Region 1 Acoustic Bat Inventory: National Wildlife Refuges in Eastern Oregon, Eastern Washington, and Idaho

BY

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INTRODUCTION

Bats are an important species group, comprising almost one-fifth of all land mammal species world-wide. They provide important ecological services by consuming large quantities of nocturnal insects, many of which are forest and crop pests (Boyles et al. 2011). They also face unprecedented threats from numerous factors, including wind power development, habitat loss, climate change, and the novel disease White-nose Syndrome (Rodhouse et al. 2012). However, they are difficult to monitor due to their nocturnal habits and secretive nature (Rodhouse et al. 2012; Manley et al. 2006). There have been recent calls for increased monitoring of bat populations by several land management agencies (Manley et al 2006; Rainey et al. 2009; Bucci et al. 2010), for large-scale monitoring of bat populations status and trend (Rodhouse et al. 2012), and for gathering baseline data on activity patterns of western bats before White-nose Syndrome arrives in the region (Schwab and Mabee 2014).

Bats are under-surveyed species on National Wildlife Refuges (refuges). A total of 8 east of the Cascade Mountains in Region 1 identified a need for bat inventories in the objectives of their Comprehensive Conservation Plans (CCP). Yet, few refuges had surveyed for bats although they were included as potential species on refuge species lists based on range maps. No information on rates of bat activity or species composition of the bat community was available.

An acoustic bat inventory was initiated in 2012 in order to obtain baseline data on bat populations on refuges in eastern Oregon, eastern Washington, and Idaho. The project was tiered to the Oregon-Washington Bat Grid in order to facilitate use of data at larger scales.

Objectives of the project were as follows:

1) Develop protocols for acoustic bat detection on National Wildlife Refuges.
2) Document the occurrence and activity of bats on National Wildlife Refuges.
3) Provide baseline data for use in developing general monitoring strategy and assessing future impact of White-nose Syndrome.
4) Provide data in formats that are easily accessible to site managers, scientists, and the public.

METHODS

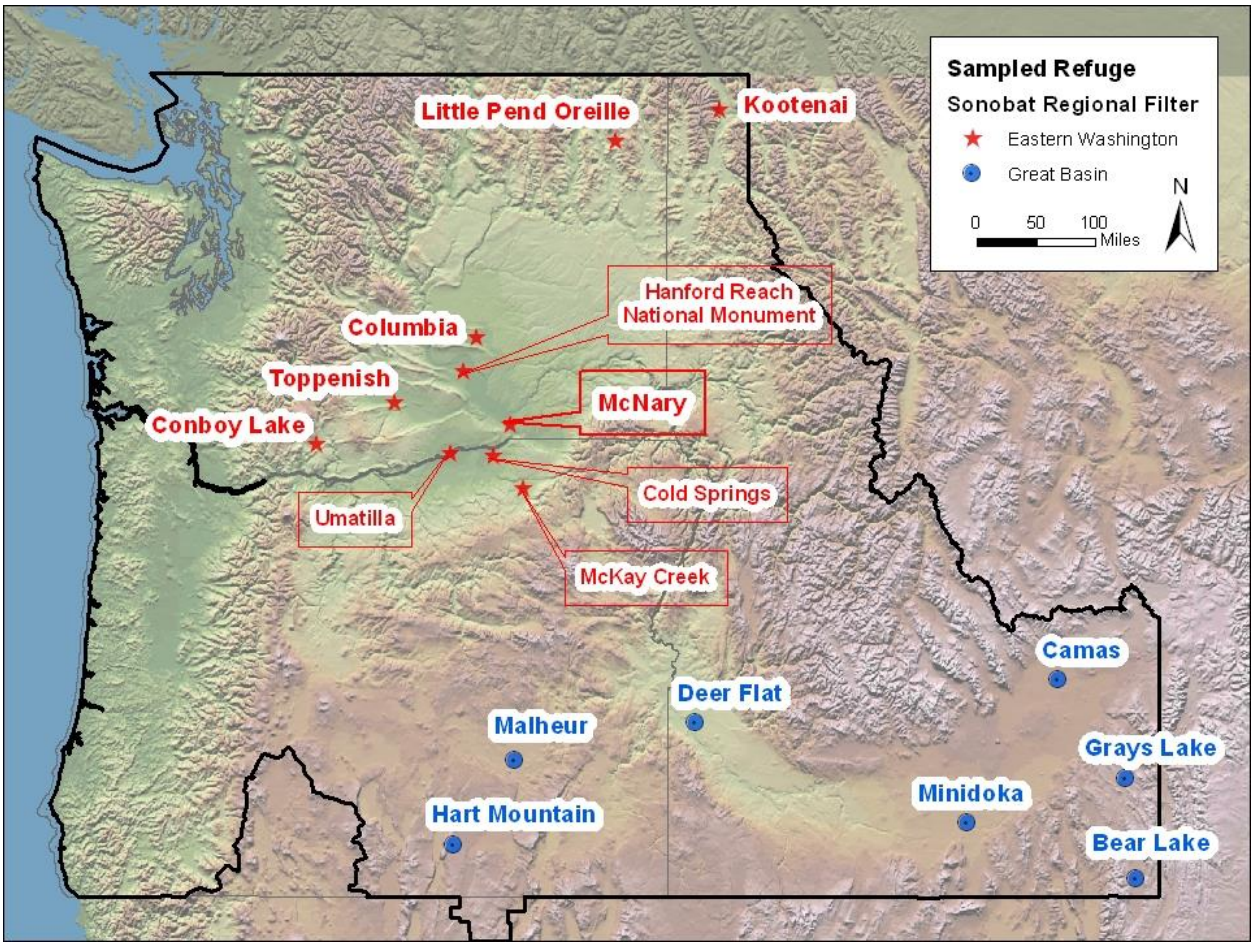
The study was conducted on National Wildlife Refuges (refuges) in the Eastside Zone of Region 1 during summer 2012 and 2013 (Figure 1). The Eastside Zone includes refuges east of the Cascade Mountains in Oregon and Washington and all refuges in Idaho. All refuges in the zone except Turnbull and Sheldon (which had bat species lists through prior survey work on the refuges) participated in the project.

Bats were sampled in foraging habitat, where they were most detectable. Sample sites focused on water features, where bats tend to forage or commute. Surveyed water sources included streams, riparian areas, ditches, wetlands, springs, and ponds. The sampling design was tiered to the Bat Grid, an interagency bat monitoring program developed for Oregon and Washington (P.C. Ormsbee, unpublished manuscript). The basic sample unit was the 10 km x 10 km Bat Grid cell (10k BG cell), from which 3

sample sites were chosen. Sampling effort varied based on size of the refuge (number of 10-km BG cells) and availability of refuge staff.

Pettersson D500x bat detectors, with external microphones, were used for sampling. The detectors were placed adjacent to the water. The microphone was placed approximately 3 meters above the ground, perpendicular to the shoreline and parallel to the ground surface (Figure 2). Detector settings were standardized across the project and were as follows: Frequency = **500**; Pretrigger = **OFF**, File Length = **5 seconds**; Input Gain = **80**; Trigger Level = **120**; Interval = **0**. The detector was powered with an external battery and set to automatically record from sunset to 3.5 hours after sunset. Detectors were left on site for 7 consecutive nights. Target dates for sampling were June 1 through September 5.

Figure 1. National Wildlife Refuges sampled in the Region 1 Acoustic Bat Inventory, 2012 and 2013, showing regional filter of SonoBat software used for bat call analysis.



File Processing:

Files were processed and analyzed with SonoBat Software (v3.1). The SonoBat D500x File Attributer 2.2 with Medium Grade scrub settings was used to remove noise files which did not contain characteristics of bat calls and to tag files with attributing notes. The SonoBatch feature was used to automatically classify call files to species or frequency groups (high or low frequency). Reference files from the Great Basin Region were used for refuges in southern Oregon and southern Idaho while reference files for the

Eastern Washington Region were used for all other refuges (Figure 1). SonoBatch default settings were standardized as follows: Max # of calls to consider per file = **8**, acceptable call quality = **0.80**, acceptable quality to tally passes = **0.20**, decision threshold = **0.90**. Filter settings were 5 kHz and autofilter.

A second process was used to look for spotted bat. Spotted bat has a very low frequency echolocation call, which overlaps common noise frequencies such as insects, and there was concern that it was filtered out by the SonoBat software as noise files. Files scrubbed by SonoBat software were run through Kaleidoscope software, with filters set to 7-10 kHz, 3-8 milliseconds, and a minimum of 2 calls(E. Rowan, pers. comm). This resulted in Kaleidoscope software identifying call files as noise or as containing characteristics of bat calls. Those with bat call characteristics were then opened and inspected in SonoBat and played in Windows Media Player to determine source of the call.

Figure 2. Examples of bat detector set-up.



Hanford Reach – South Inflow Creek



Hanford Reach – Saddle Mountain East

Automatic file classification is not perfect because characteristics of bat calls can overlap and it can be difficult to distinguish species. Therefore, a portion of the call files were vetted manually. A biologist experienced with bat call identification opened the files and manually identified the call. Sometimes 2 or more bats were recorded in a single file. When this was discovered during the vetting process, all bats were entered into the project database (a line for each bat), and included in the total count of bats. At least 20 or 10% of the call files per deployment were vetted, whichever was greater. We also vetted at least 1 call from every species per sample site and all calls from species that were out of known range. During the first year of the project (2012), we attempted to manually vet every call file, but found that goal unfeasible and were unable to finish before the contract ran out. Subsequently, the target was 10% per deployment. In many cases, calls could not be identified to species, but could be placed into a

group, based on characteristic call frequency. We used high and low frequency groups (Table 1). For the remainder of the report, the term species refers to species and frequency groups.

Table 1. Codes, scientific and common names, and frequency groups of bat species acoustically detected on National Wildlife Refuges in eastern Oregon, eastern Washington and Idaho during summer 2012 and 2013.

GROUP	CODE	SCIENTIFIC NAME	COMMON NAME
high frequency	myca	*Myotis californicus*	California myotis
	myci	*Myotis ciliolabrum*	western small-footed myotis
	myev	*Myotis evotis*	long-eared myotis
	mylu	*Myotis lucifugus*	little brown myotis
	myvo	*Myotis volans*	long-legged myotis
	myyu	*myotis yumanensis*	Yuma myotis
	pahe	*Parastrellus hesperus*	canyon Bat
	high		high-frequency bat
low frequency	anpa	*Antrozous pallidus*	pallid bat
	coto	*Corynorhinus townsendii*	Townsend's big-eared bat
	epfu	*Eptesicus fuscus*	big brown bat
	lano	*Lasionycteris noctivagans*	silver-haired bat
	laci	*Lasiurus cinereus*	hoary bat
	myth	*Myotis thysanodes*	fringed myotis
	tabr	*Tadarida brasiliensis*	Brazilian free-tailed bat
	low		low-frequency bat

Data Analysis:

Species presence: Only call files identified to species by hand vetting were used to document presence of a species on a refuge. At least one vetted call file from a species was necessary to consider the species "Present" on the refuge.

Activity rates: Currently, no standard exists for quantifying bat activity. Various methods include bat passes, call files collected per night, and calls per unit of time. We defined a call file as single, 5-second *.wav file recorded by the bat detector. We used number of call files (5 seconds in length) collected per night, which consisted of 3.5 hours of sampling after sunset. All call files collected and classified as containing at least 1 bat were used in the metric, including non-vetted calls. Activity rates were reported as total bat activity and were not broken down to species.

Species composition: Only calls files vetted by hand were used for estimating species composition, and estimates account for files with more than 1 bat. Composition of bat species was calculated for each site by summing the number of vetted call files for each species and dividing by the total number of bat call files vetted.

RESULTS

Seventeen refuges in Oregon, Washington, and Idaho participated in the project. Data were reported from a total of 124 sites sampled during summer 2012 and 2013. Equipment problems occurred at 6 sites for various reasons including human error, equipment failure, tampering by wildlife, flooding and excessive noise at deployment sites. These sites were not resampled and were not included in the study. Disruption of the detector set-up by wildlife or cattle resulted in sampling for only 3 days at 2 sites but these sites were included in the results (Chapman North at Conboy Lake and Bear Island Right of Way on Grays Lake).

Species Presence

A total of 14 bat species was detected on the 17 refuges sampled (Table 2). Hoary bat, silver-haired bat and little brown myotis were detected on all refuges while western small-footed myotis and Yuma myotis were detected on 16 refuges. In contrast, Brazilian free-tailed bat was only detected on Hart Mountain, where it is just north of its mapped range (Bat Conservation International 2014).

Canyon bat was detected at 6 refuges, including Kootenai. Kootenai is well north of the mapped range of canyon bat. In Idaho, canyon bat distribution spans the southwest corner of the state, north to the Hells Canyon National Recreation Area (Miller et al. 2005). In Washington, observations exist from as far north as Douglas and Lincoln counties (Hayes and Wiles 2013). One call file from Kootenai was vetted as canyon bat and sent to a bat biologist in British Columbia for further review; the consensus was that it was a canyon bat call. Several calls of canyon bat have been recorded in British Columbia, although none have been captured in mist nets yet (C. Lausen, pers. comm.).

