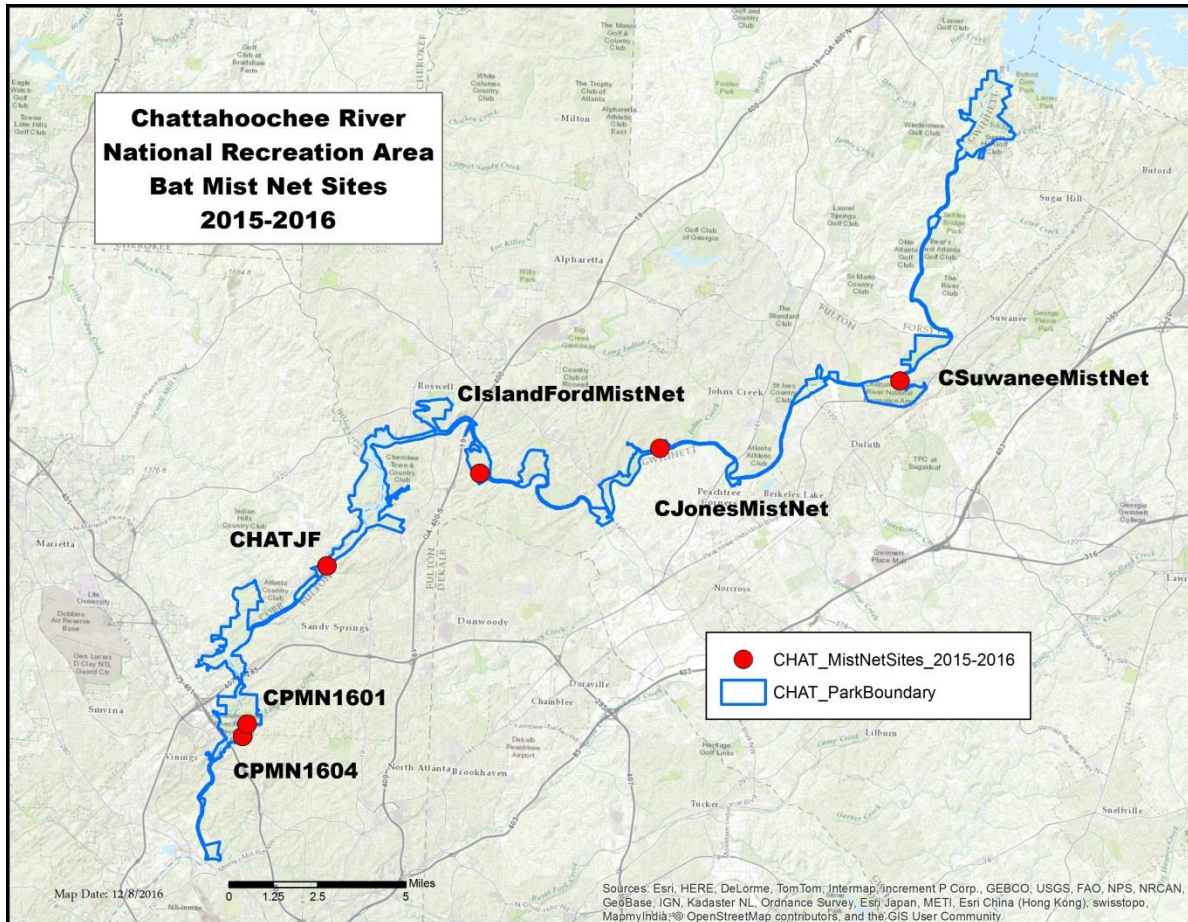


Figure1. Bat mist net locations at CHAT during 2015-2016.

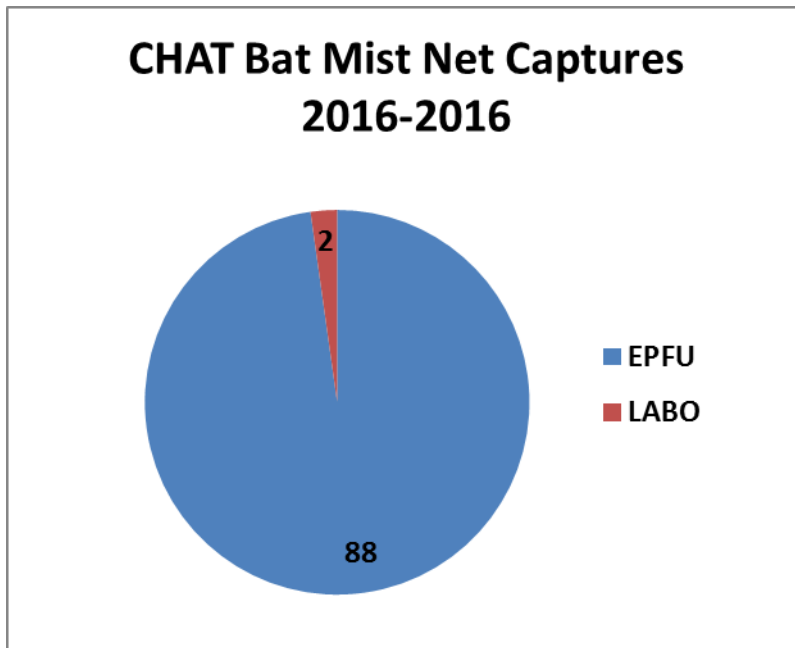


Figure 2. Bat mist net captures at CHAT during 2015-2016.