Townsend's big-eared bat was detected at 7 refuges. Its distribution is linked to presence of suitable sites for maternity roosts and hibernacula, located near foraging areas (Hayes and Wiles 2013). It is not known to migrate long distances (Miller et al. 2005; Adams 2003). Because this bat has a quiet call, it maybe underrepresented in acoustic sampling (Bucci et al. 2010). Townsend's big-eared bat is very vulnerable to human disturbance, is experiencing population declines, and is classified as a sensitive species in Idaho, Washington, and Oregon.

Pallid bat was only detected at 4 refuges (Hart Mountain, Conboy Lake, Hanford Reach, and Columbia). Pallid bats are gregarious and locally common in arid habitats (Adams 2013). They prey on medium to large sized ground-dwelling arthropods, including grasshoppers, beetles and scorpions (Hayes and Wiles 2013). Rosier (2008) found equal activity of pallid bat in upland and riparian habitat, indicating high use of upland habitat by the species. This species may have been under sampled by our method of sampling water features.

Spotted bat was not detected in our study. The species is considered to be wide-spread, but uncommon (Hayes and Wiles 2013). Spotted bats require high cliffs for roosting, and may be locally abundant where suitable cliffs and water sources are available (Hayes and Wiles 2013; Adams 2003). Columbia Refuge may have appropriate habitat for spotted bat, although many of the refuges sampled likely lack suitable habitat. In Washington, they are only known from 4 counties in the north central part of the state. In Idaho, they are known to occur in the southwestern corner. The species has a very low frequency echolocation call, which can be heard by many people and there is a possibility it was filtered out by the SonoBat software as noise files. The second processing step with Kaleidoscope software was

conducted to ensure spotted bat calls were not filtered out by SonoBat as noise. However, all call files tagged by Kaleidoscope as potential bat calls turned out to be crickets or birds.

Table 2. Bat Species Acoustically Detected on National Wildlife Refuges, Summer 2012 and 2013.

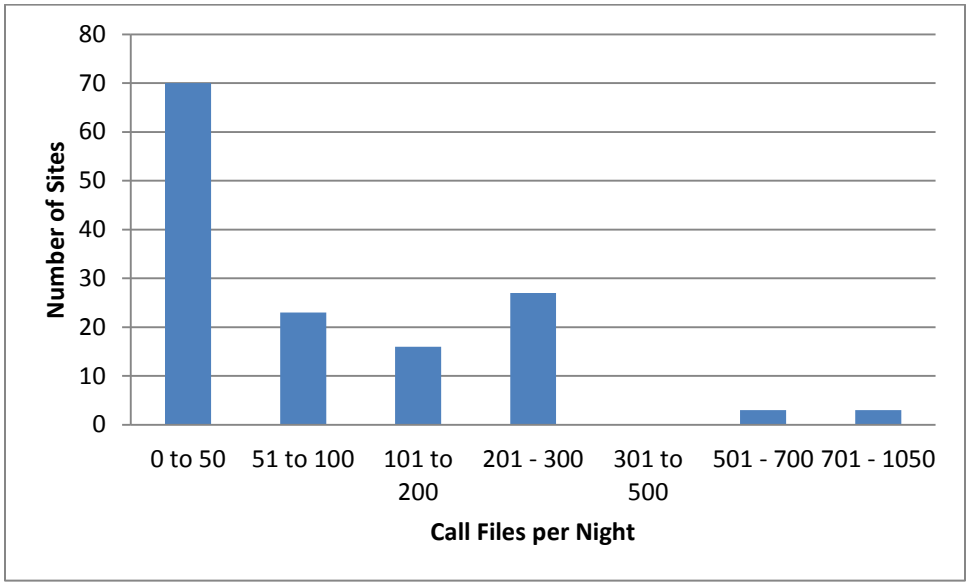
Refuge	anpa	coto	epfu	laci	lano	myca	myci	myev	mylu	Myth	myvo	myyu	pahe	tabr
IDAHO														
Bear Lake			X	X	X	X	X		X			X		
Camas			X	X	X	X	X	X	X			X		
Grays Lake			X	X	X		X	X	X		X	X		
Minidoka		X	X	X	X	X	X	X	X	X		X		
Deer Flat				X	X				X			X		
Kootenai		X	X	X	X	X	X	X	X	X	X	X	X	
OREGON														
Hart Mountain	X			X	X		X	X	X			X		X
Malheur		X	X	X	X	X	X	X	X			X	X	
McKay Creek				X	X	X	X		X		X	X		
Cold Springs				X	X	X	X		X			X		
McNary			X	X	X		X		X			X		
Umatilla				X	X	X	X	X	X				X	
WASHINGTON														
Conboy Lake	X		X	X	X	X	X	X	X	X	X	X		
Toppenish		X	X	X	X	X	X	X	X	X	X	X	X	
Hanford Reach	X	X	X	X	X	X	X	X	X	X	X	X	X	
Columbia	X	X	X	X	X	X	X		X		X	X	X	
Little Pend Oreille		X	X	X	X	X	X	X	X	X	X	X		

Anpa = pallid bat; coto = Townsend's big-eared bat; epfu = big brown bat; laci = hoary bat; lano = silver-haired bat; myca = California myotis, myci = western small-footed myotis; myev = long-eared myotis; mylu = little brown myotis; myth = fringed myotis; myvo = long-legged myotis, myyu = Yuma myotis, pahe = canyon bat; tabr = Brazilian free-tailed bat

Activity Rates – overview

Activity rates (call files per 3.5 hour sampling night) varied greatly, ranging from 0.14 to 1048. The average was 96. Only 6 sites had more than 500 files per night (1 on Conboy Lake, 1 on Malheur, and 2 each on Columbia and Toppenish). However, the activity rate was less than 100 call files per night at 74% of the sites.

Figure 3. Average call files collected per night (3.5 hours), over 124 sample sites



Maps showing sample site locations and activity rates for each refuge are shown below (Figures 4 through 39).

Species Composition – overview

In many cases bat calls cannot be identified to species. Various factors contribute to the problem including the quality of the call files collected, distance of bat from the microphone, and inherent overlap of bat call characteristics. However, they can be grouped according to the call frequency (Table 1). Percentage of calls that could not be classified to species varied between the 124 sites sampled but was typically substantial. Pie charts showing species composition for each site are organized by refuge and shown below (Figures 4 through 39).

Across all sample locations three species were wide spread and relatively common. Hoary bat was detected at 96 sites. It comprised greater than 50% of the sample at 6 sites and greater than 10% at 35 sites. Silver-haired bat was detected at 106 sites, comprising more than 10% of the sample at 62 sites and more than 50% at 4 sites. Little brown myotis was detected at 102 sites, and comprised more than 10% of the sample at 49 sites and more than 50% of the sample at 2 sites.

Some species never contributed a large percentage of the species composition. Pallid bat was classified at 14 sites and never contributed more than 10% of the call files. Pallid bat were most common at Hanford Reach, where they were detected at 7 sites and they comprised 9% of the call files at Ringold Powerline River Crossing and Powerline Pond sites. Townsend's big-eared bat was detected at 11 sites and contributed a maximum of 4% of the calls. As discussed previously, this quiet bat may be underrepresented in acoustic sampling. Fringed myotis was also relatively rare, detected at 13 sites but comprised less than 2% of the sample at 11 of them. It comprised 15% of the sample at Slide Creek and 8% at Cusick sites, both on Little Pend Oreille. Long-legged myotis was another rare bat, detected at 14 sites on 8 refuges. It comprised 5% of the sample at Slide Creek on Little Pend Oreille, but 2% or less on the other sites.

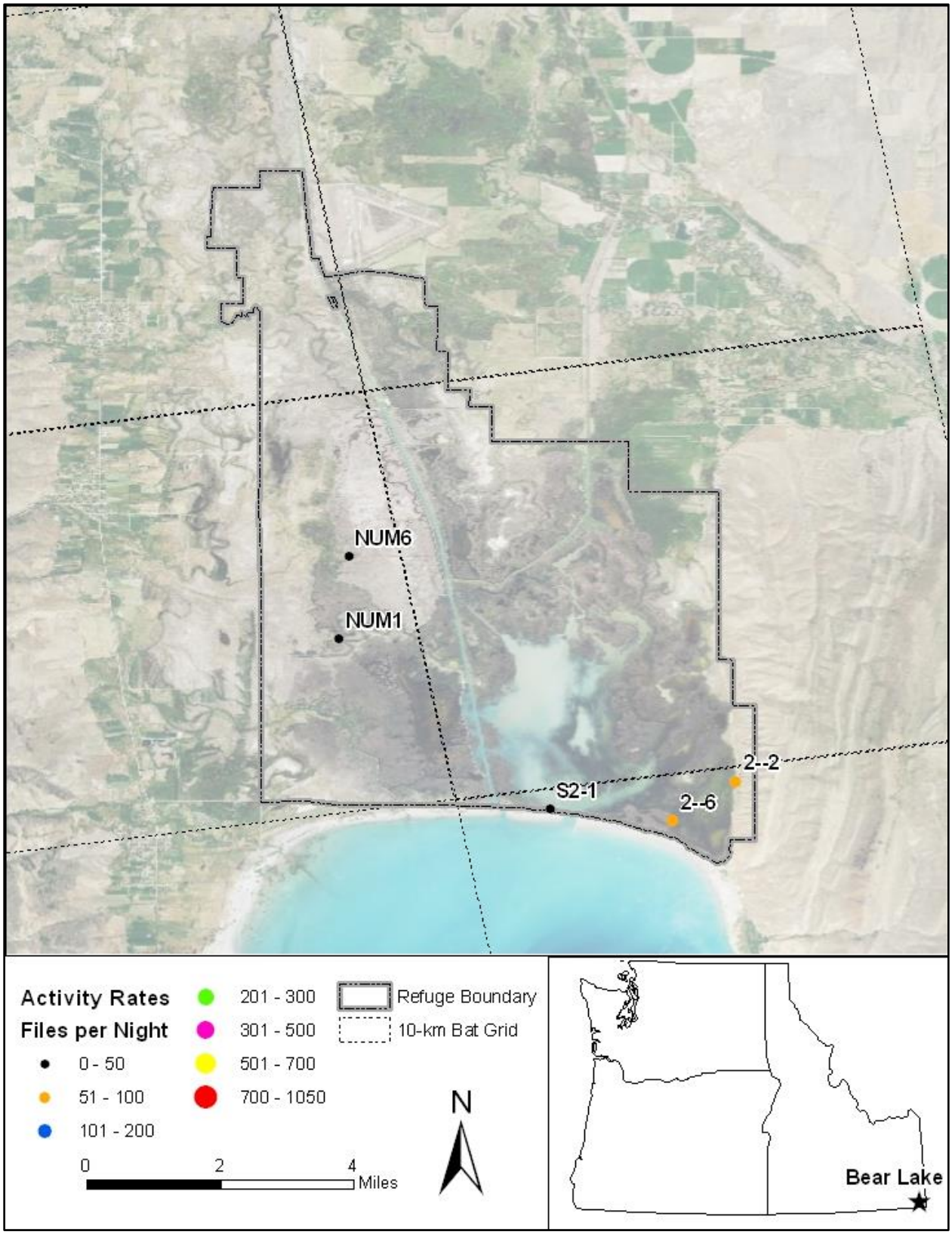
Canyon bat was detected at 32 sites. It was most common at Columbia where it was detected at all 9 sites sampled. It comprised 20% of the sample at Coyote Creek Crossing and Clifford Pond sites. It was also detected at 14 of 29 sites (48%) sampled on Hanford. It comprised 10 and 13% of the sample at B-Reactor Tree Gap and Ringold Powerline Crossing sites, respectively. Canyon bat is typically associated with arid lowland habitats and prefers rocky canyons and outcrops (Hayes and Wiles 2013, Miller et al. 2005). Canyon bat was found only at Columbia, Hanford Reach, Kootenai, Malheur, Toppenish, and Umatilla. Columbia in particular offers many cliff habitats with permanent water nearby. Canyon bat has been detected at Columbia year-round (Hager et al. 2013, USFWS unpublished data).

One Brazilian free-tailed bat was detected at Hart Mountain, at the Kaske Spring Dugout site. Brazilian free-tailed bats are widespread and common throughout the Southwestern US and Mexico; however most of the refuges sampled were north of its range (Bat Conservation International).

Other species of bat were intermediate in their distribution (# of sites detected) and species composition at sites detected. Yuma myotis was detected at 67 sites but never comprised more than 38% of the sample. Western small-footed myotis was detected 75 sites; greater than 10% of the sample at 27 sites and greater than 50% at 1. California myotis were detected at 55 sites but comprised less than 5% of the sample at 46 of them. Big brown bats were detected at 53 sites. They comprised 25% of the sample at Minidoka site Number 6, and more than 10% of the sample at sites on Conboy Lake, Columbia, and Hanford Reach. Long-eared myotis was detected at 37 sites and comprised less than 10% of the sample at 33 of them and less than 1% at 11.

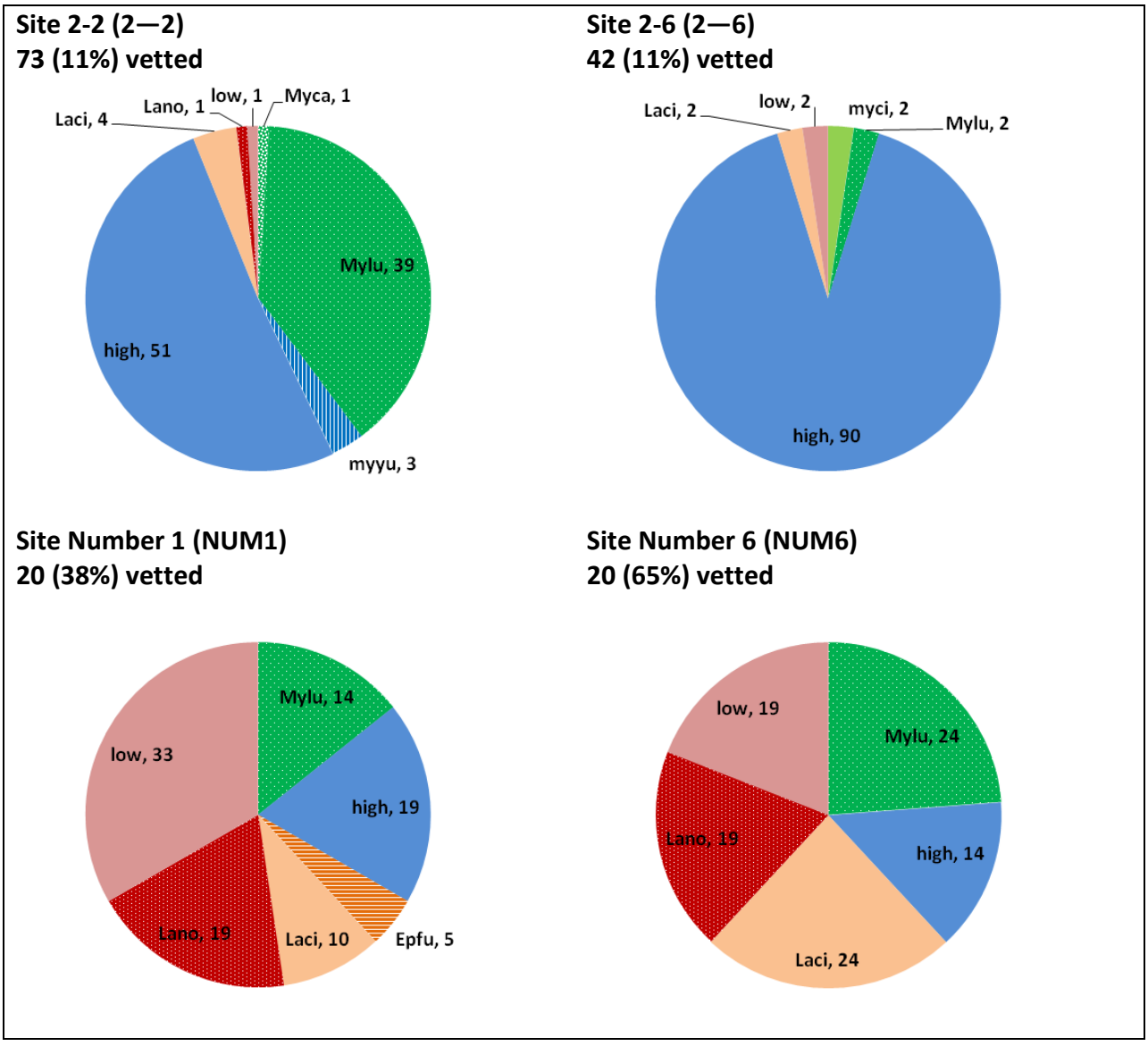
In the following section, activity rates and species composition were presented by refuge and sampling site (Figures 4 through 39). With the exception of Brazilian free-tailed bat, the range of most of the bat species detected overlaps most of the study area. Brazilian free-tailed bats were common in the southern US and Mexico, but the species reached the northern edge of its range in southwestern Oregon and Northern Utah. Refuges in northern Oregon, Washington, and Northern Idaho would be well out of its range so the species was not discussed as missing from those refuges.

Figure 4. Bear Lake NWR - Sample Sites (Short Name) and Activity Rates from the Region 1 Acoustic Bat Inventory.



Five sites are reported for Bear Lake NWR, all in 2013. Six sites were sampled, but equipment malfunctioned at 1 site. Activity rates were relatively low at all sites (<100 files/night). Little brown bat was most commonly detected (2 to 39% species composition) across all sites.

Figure 5. Bear Lake NWR - Species composition from 5 sites. Data were collected during the Region 1 Acoustic Bat Inventory. Vetted files were inspected in SonoBat software by an expert in bat call identification to verify automatic species classification. The values for vetted represent total numbers of files vetted and percent of call files vetted, respectively.



Site 2-1 (S2-1)
36 (10%) vetted

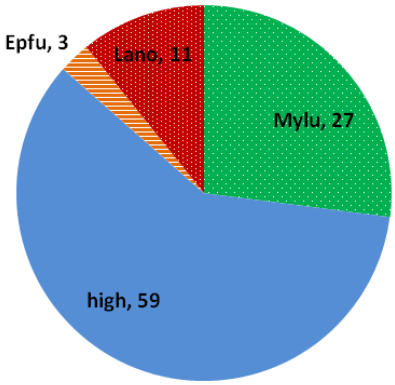
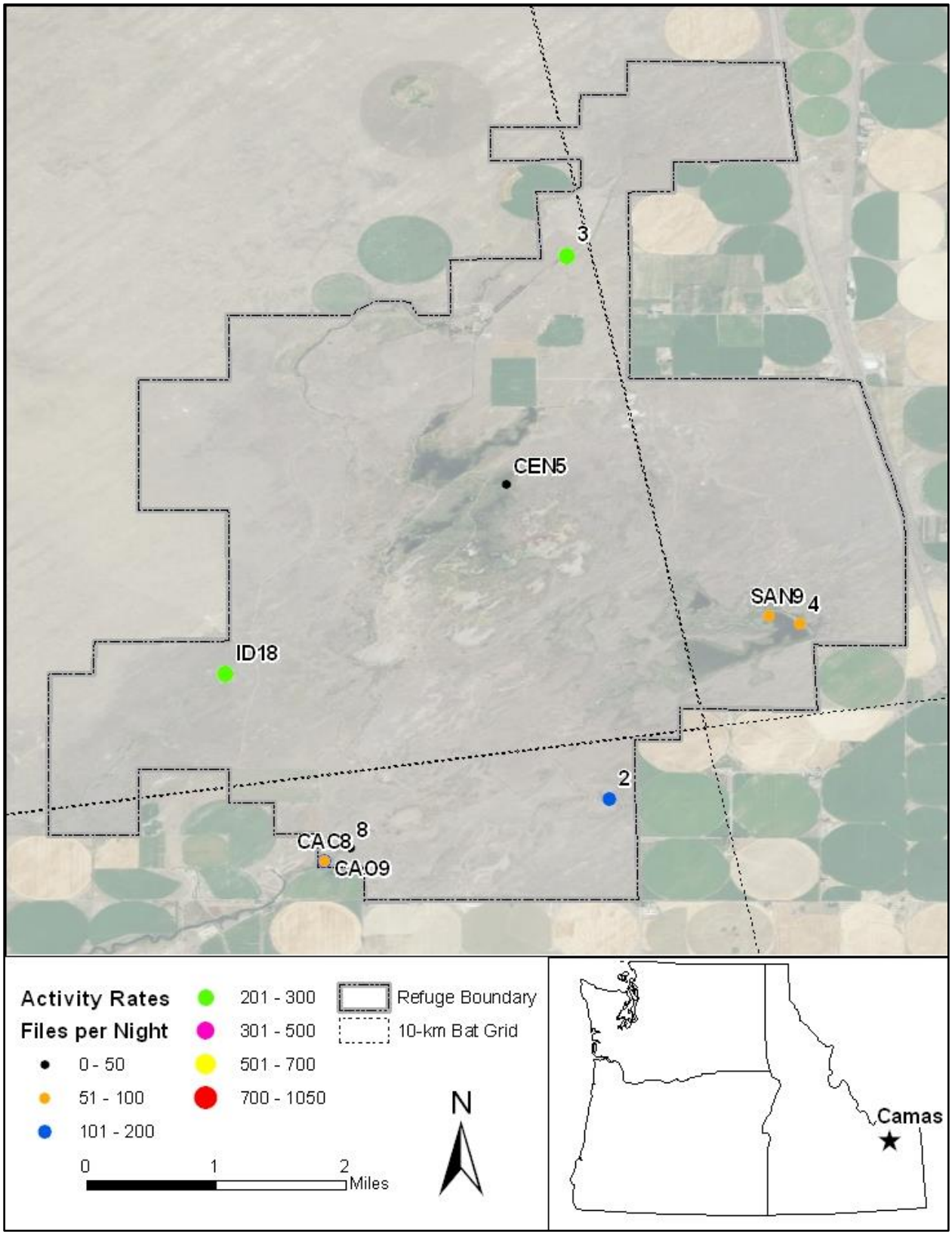
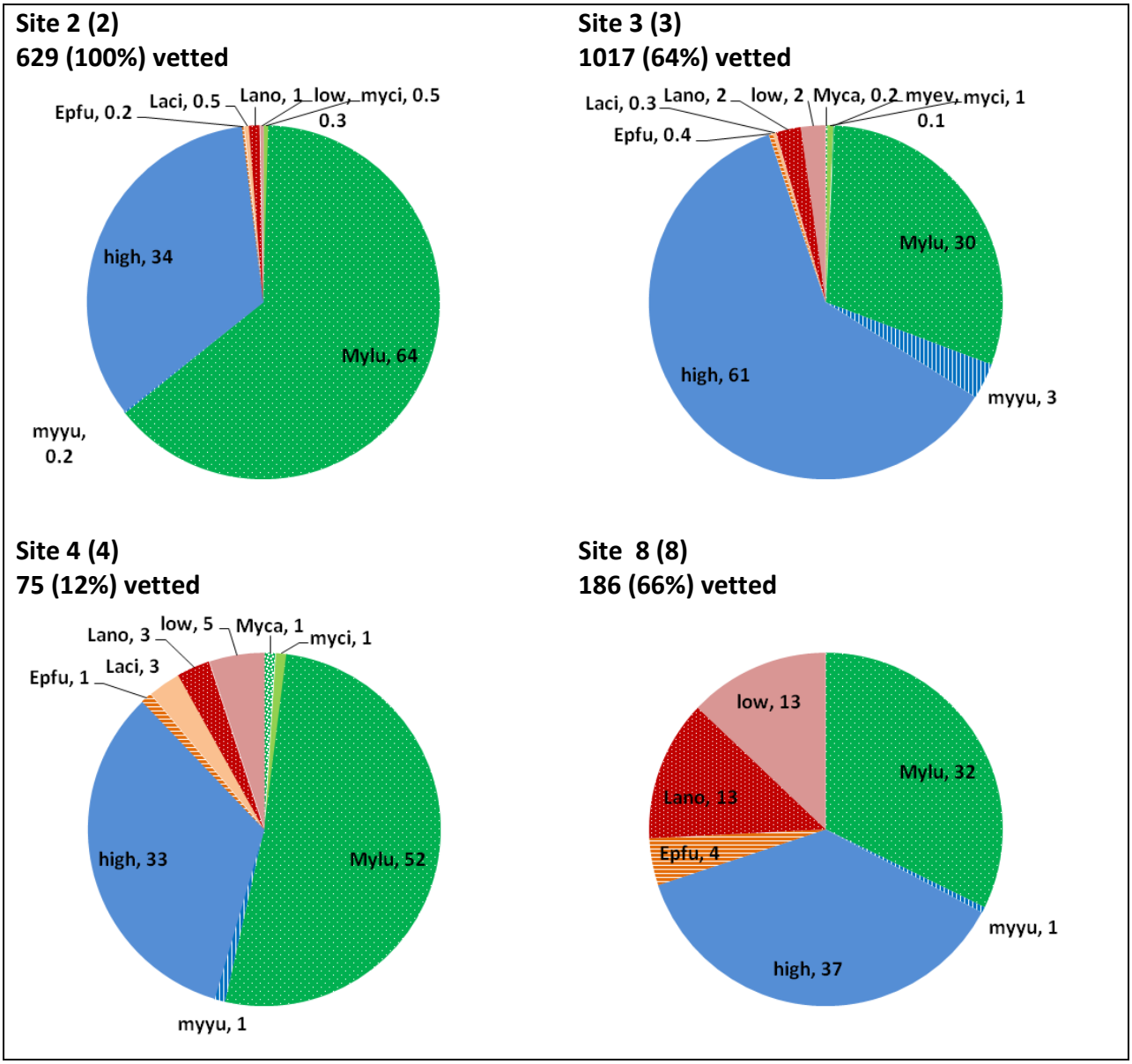


Figure 6. Camas NWR - Sample Sites (Short Name) and Activity Rates from the Region 1 Acoustic Bat Inventory.