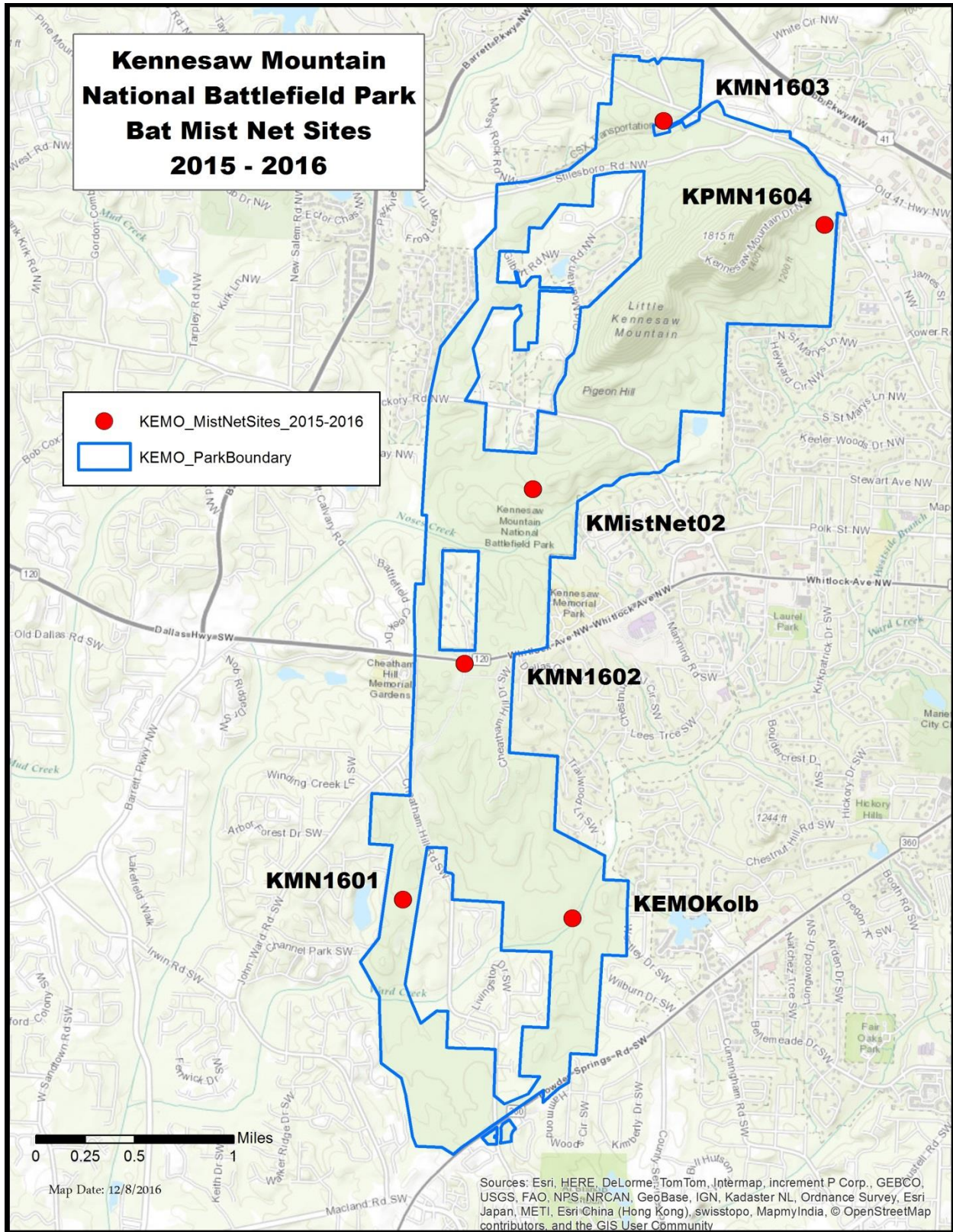


Figure 3. Bat mist net locations at KEMO during 2015-2016.

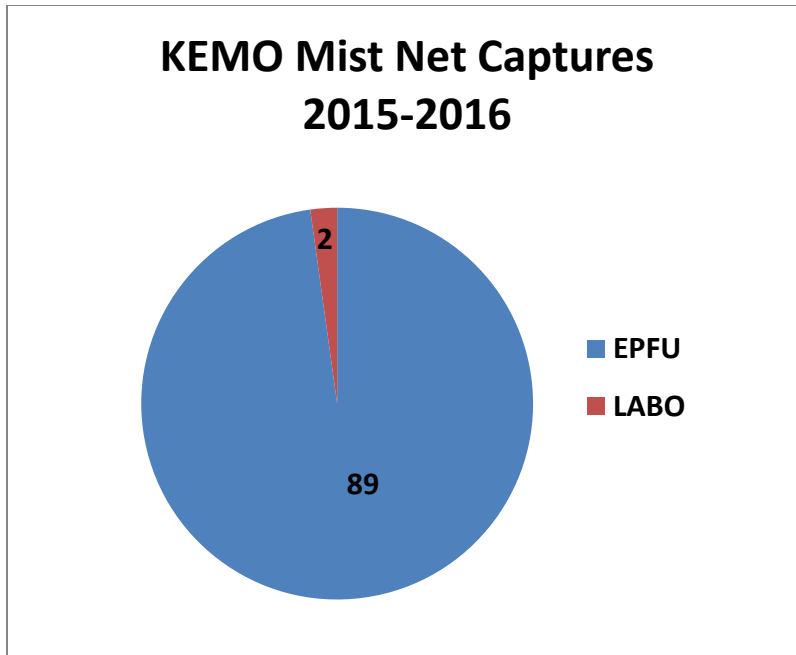


Figure 4. Bat mist net captures at KEMO during 2015-2016.

Stationary Anabat Units

Foraging bats are difficult to study due to their small size and volant, nocturnal nature. Because trapping bats is both labor intensive and biased towards species or individuals that do not detect the traps or nets (Berry et al. 2004, Larsen et al. 2007), acoustic methods are often employed for foraging studies. Generally, bat activity is measured in the number of files or passes recorded (Hayes 2007). Because it is not possible to discriminate between several bat passes made by a single bat flying repeatedly through a sampling area versus several bats each making a single pass, and because some species may be indistinguishable from others due to similar call characteristics or difficult to record (Fenton 1982, Lacki et al. 2007), bat activity should be used as a relative term for assessing bat use (traveling and foraging). While bat passes do not allow a direct estimate of population densities, this method does provide a relative measure of bat activity in an area and allows for comparisons to be made between sites over time (Adams et al. 2012).

Bat presence and activity was acoustically monitored at a total of 3 sites within the CHAT park boundary in late June through early July in 2016, and at a total of 5 sites within the KEMO park boundary in late July in 2015 and from June through July in 2016 (Figs 5 & 7). AnaBat Express detectors (Titley Scientific, Brendale, Australia) were housed in a plastic weatherproofing case and mounted above 1.5m on trees with microphones oriented away from vegetation or other obstructions (Britzke et al. 2010). Detectors were deployed at each sampling point to record bat echolocation sequences for a minimum of 4 nights in CHAT, resulting in 28 total detector nights, and for a minimum of 2 nights in KEMO, resulting in 34 total detector nights. Detectors used a built-in GPS feature to program sunset and sunrise times for automatic night recording. Sampling on nights with moderate to heavy rain was avoided when possible.

Bat echolocation call files were identified to species using Echoclass v. 3.1. bat call analysis software (Eric Britzke, ERDC) with the Species Set 1 classifier and a minimum of 3 call pulses. All passes identified as possible *Myotis* spp. were then manually examined to verify accuracy of the identification using AnaLookW v. 4.2f software (Titley Scientific, Columbia, MO). Bat activity was recorded in all 3 CHAT sites sampled in 2016, and in 4 of the 5 KEMO sites sampled between 2015 and 2016. The level of activity (mean number passes/night) varied by sites in both parks. *Myotis* spp. identified in CHAT and KEMO by Echoclass software, were classified after manual examination as other species. Six species were identified by Echoclass in both CHAT and KEMO (respectively Table 2, Table 3). Big brown bats and eastern red bats (*Lasiurus borealis*) were the most commonly recorded species identified in both CHAT and KEMO. Silver-haired (*Lasionycteris noctivagans*) and hoary (*L. cinereus*) bats were rarely recorded in CHAT, while hoary, evening (*Nycticeius humeralis*), and tri-colored bats were rarely recorded in KEMO. Within CHAT, the CSA1601 stationary acoustic site was the most productive, both in terms of call frequency and species richness, with 45% of all mean passes recorded in CHAT found at this site and all 6 identified species recorded there. Within KEMO, although the KSA1502 stationary acoustic site appears to be the most productive in terms of call frequency (with 63% of all mean passes recorded in KEMO found at this site), all calls were unidentifiable to species by Echoclass. These files were likely identified as bat passes in error as this unit was vandalized during deployment. Therefore, results at this site should be interpreted cautiously. Instead, stationary acoustic site KSA1602, with 22% of all mean passes recorded in KEMO and 4 identified species recorded, may actually be the most productive stationary acoustic site within KEMO. A summary of 2015 and 2016 acoustic sampling locations for CHAT and KEMO and their results are below (see Table 2 & 3, Fig 6 & 8).