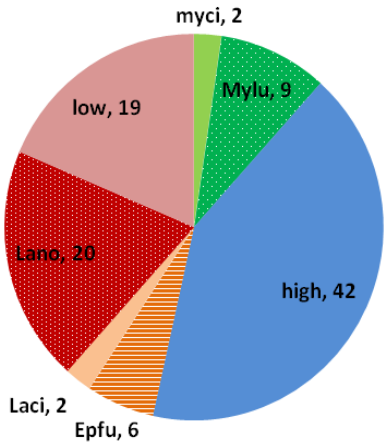


Nine sites were sampled at Camas NWR, 4 in 2012 and 5 in 2013. Site Number 2 was only sampled for 6 nights, due to elk tampering with the equipment. Activity rates varied, although 2 sites had more than 200 files/night. A total of 8 species were detected. Overall, little brown bat was the most common species across all sites.

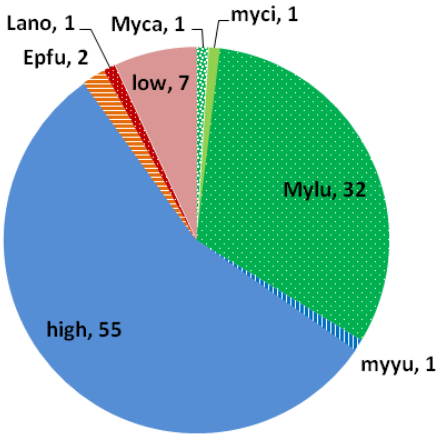
Figure 7. Camas NWR - Species composition from 9 sites. Data were collected during the Region 1 Acoustic Bat Inventory. Vetted files were inspected in SonoBat software by an expert in bat call identification to verify automatic species classification. The values for vetted represent total numbers of files vetted and percent of call files vetted, respectively.



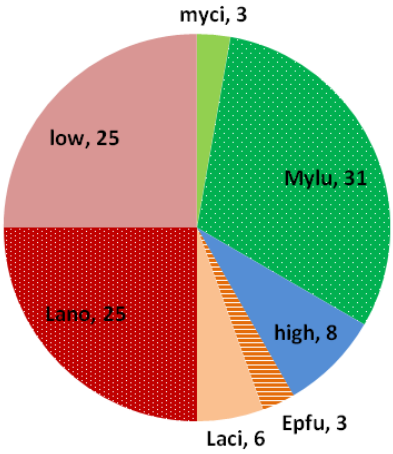
Camas Creek 8 (CAC8)
82 (12%) vetted



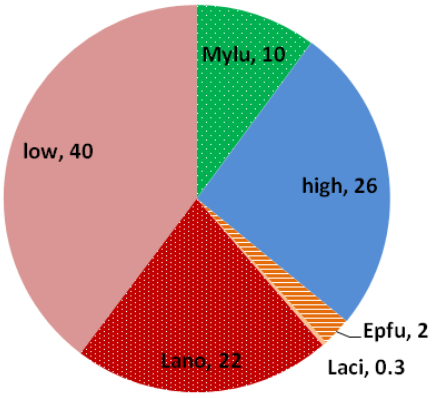
Camas Outlet 9 (CAO9)
92 (12%) vetted



Center 5 (CEN5)
34 (19%) vetted



Independence Ditch 18 (ID18)
238 (16%) vetted



Sandhole 9 (SAN9)
58 (11%) vetted

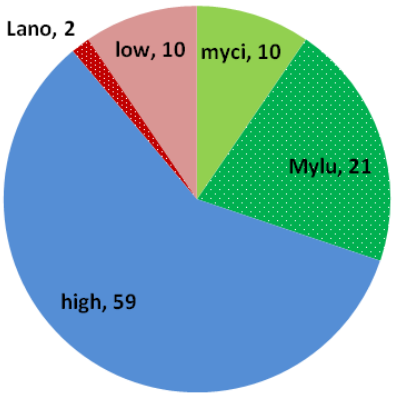
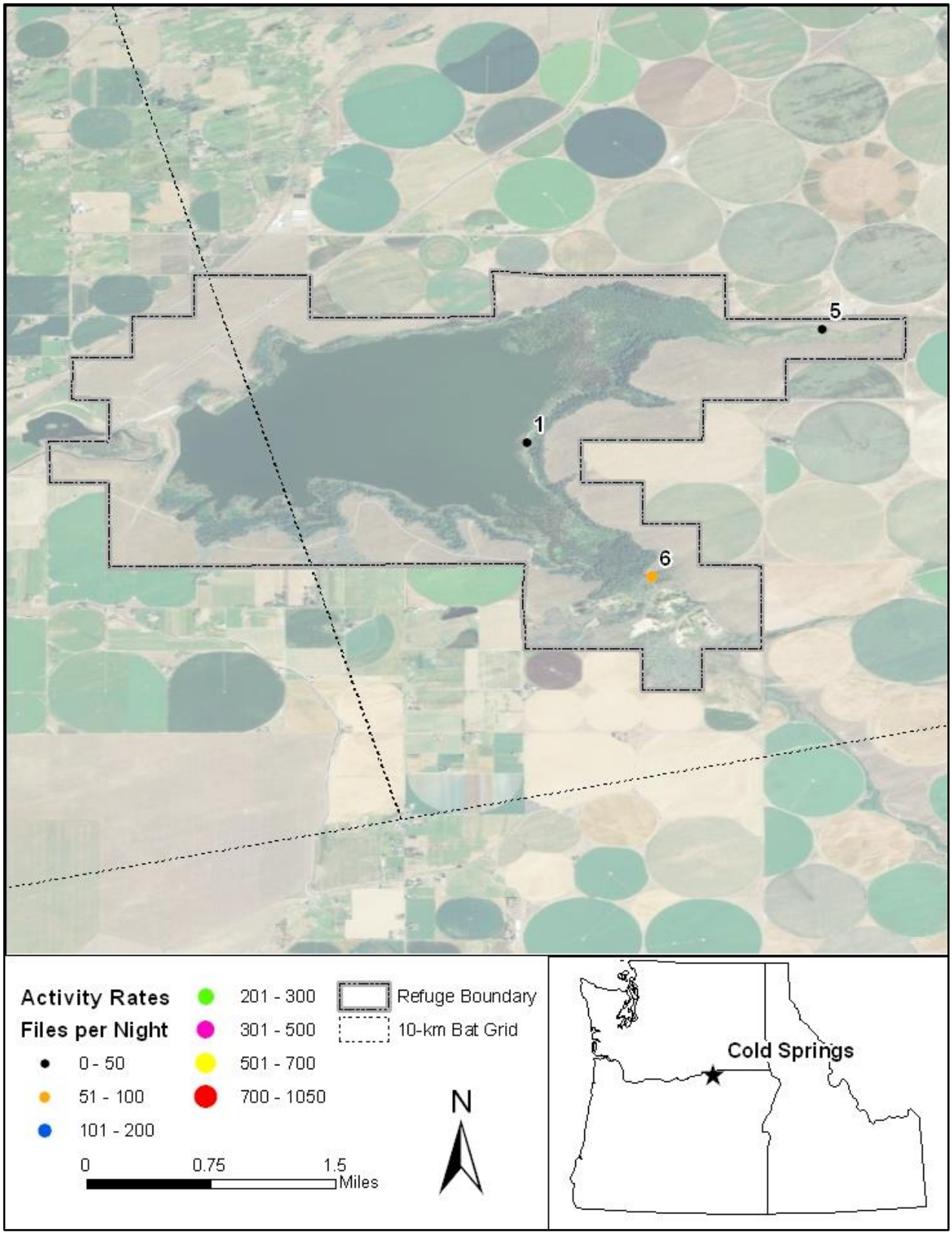


Figure 8. Cold Springs NWR - Sample Sites (Short Name) and Activity Rates from the Region 1 Acoustic Bat Inventory.



Activity rates were low at Cold Springs NWR, where 3 sites were sampled. Only 6 species were detected. Silver-haired bat and little brown myotis contributed significantly to the sample. Hoary bat comprise 40% of the sample at Site Number 6.

Figure 9. Cold Springs NWR - Species composition from 3 sites. Data were collected during the Region 1 Acoustic Bat Inventory. Vetted files were inspected in SonoBat software by an expert in bat call identification to verify automatic species classification. The values for vetted represent total numbers of files vetted and percent of call files vetted, respectively.

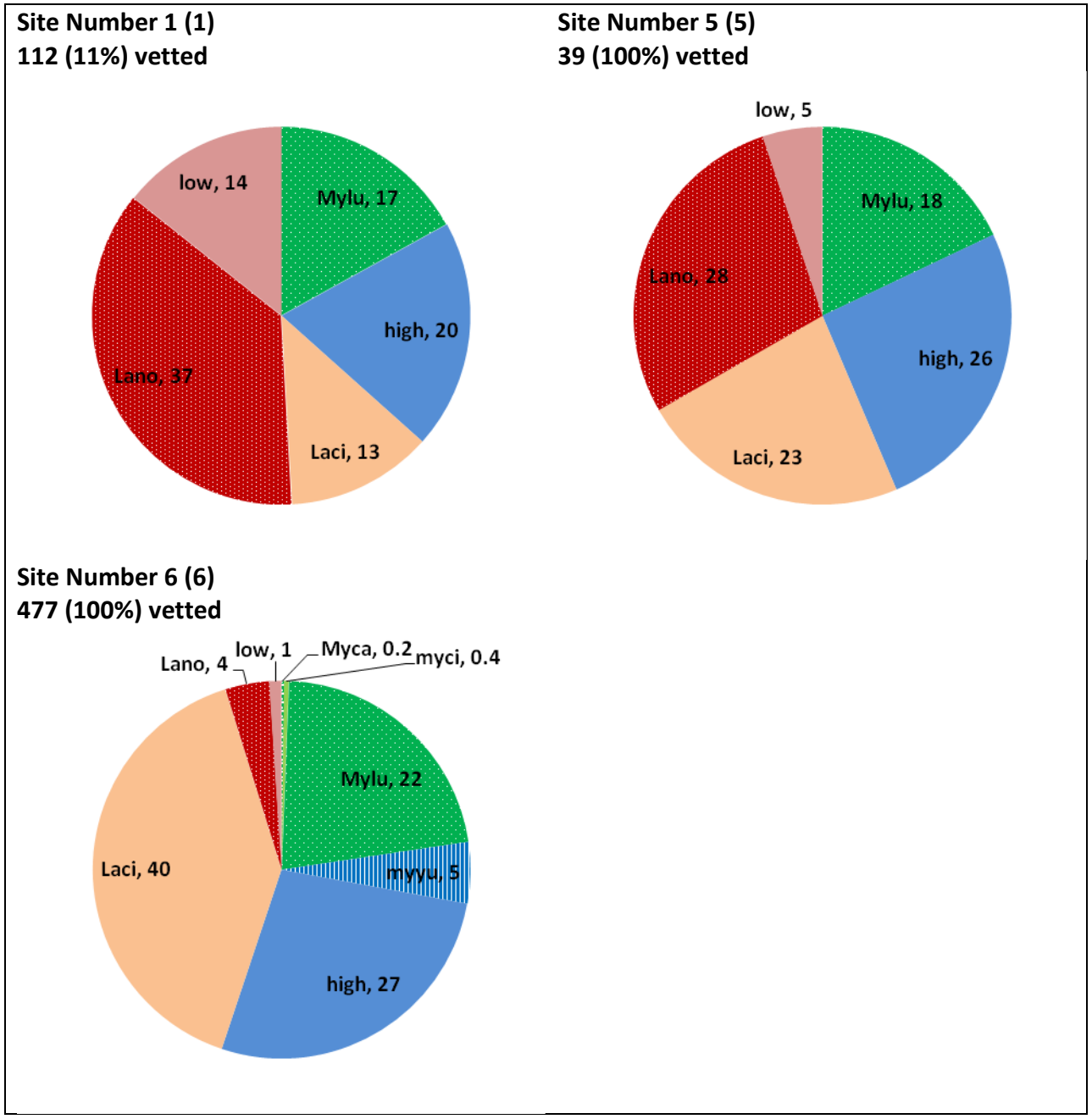
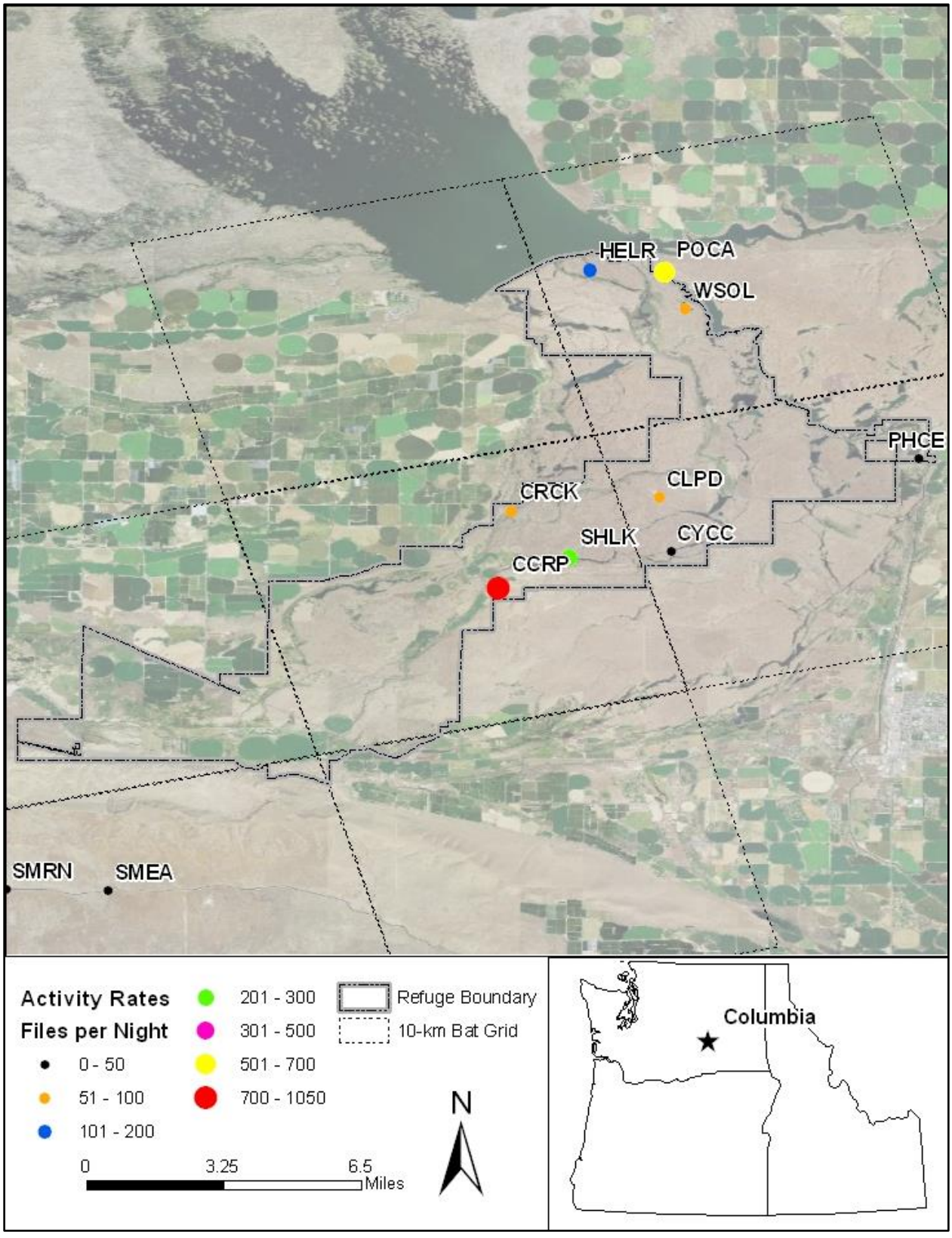
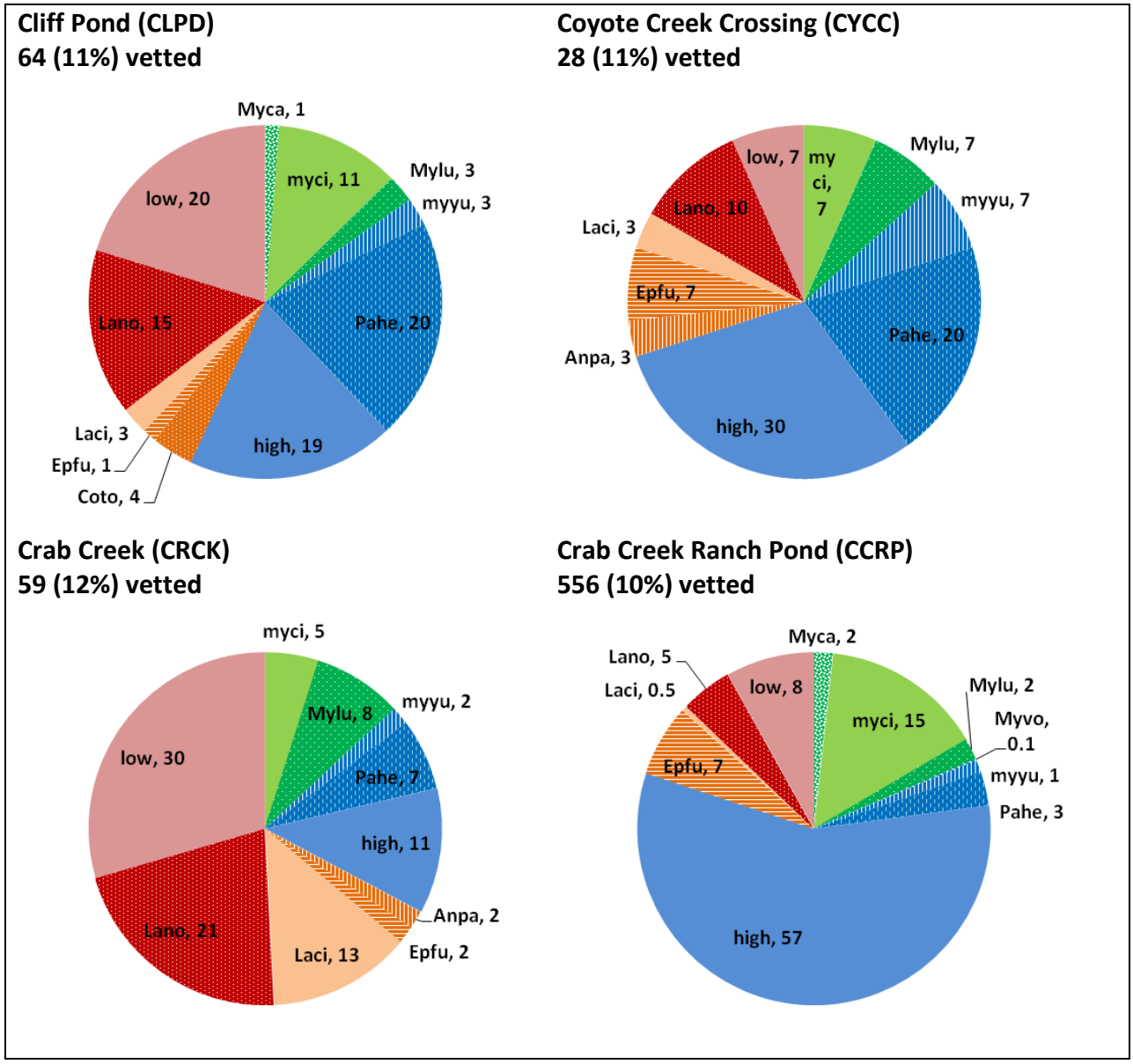


Figure 10. Columbia NWR - Sample Sites (Short Name) and Activity Rates from the Region 1 Acoustic Bat Inventory.

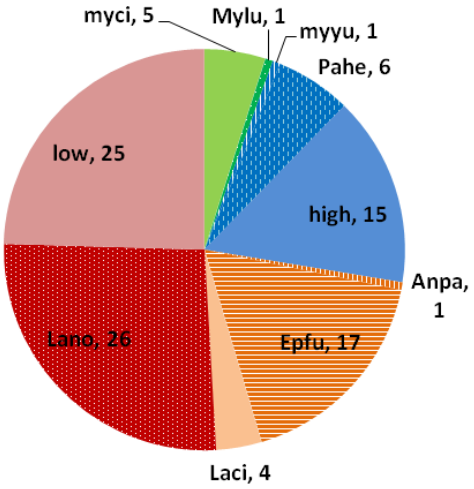


In 2013, 9 sites were sampled at Columbia NWR. Three sites had high activity (>300 files/night) and Crab Creek Ranch Pond had 899 files/night, the second highest in the study. Species richness was high, with 11 species detected. Only long-eared myotis, and fringed myotis were not detected. Pallid bat was detected at 5 sites, although it never comprised more than 3% of the sample.

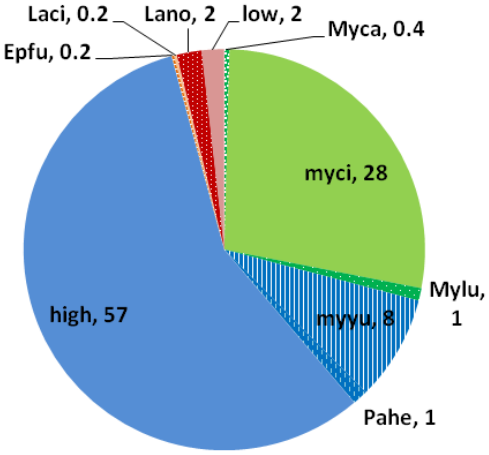
Figure 11. Columbia NWR - Species composition from 9 sites. Data were collected during the Region 1 Acoustic Bat Inventory. Vetted files were inspected in SonoBat software by an expert in bat call identification to verify automatic species classification. The values for vetted represent total numbers of files vetted and percent of call files vetted, respectively.