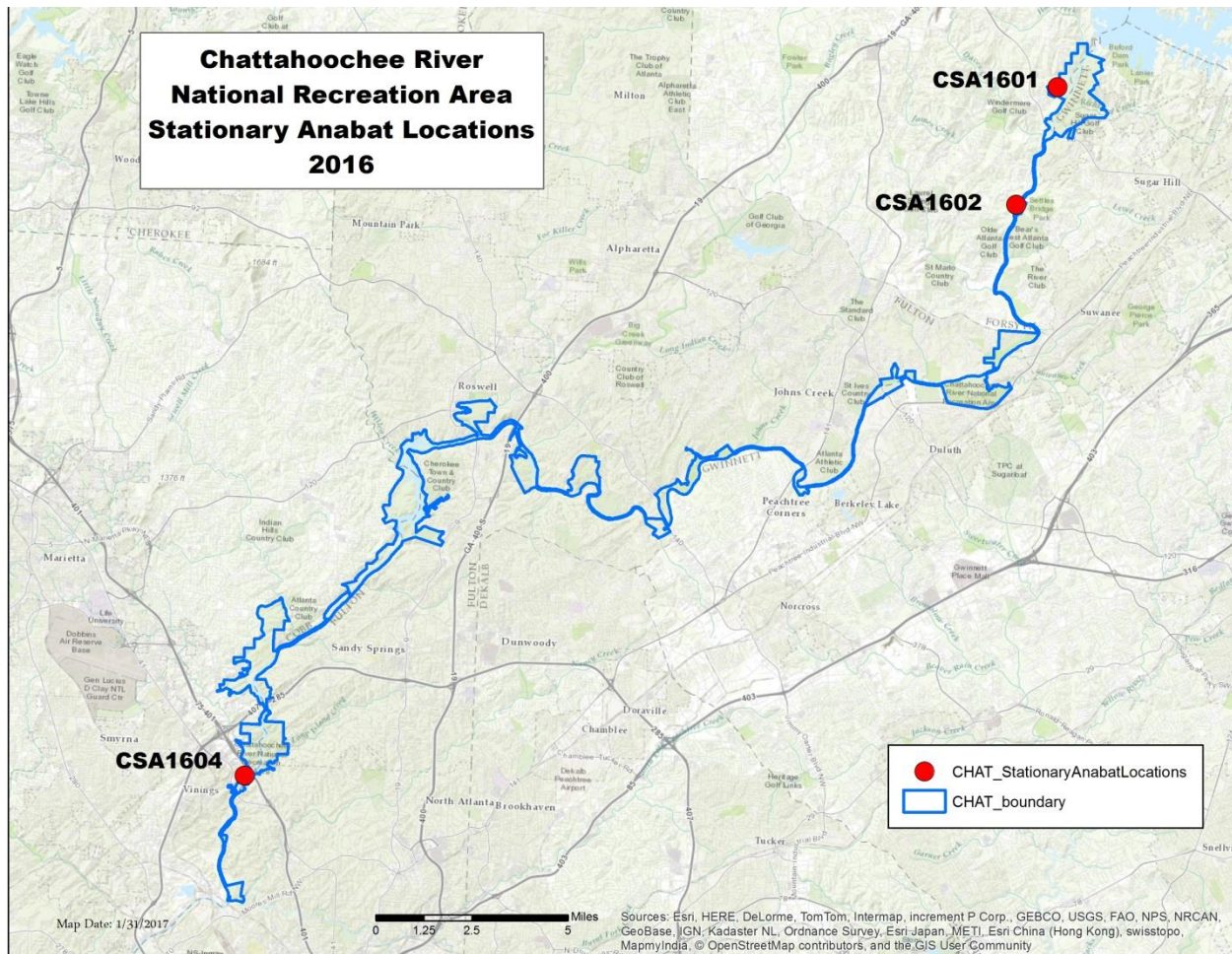


Figure 5. Stationary Anabat locations at CHAT in 2016.

Table 2. Mean activity (passes/detector night) by species in various sampling sites at CHAT in 2016. *EPFU* *Eptesicus fuscus*, *LANO* *Lasionycteris noctivagans*, *LABO* *Lasiurus borealis*, *LACI* *Lasiurus cinereus*, *MYSP* *Myotis species*, *NYHU* *Nycticeius humeralis*, *PESU* *Perimyotis subflavus*, *UNKN* unknown

Site Sampled	Sampling Dates	EPFU	LANO	LABO	LACI	MYSP	NYHU	PESU	UNKN
CSA1601	6/28/16-7/2/16	1	0	5	0	0	0	0	320
CSA1602	6/28/16-7/2/16	178	1	62	2	0	9	5	309
CSA1604	7/5/16-7/8/16	9	0	54	0	0	0	0	292

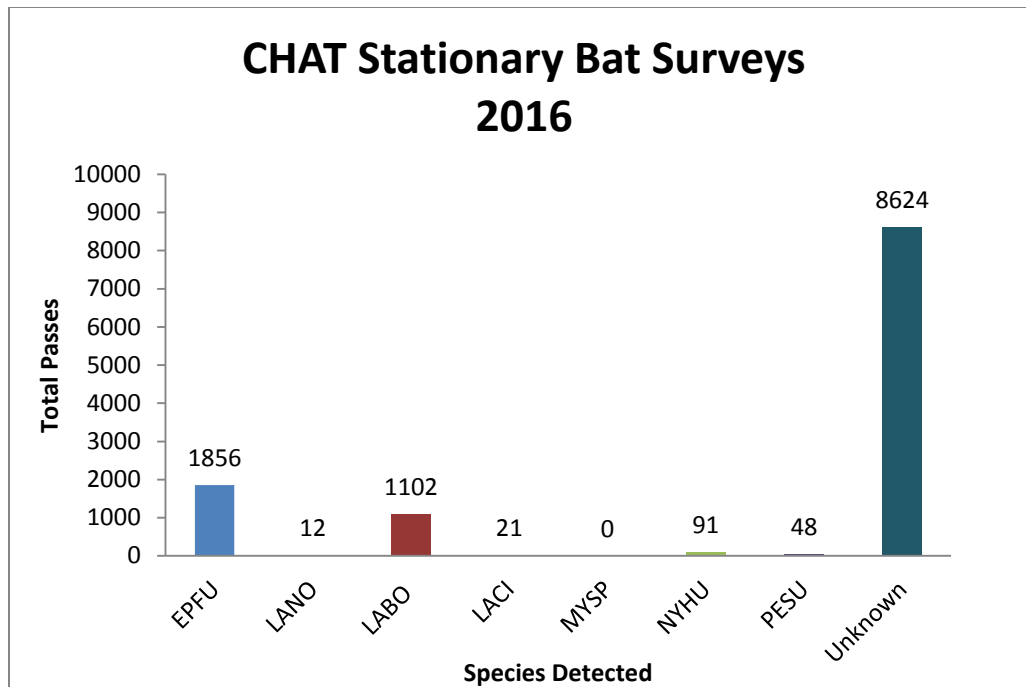


Figure 6. Total stationary acoustic passes recorded at CHAT in June-July 2016 by species.

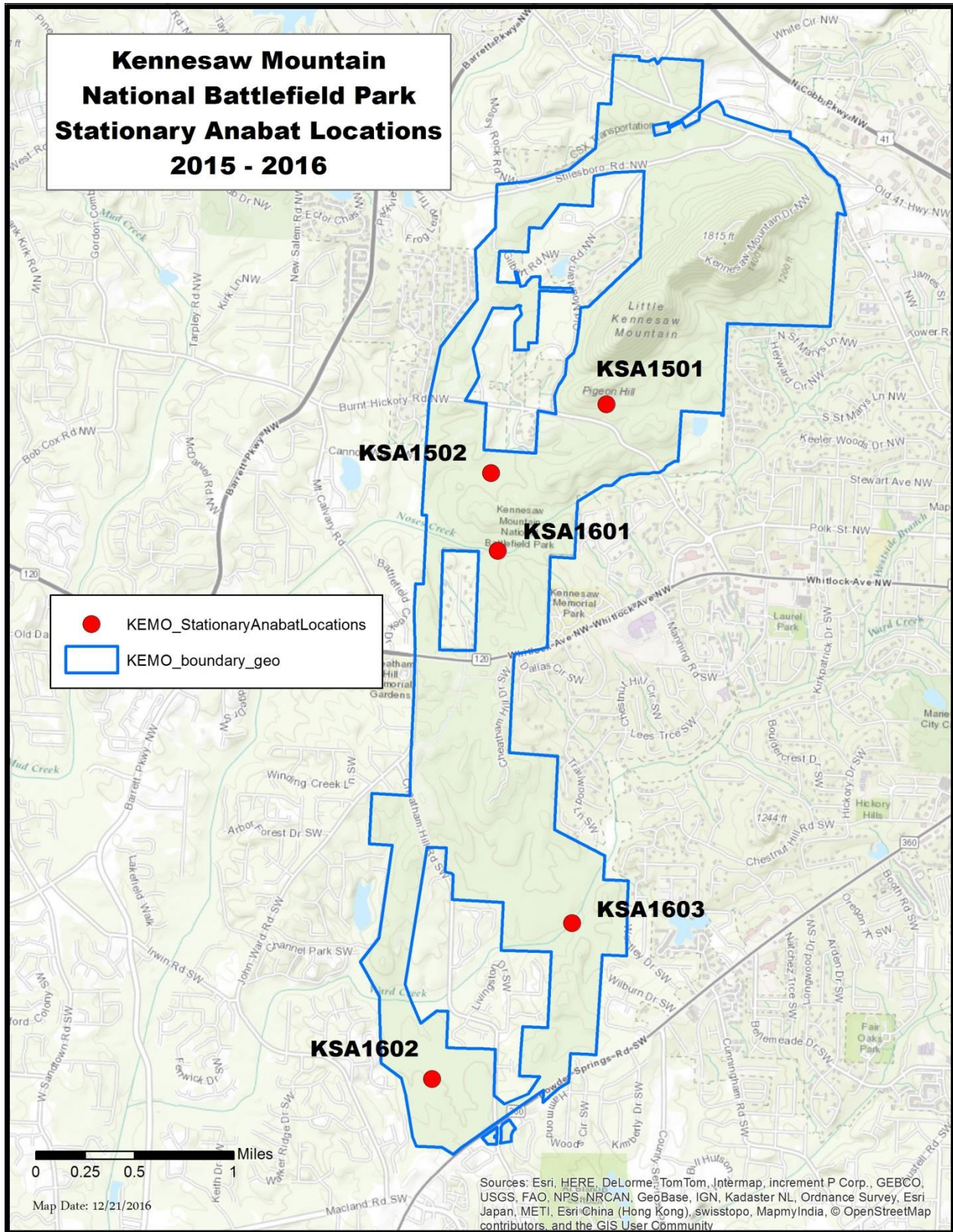


Figure 7. Stationary Anabat locations at KEMO in 2015 and 2016.

Table 3. Mean activity (passes/detector night) by species in various sampling sites at KEMO in 2015 and 2016. *EPFU* *Eptesicus fuscus*, *LANO* *Lasionycteris noctivagans*, *LABO* *Lasiurus borealis*, *LACI* *Lasiurus cinereus*, *MYSP* *Myotis species*, *NYHU* *Nycticeius humeralis*, *PESU* *Perimyotis subflavus*, *UNKN* unknown

Site Sampled	Sampling Dates	EPFU	LANO	LABO	LACI	MYSP	NYHU	PESU	UNKN
KSA1501	7/23/15-7/24/15	0	0	2	1	0	0	0	11
KSA1502	7/20/15-7/21/15	0	0	0	0	0	0	0	429
KSA1601	6/2/16-6/6/16	7	0	5	0	0	1	1	52
KSA1602	6/7/16-6/11/16	32	15	10	4	0	0	0	86
KSA1603	6/7/16-6/11/16	6	0	4	0	0	0	0	19

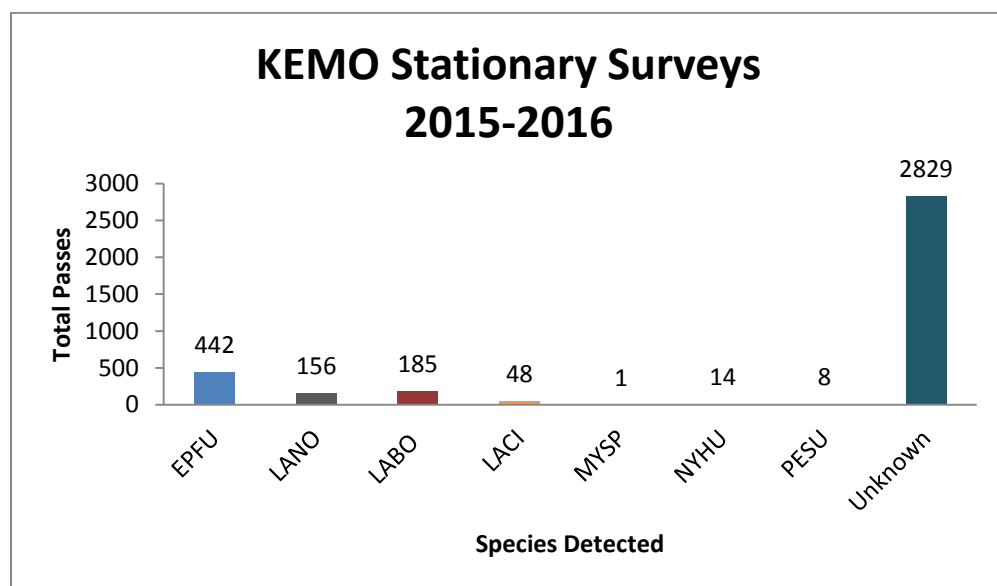


Figure 8. Total stationary acoustic passes recorded at KEMO in 2015 and 2016 by species.