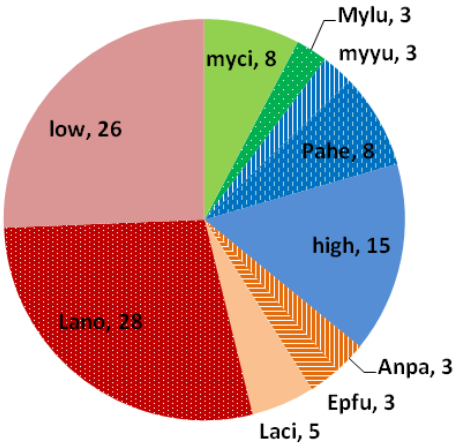
Heron Lake Road (HELR)
137 (10%) vetted



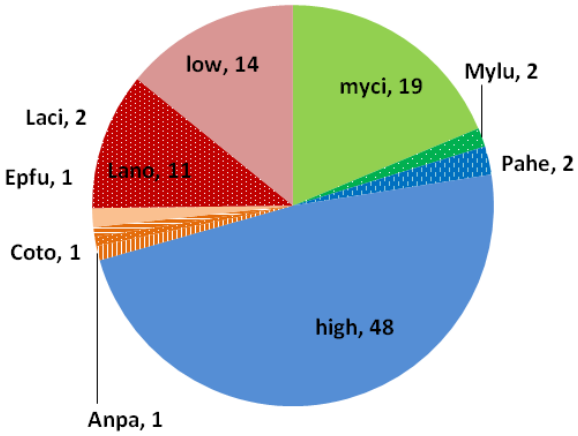
Potholes Canal (POCA)
375 (10%) vetted



Potholes Canal East (PHCE)
36 (10%) vetted



Shiner Lake (SHLK)
188 (10%) vetted



West of Soap Lake (WSOL)
46 (12%) vetted

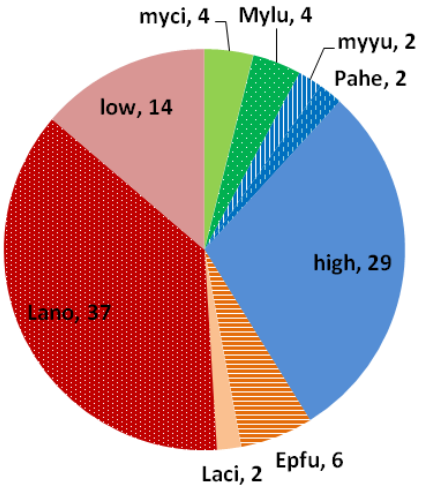
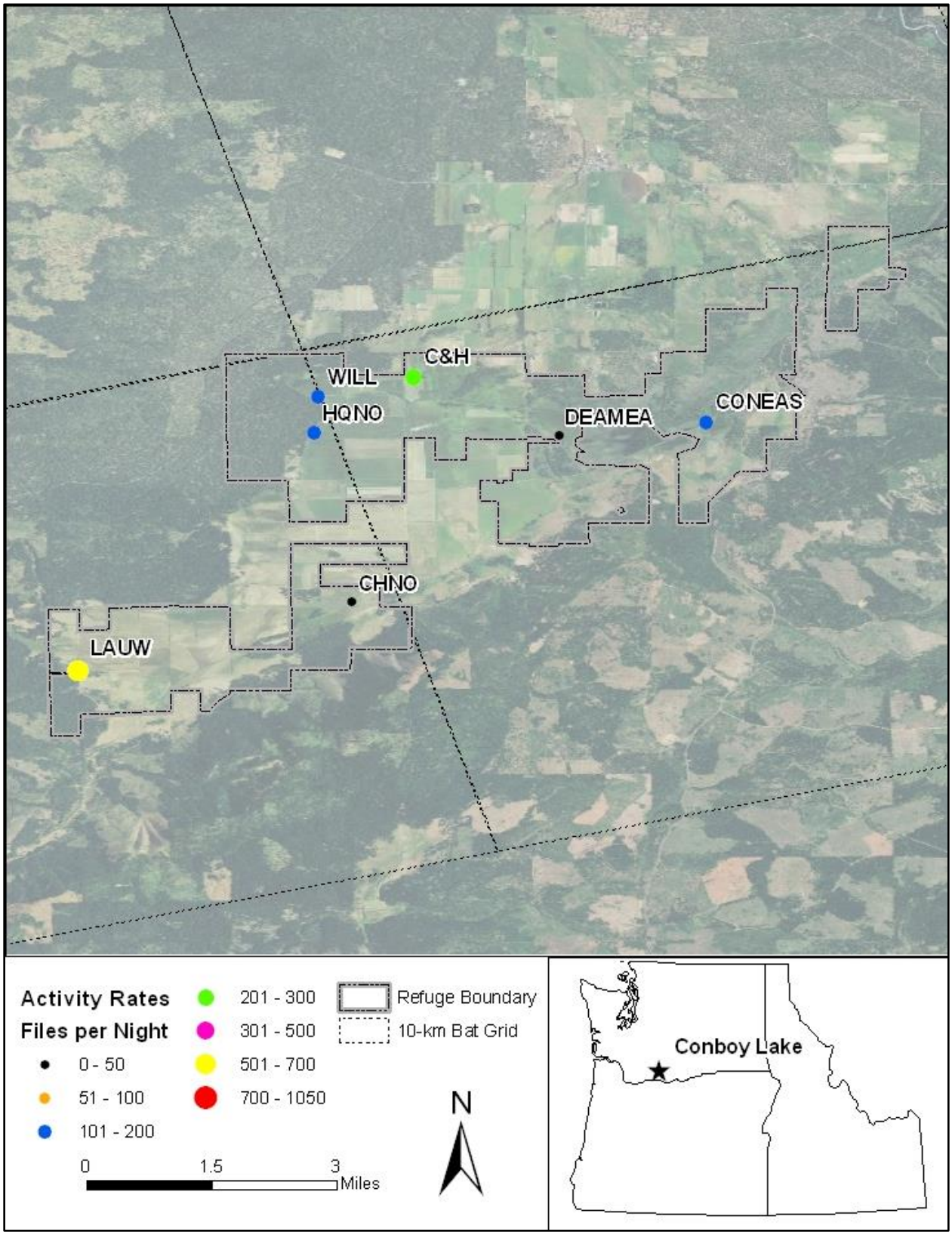
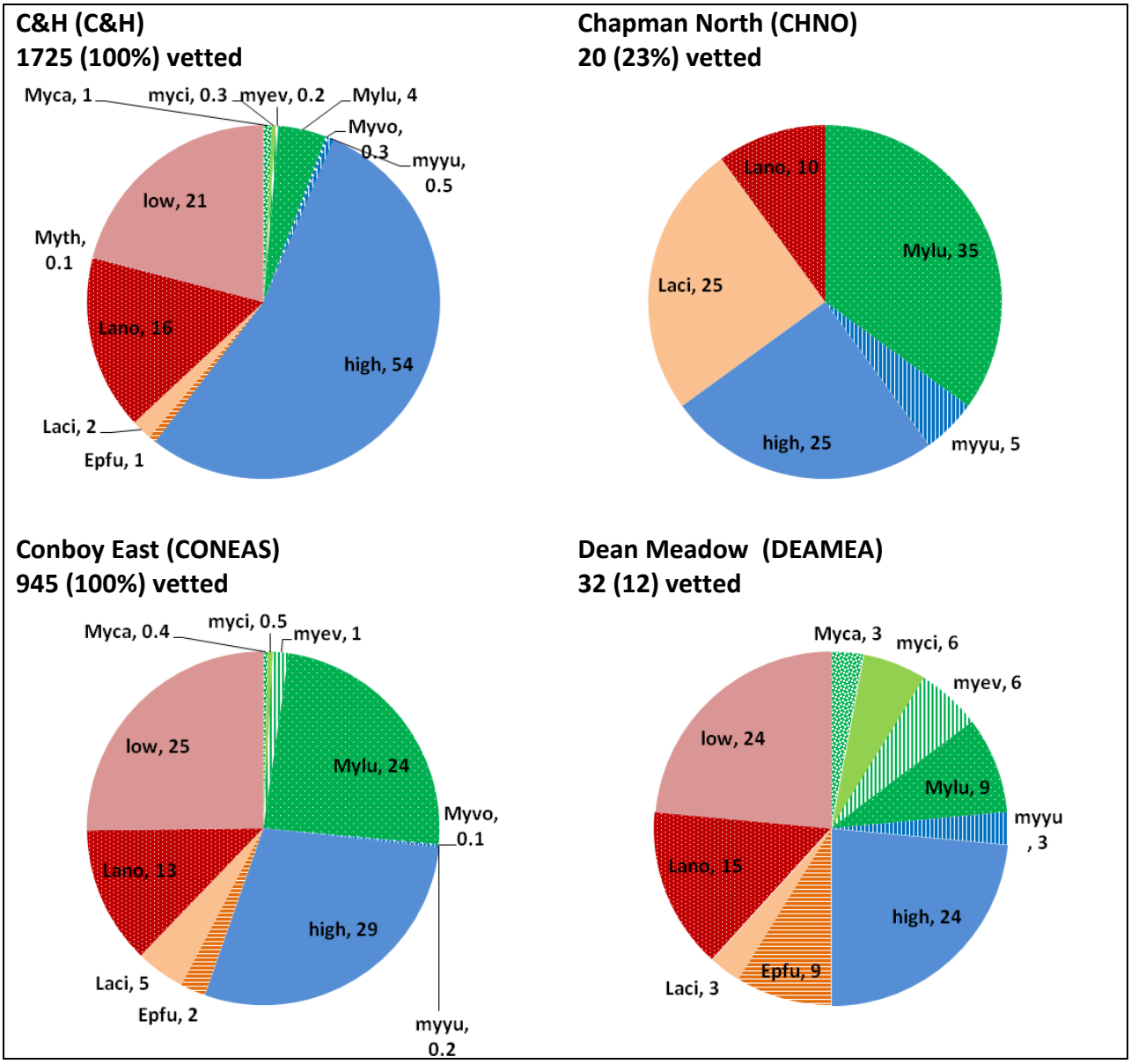


Figure 12. Conboy Lake NWR - Sample Sites (Short Name) and Activity Rates from the Region 1 Acoustic Bat Inventory.

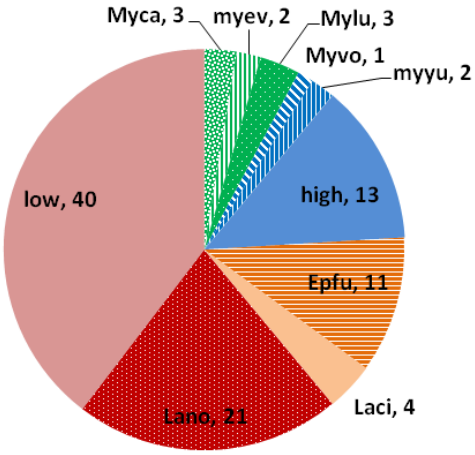


Conboy Lake sampled 7 sites, but 2 had problems with equipment. An animal bit through the microphone cord at Chapman North, which only had 3 nights sampling. Dean Meadow was a very noisy site and 84% of the vetted files were noise. Activity rates were relatively high and Laurel West had 573 files per night. Only 2 species were not detected, canyon bat and Townsend's big-eared bat. Averaged across all sites, silver-haired bat was the most commonly recorded species. Conboy Lake had a higher proportion of low-frequency bats than many of the other refuges.

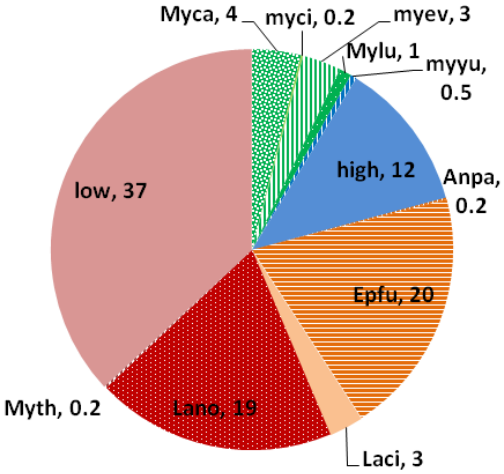
Figure 13. Conboy Lake NWR - Species composition from 7 sites. Data were collected during the Region 1 Acoustic Bat Inventory. Vetted files were inspected in SonoBat software by an expert in bat call identification to verify automatic species classification. The values for vetted represent total numbers of files vetted and percent of call files vetted, respectively.



HQ North (HQNO)
144 (11%) vetted



Laurel W (LAUW)
410 (10%) vetted



Willard (WILL)
77 (10%) vetted

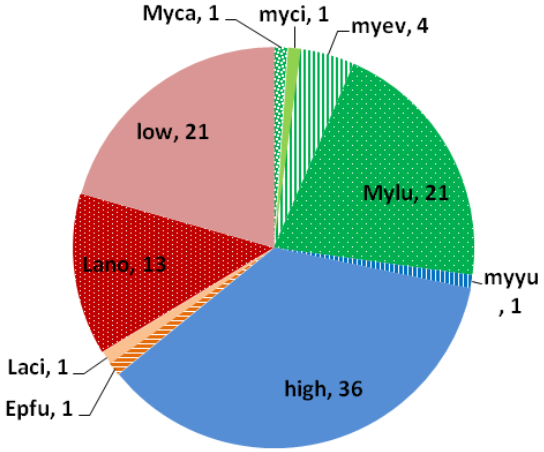
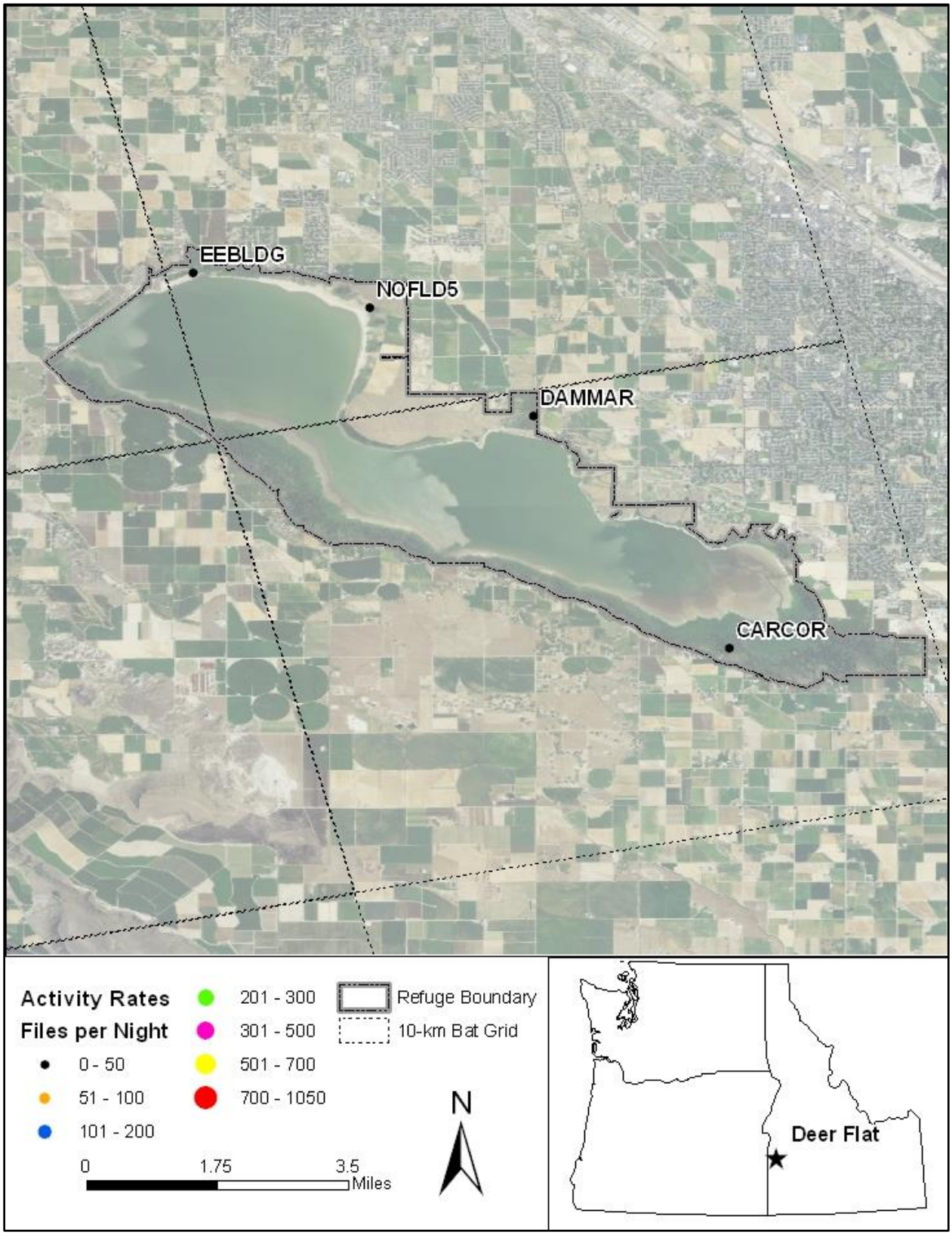


Figure 14. Deer Flat NWR - Sample Sites (Short Name) and Activity Rates from the Region 1 Acoustic Bat Inventory.



Very few bats were detected at Deer Flat. Overall, low numbers of file were collected and the vast majority of files were noise. Refuge staff wondered if there was a problem with equipment. However, when equipment malfunctioned no files were typically collected and the total number of files collected per deployment at Deer Flat was typical of other refuges with low activity. The equipment was sent to Malheur after Deer Flat, where it functioned normally and high numbers of bats were detected.
Deer Flat resampled 1 site in September (Carter's Corner) and found higher levels of activity. That sampling was conducted outside the project period and was not included here. Year-round sampling at McNary Refuge in 2013 revealed high levels of bat activity in Spring and Fall with low levels in summer (USFWS unpublished data). Perhaps bats used these refuges during migration rather than breeding season.