Mobile Transects

Mobile transects were conducted over 1 night in 2015 and 3 nights in 2016 in CHAT and over 2 nights in 2015 and 1 night in 2016 in KEMO. Anabat SD2 bat detectors (Titley Electronics, Ballina, Australia) were fixed to the roof of a vehicle, which was then driven slowly (< ~10 km/h), along predetermined CHAT and KEMO routes. The transects commenced 45 min after sunset.

Bat echolocation call files were identified to species using Echoclass v. 3.1 bat call analysis software (Eric Britzke, ERDC) with the Species Set 1 classifier and a minimum of 3 call pulses. For both CHAT and KEMO mobile transect routes manual examination using AnaLookW v. 4.2f software (Titley Scientific, Columbia, MO) was not required as no passes were identified by Echoclass software as possible *Myotis* spp. Six species were identified from the CHAT River mobile route (Table 4) and the other CHAT mobile transects (Table 5). Big brown bats were the most commonly recorded species identified during all CHAT mobile transect routes. Four

species were identified from the KEMO mobile routes (Table 6). Eastern red bats were the most commonly recorded species identified during KEMO mobile transect routes. A summary of the 2015 and 2016 CHAT and KEMO mobile transect locations and results are below.

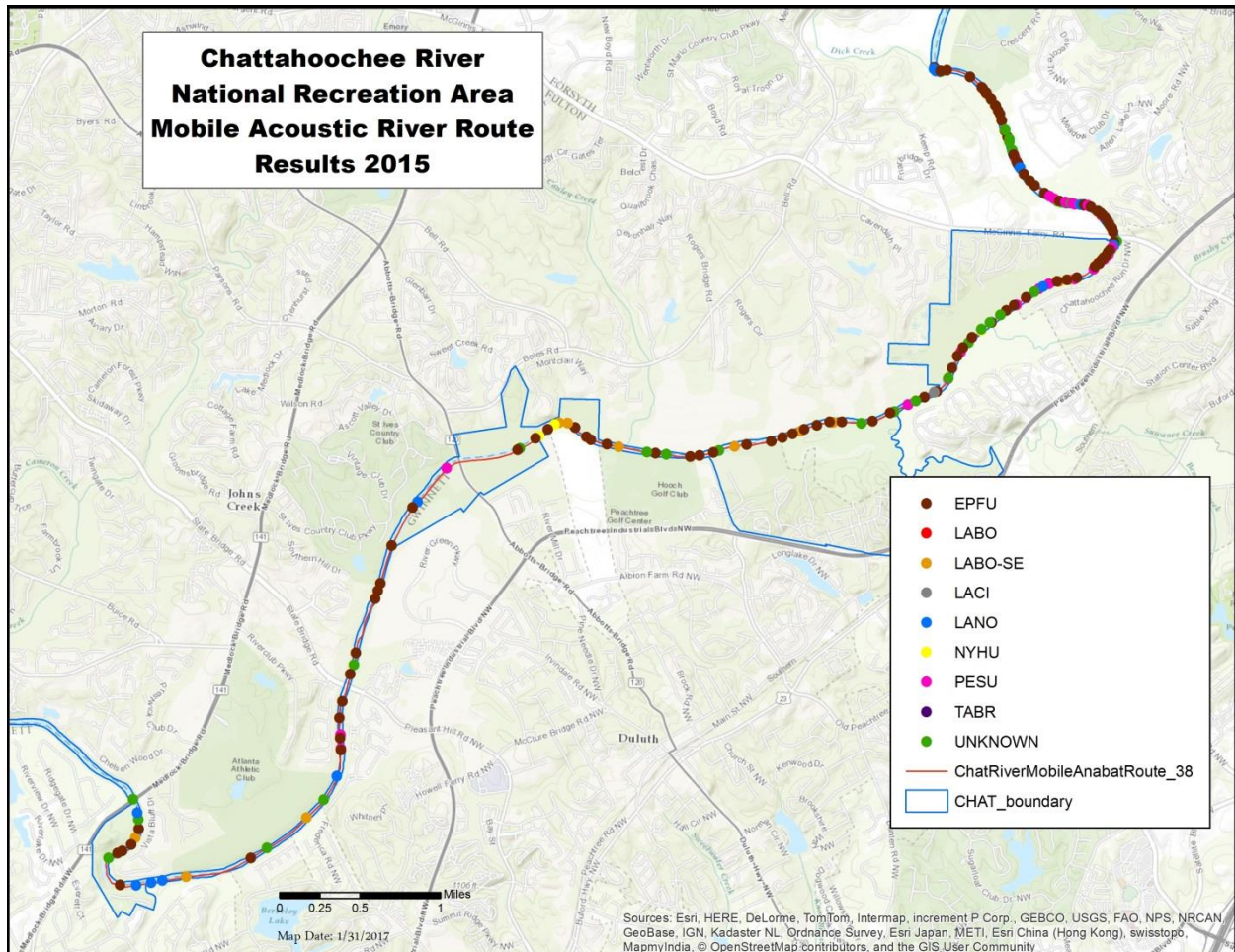


Figure 9. Mobile transect River route and species detection locations at CHAT in 2015.

Table 4. Nightly activity (passes/transect) by species during mobile River route at CHAT in 2015. *EPFU* *Eptesicus fuscus*, *LANO* *Lasionycteris noctivagans*, *LABO* *Lasiurus borealis*, *LACI* *Lasiurus cinereus*, *MYSP* *Myotis* species, *NYHU* *Nycticeius humeralis*, *PESU* *Perimyotis subflavus*, *UNKN* unknown

Site Sampled	Sampling Dates	EPFU	LANO	LABO	LACI	MYSP	NYHU	PESU	UNKN
CHAT RIVER #38	6/25/2015	55	22	17	6	0	3	12	93

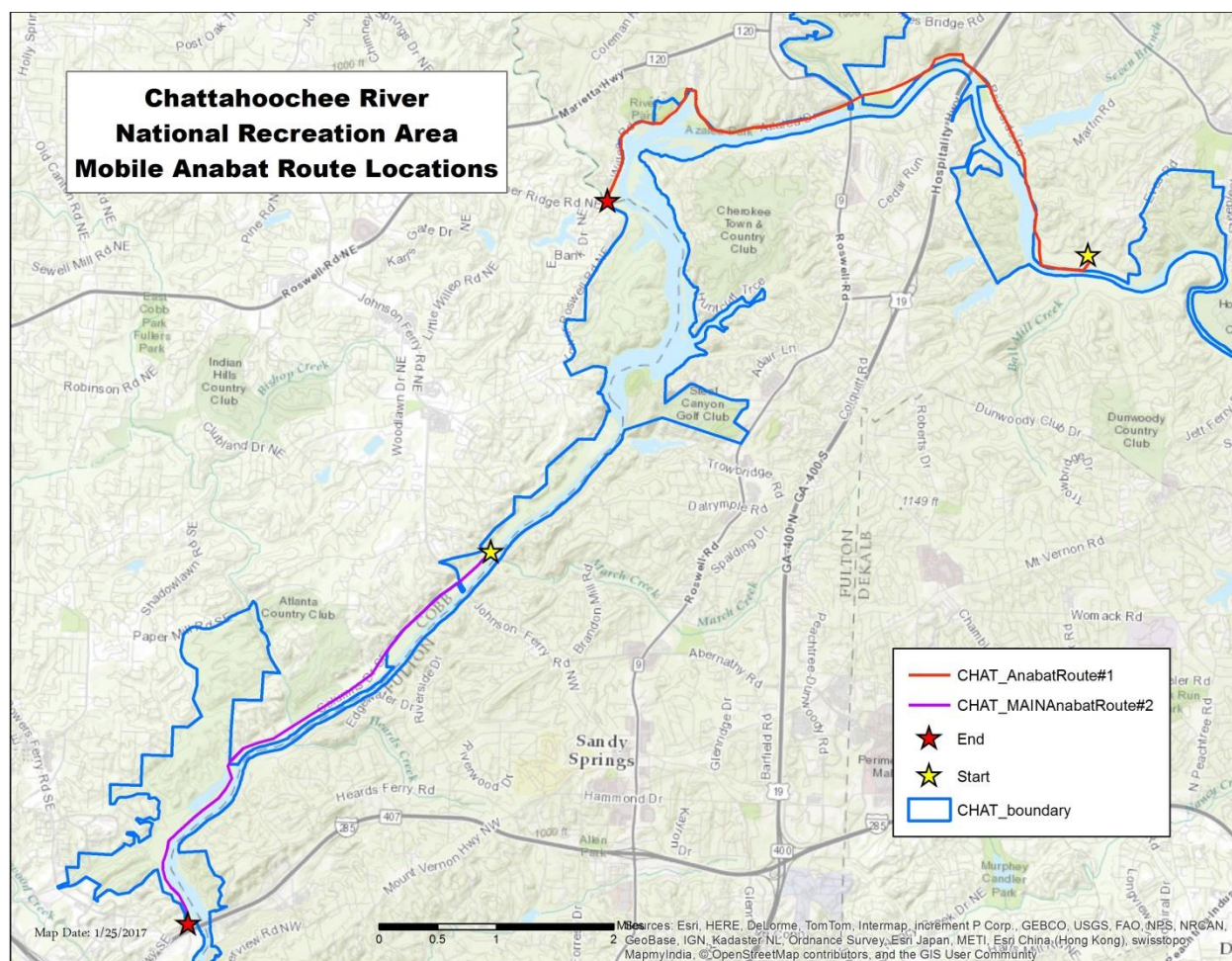


Figure 10. Mobile transect route locations at CHAT in 2015 and 2016.

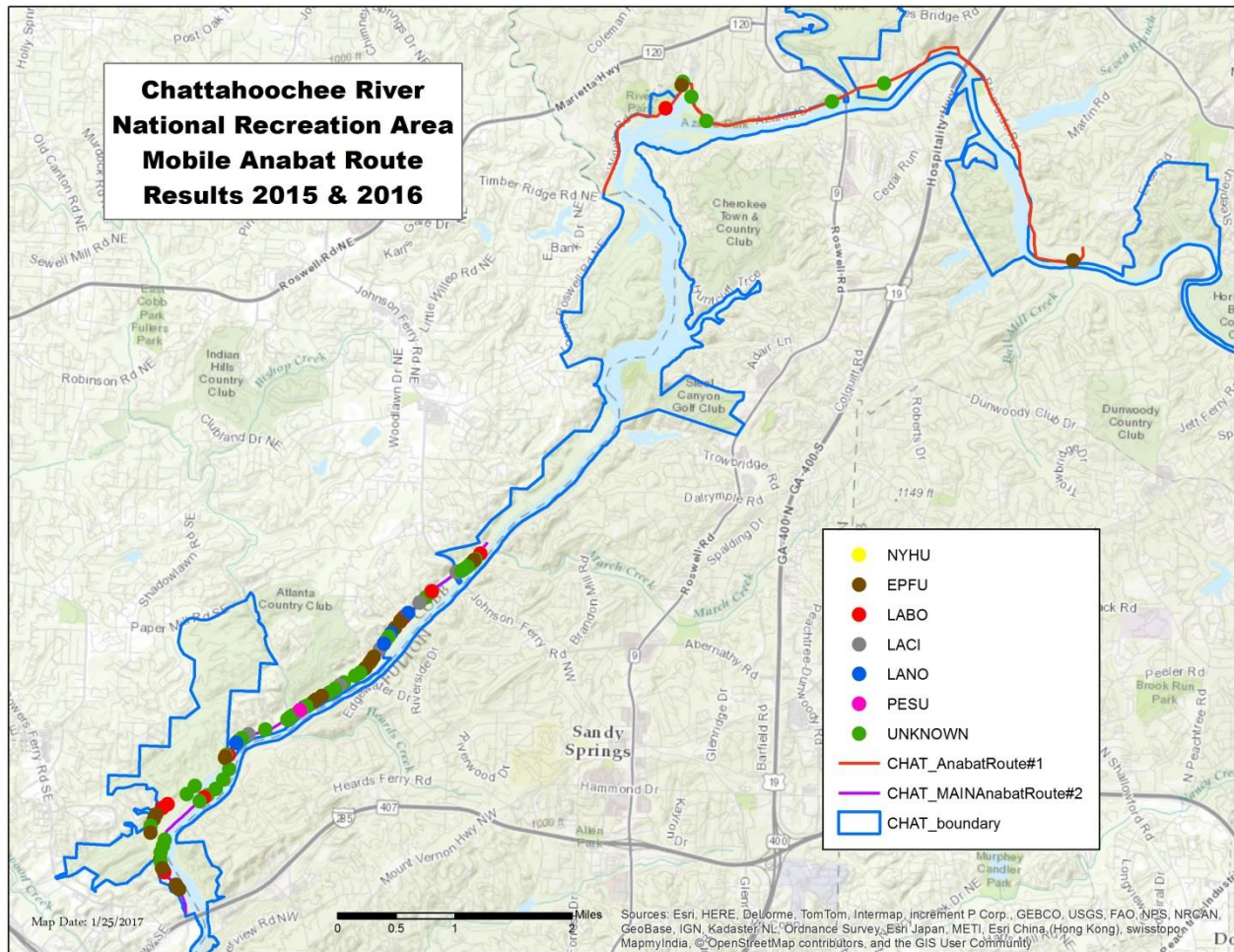


Figure 11. Mobile transect routes and species detection locations at CHAT in 2015 and 2016.