Figure 15. Deer Flat NWR - Species composition from 4 sites. Data were collected during the Region 1 Acoustic Bat Inventory. Vetted files were inspected in SonoBat software by an expert in bat call identification to verify automatic species classification. The values for vetted represent total numbers of files vetted and percent of call files vetted, respectively.

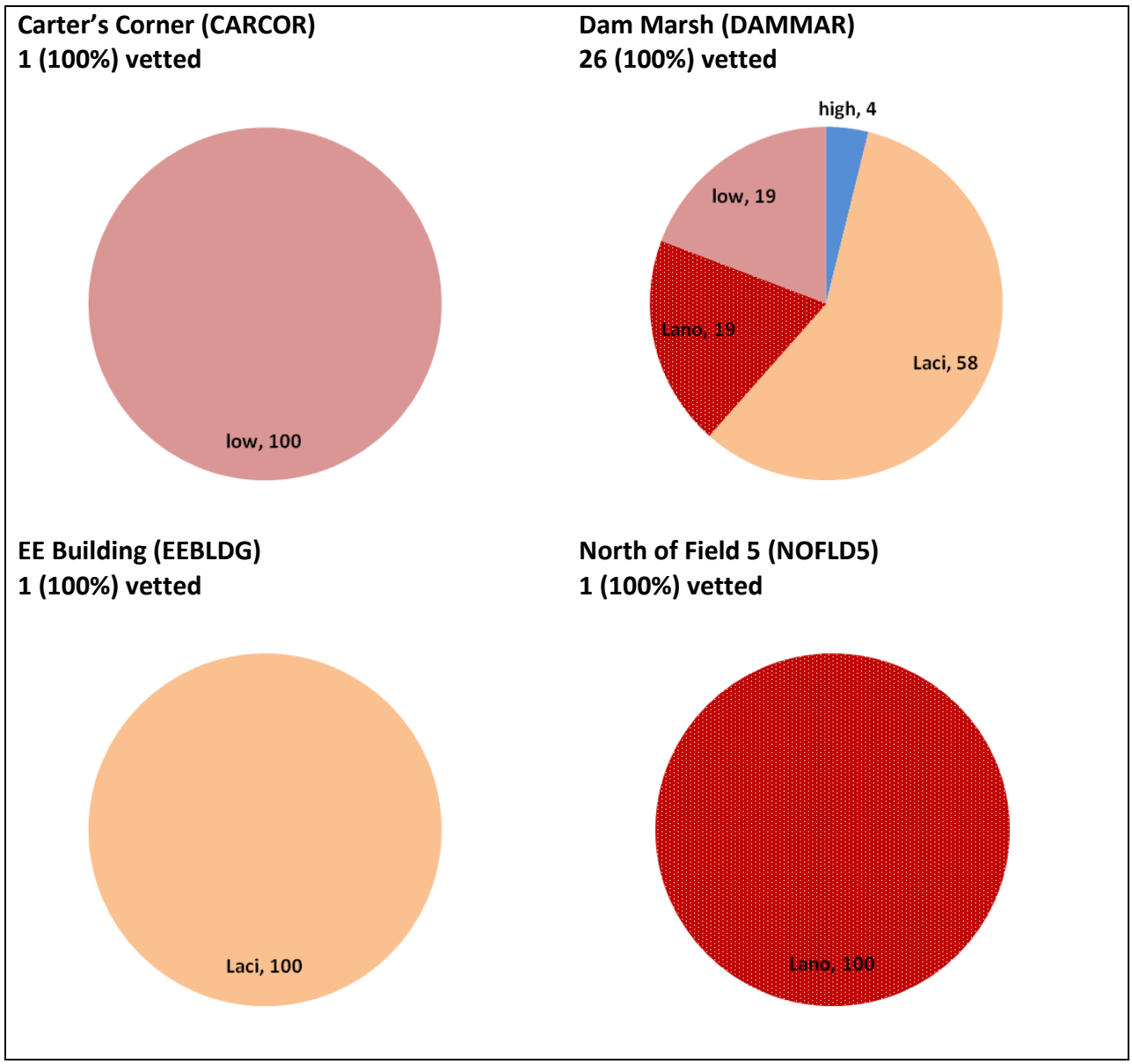
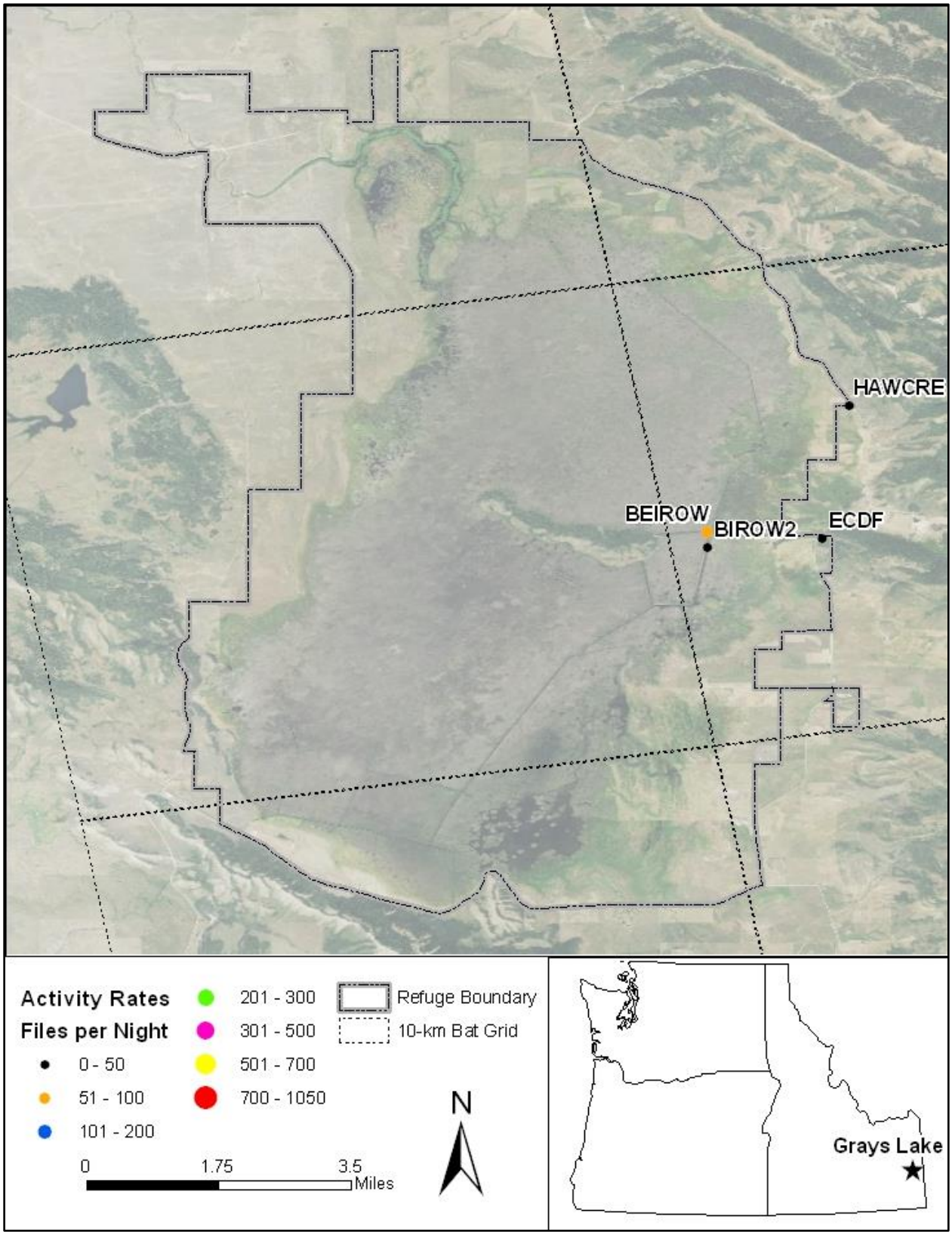


Figure 16. Grays Lake NWR - Sample Sites (Short Name) and Activity Rates from the Region 1 Acoustic Bat Inventory.



Four sites were sampled at Grays Lake, but one was a replacement site. Cattle knocked the antenna over at the Bear Island ROW site, and only 3 nights of data were collected (July 17, 18, and 19, 2012). A replacement site (Bear island ROW – site 2) was sampled for 7 nights in early August. Activity rates and species composition were different between the 2 sites; they are both reported here. Overall, activity rates were relatively low at Grays Lake. There was more activity at the Bear Island ROW site than the replacement site, sampled 2 weeks later. A total of 8 species were detected. Silver-haired bat and hoary bat were the only species detected at all 4 sites. Overall, hoary bat was the most common, followed by silver-haired bat and little brown myotis.

Figure 17. Grays Lake NWR - Species composition from 4 sites. Data were collected during the Region 1 Acoustic Bat Inventory. Vetted files were inspected in SonoBat software by an expert in bat call identification, to verify automatic species classification. The values for vetted represent total numbers of files vetted and percent of call files vetted, respectively.

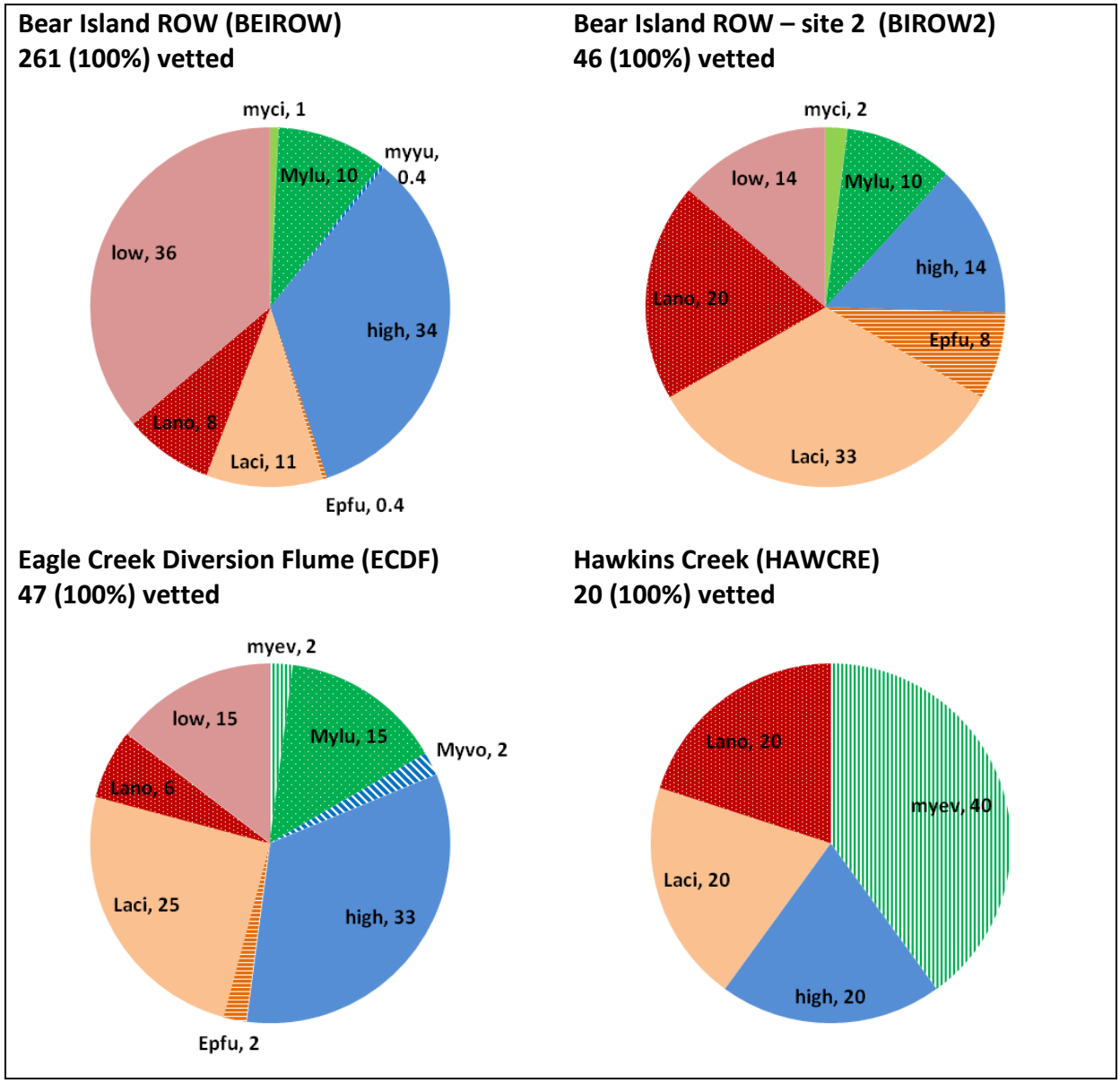
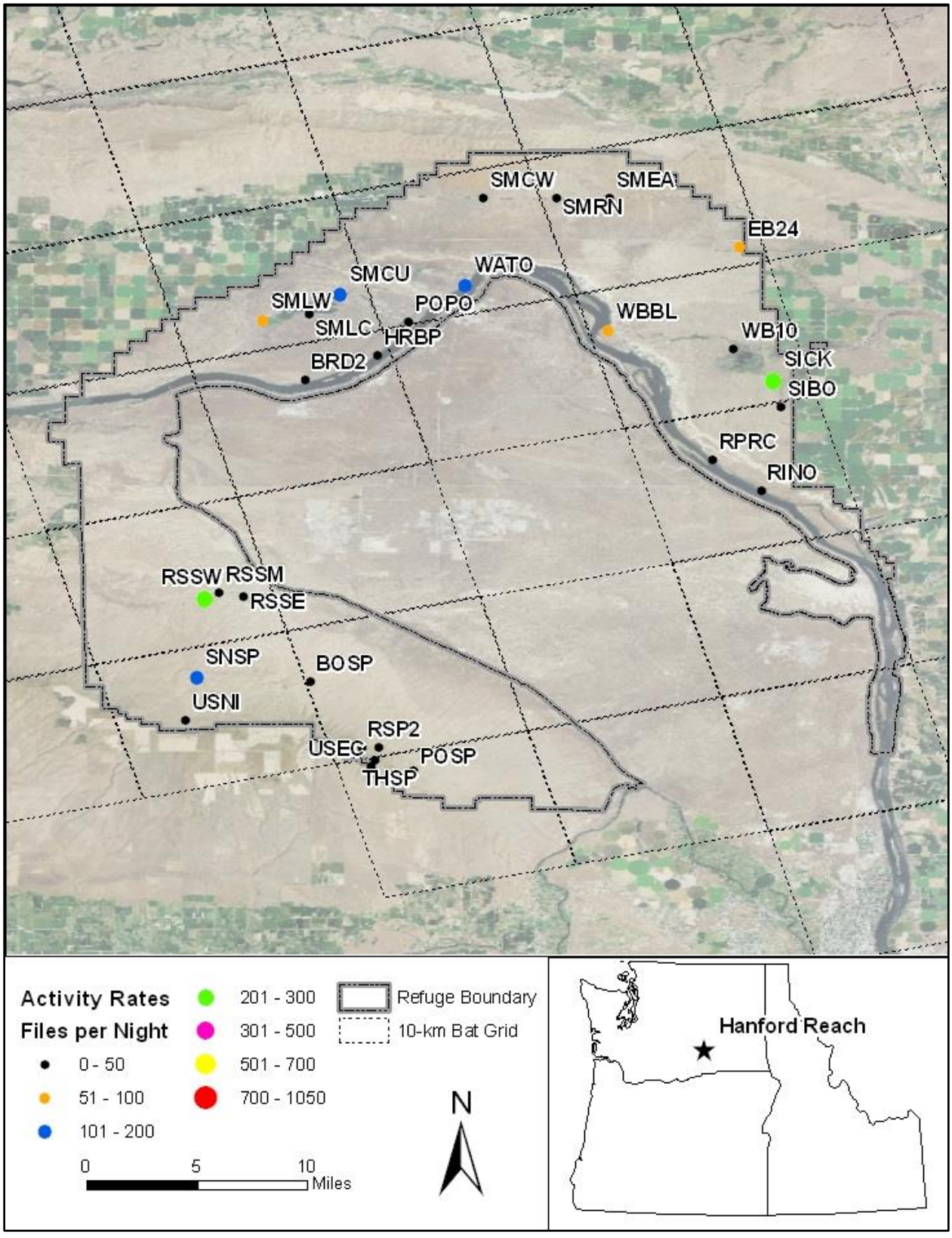