Table 5. Nightly activity (passes/transect) by species during mobile routes at CHAT in 2015 and 2016. *EPFU* *Eptesicus fuscus*, *LANO* *Lasiurus noctivagans*, *LABO* *Lasiurus borealis*, *LACI* *Lasiurus cinereus*, *MYSP* *Myotis species*, *NYHU* *Nycticeius humeralis*, *PESU* *Perimyotis subflavus*, *UNKN* unknown

Site Sampled	Sampling Dates	EPFU	LANO	LABO	LACI	MYSP	NYHU	PESU	UNKN
CHAT_MAINAB2	7/23/2015	13	3	8	2	0	1	1	24
CHAT_AB1	6/6/2016	2	0	1	0	0	0	0	7
CHAT_MAINAB2	7/8/2016	9	3	7	9	0	0	3	33

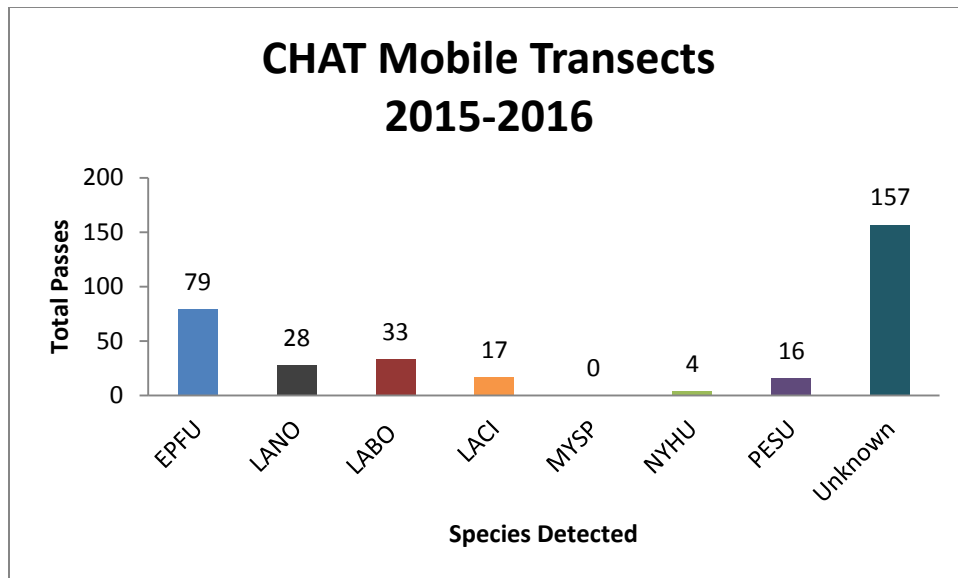


Figure 12. Total acoustic passes recorded during all mobile transects at CHAT in 2015 and 2016 by species.

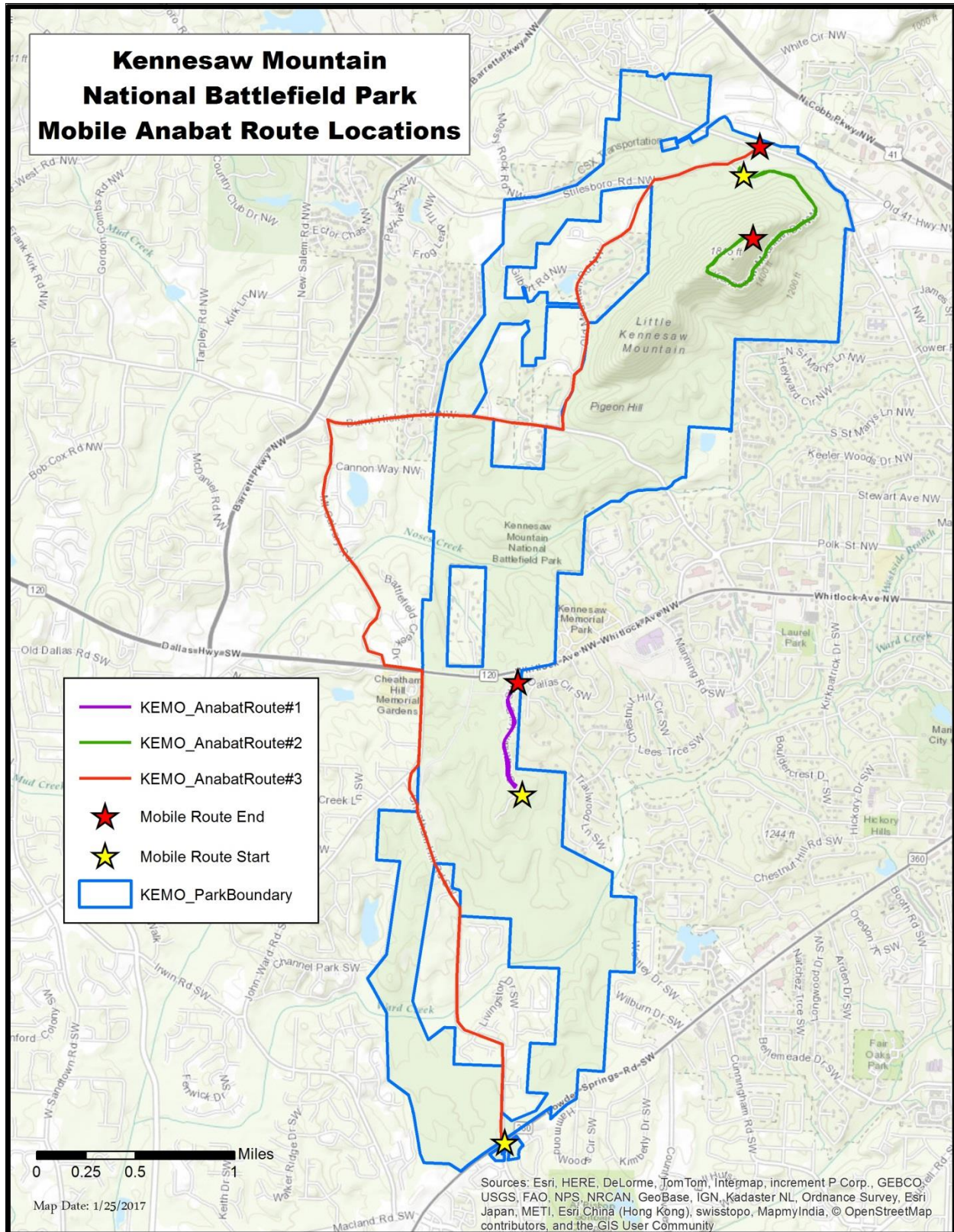


Figure 13. Mobile transect route locations at KEMO in 2015 and 2016.

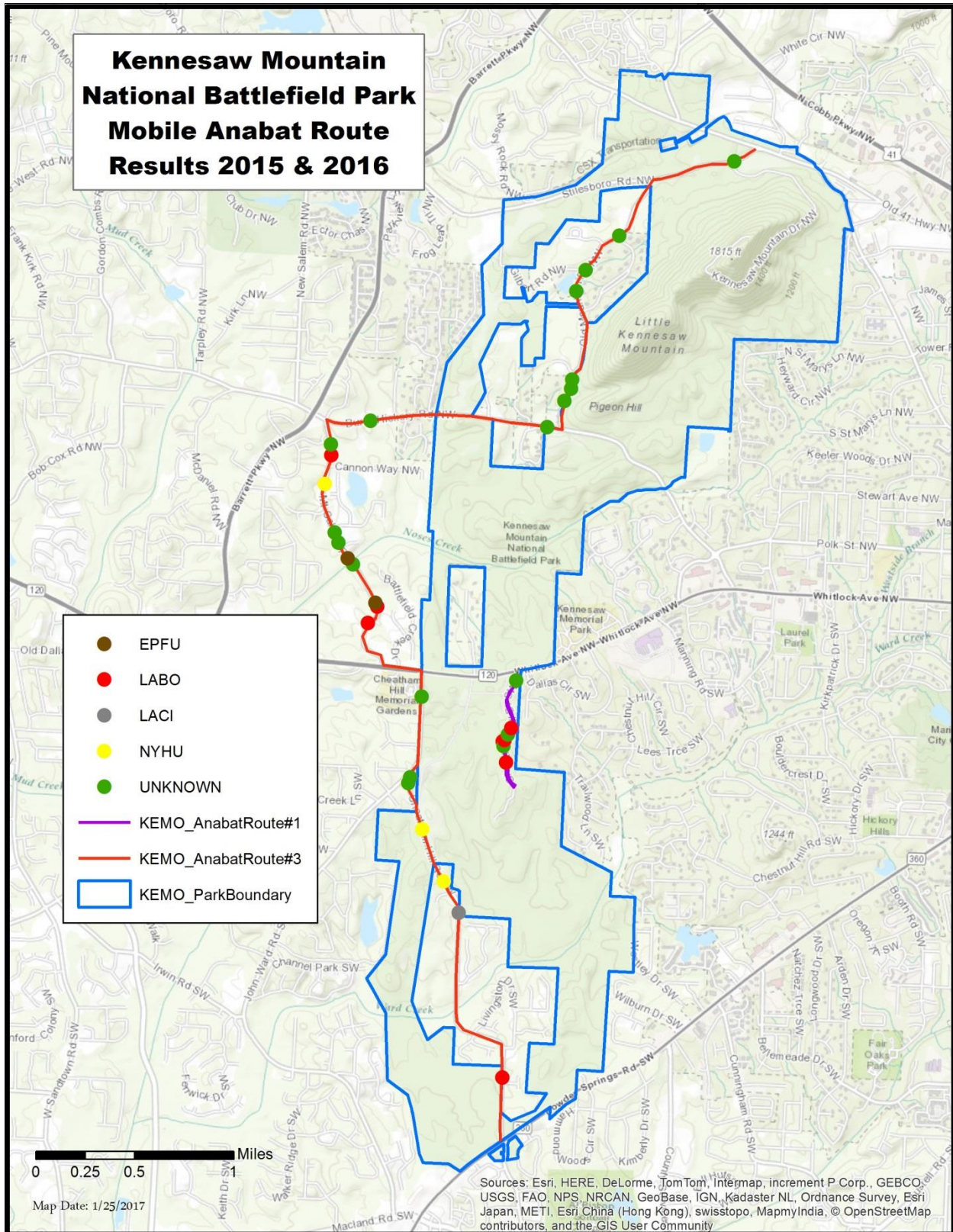


Figure 14. Mobile transect routes and species detection locations at KEMO in 2015 and 2016.

Table 6. Nightly activity (passes/transect) by species during mobile routes at KEMO in 2015 and 2016. *EPFU* *Eptesicus fuscus*, *LANO* *Lasionycteris noctivagans*, *LABO* *Lasiurus borealis*, *LACI* *Lasiurus cinereus*, *MYSP* *Myotis species*, *NYHU* *Nycticeius humeralis*, *PESU* *Perimyotis subflavus*, *UNKN* unknown

Site Sampled	Sampling Dates	EPFU	LANO	LABO	LACI	MYSP	NYHU	PESU	UNKN
KEMO_AB1	7/16/15	0	0	5	0	0	0	0	4
KEMO_AB2	7/22/15	0	0	0	0	0	0	0	0
KEMO_AB3	7/6/16	2	0	5	2	0	3	0	23

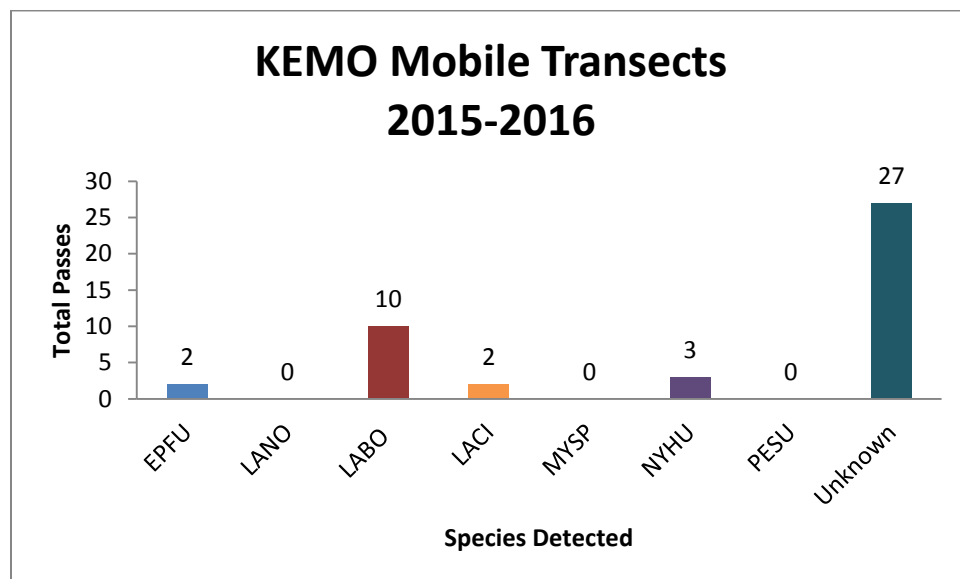


Figure 15. Total acoustic passes recorded during all mobile transects at KEMO in 2015 and 2016 by species.

Recommendations for Future Bat Monitoring

Future bat monitoring should focus on continuing stationary Anabat surveys and mobile transect routes. Priority of stationary Anabat surveys should be given to the most productive sites, both in terms of call frequency and species richness: at CHAT the CSA1601 stationary acoustic site was the most productive, while KSA1602 is likely the most productive stationary acoustic site within KEMO due to KSA1502 being vandalized. Mobile transect attention should be directed toward the River route in CHAT as that route was most productive and it has been surveyed most frequently in the past. If additional mobile transect routes are possible in CHAT, then the CHAT_MainAB2 route should be prioritized as it has been sampled consecutively over 2 years and is also productive, both in terms of call frequency and species richness. In KEMO the KEMO_AB3 route should be prioritized as the most productive. Surveys should be conducted when weather conditions are optimal for bat activity: (1) seasonally warm temperatures, (2) low wind, and (3) little or no rain. Future mist-netting is advised to confirm the presence of recorded species.

Acknowledgements

Completion of this work would not have been possible without the efforts of two DNR employees, Jackie Beck and Rebekah Tuck. Jackie and Rebekah took responsibility for developing a schedule, planning surveys, completion of sampling, maintaining data and supervising the seasonal employees working on the project. Those seasonal University of Georgia employees were also critical in the completion of this project. We greatly appreciate the efforts of Sarah Sherburne, Garrett Roper, Kelly Lutsch, Pallavi Surajuddin, Kyle Shute, Sarah Gorton and Elysia Webb. We would also like to sincerely thank DNR employees Leanne Burns, Cindy Alcazar and Laci Coleman. Their work organizing data from the two field seasons, analyzing thousands of bat calls and writing reports was invaluable. We would also like to thank the Georgia Forestry Commission for assistance with housing and the many National Park Service staff and volunteers who helped us over the two years of this project.

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