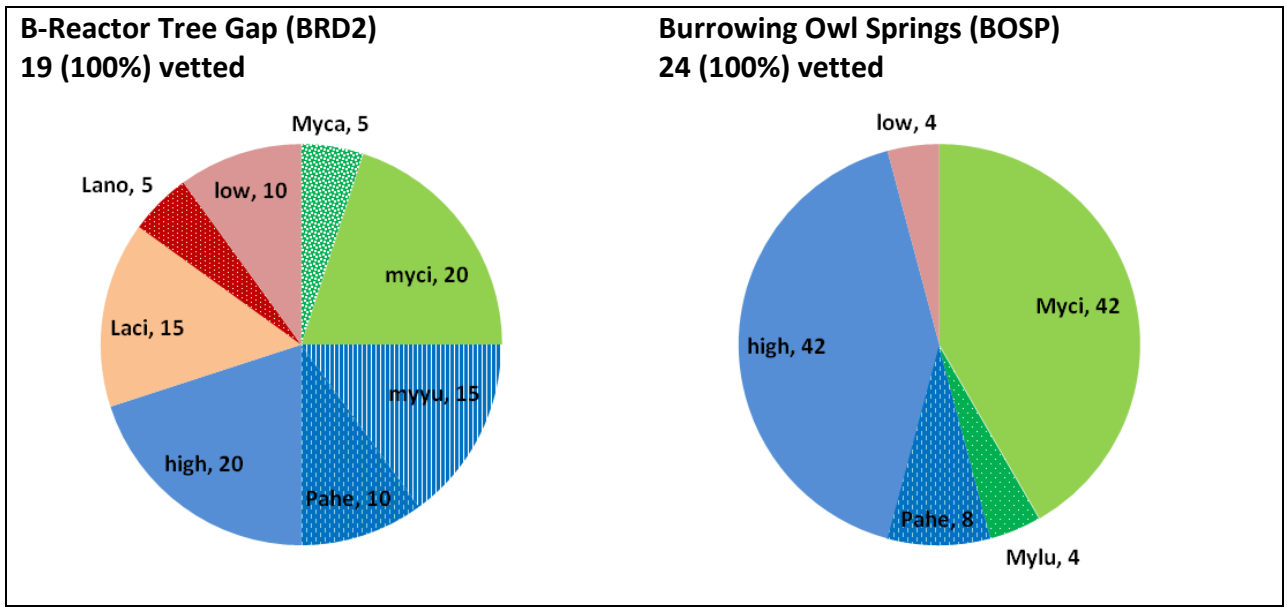
Figure 18. Hanford Reach National Monument - Sample Sites (Short Name) and Activity Rates from the Region 1 Acoustic Bat Inventory.



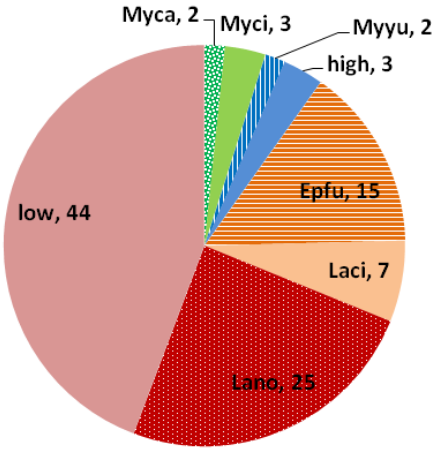
A total of 28 sites were sampled at Hanford Reach National Monument and 13 species were detected. Long-eared myotis, long-legged myotis, Townsend's big-eared bat, and fringed myotis were rare, comprising less than 1% of the sample across the entire refuge. Long-eared and long-legged myotis were detected at 2 sites, while Townsend's big-eared and fringed myotis were each detected at one (Rattlesnake Spring West and Saddle Mountain Lake Culvert, respectively). Overall western small-footed myotis, Yuma myotis, and silver-haired bat were the most common species on the refuge, comprising 13, 10, and 9 percent of the refuge-wide sample, respectively.

Overall, bat activity at sites on the Arid Lands Ecology Reserve Unit (ALE) were low, except Rattlesnake Springs West and Snively Sping. Rattlesnake Springs West Unit had 291 call files per night and high species richness. Twelve species were detected there, including long-eared myotis, long-legged myotis and Townsend's big-eared bat.

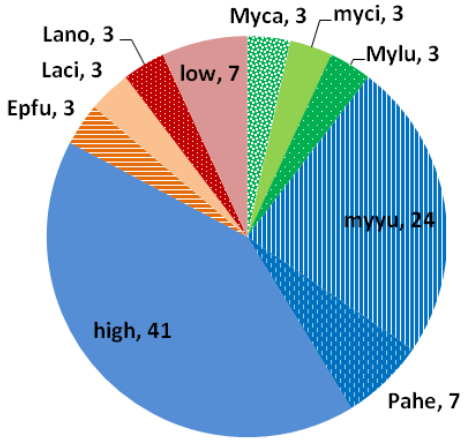
Figure 19. Hanford Reach National Monument - Species composition from 28 sites. Data were collected during the Region 1 Acoustic Bat Inventory. Vetted files were inspected in SonoBat software by an expert in bat call identification to verify automatic species classification. The values for vetted represent total numbers of files vetted and percent of call files vetted, respectively.



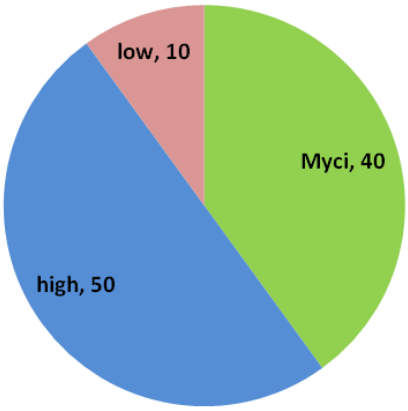
East Boundary, S of Hwy 24 (EB24)
57 (10%) vetted



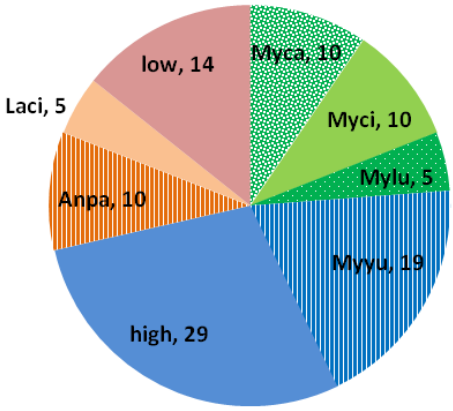
Hanford River Bullfrog Puddle (HRBP)
22 (18%) vetted



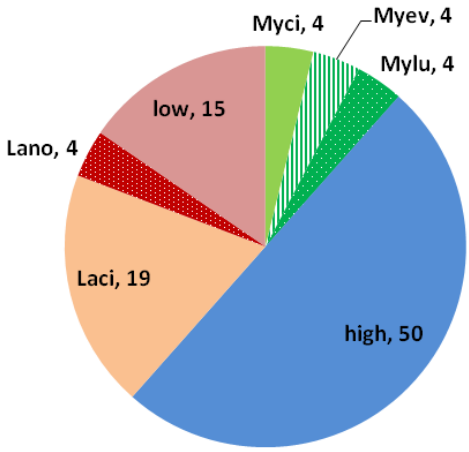
Lower Ridge Spring 1 (LRS1)
10 (100%) vetted



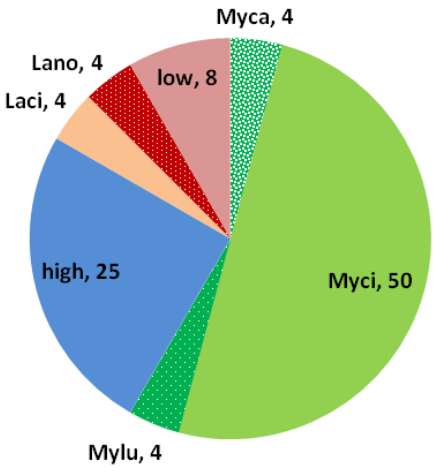
Powerline Pond (POPO)
20 (25%) vetted



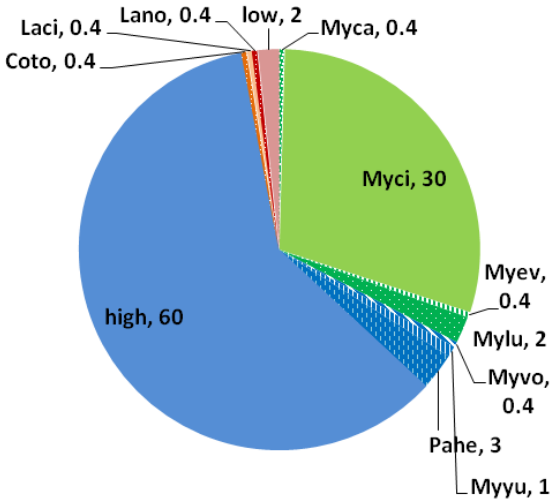
Powerline Spring (POSP)
26 (100%) vetted



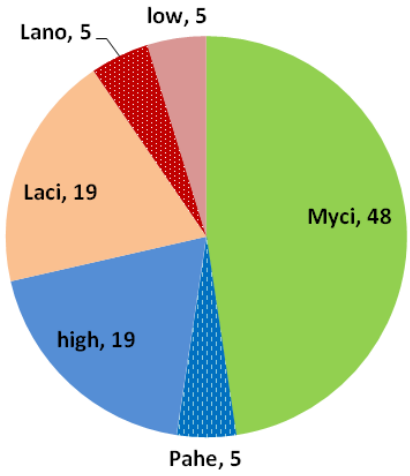
Rattlesnake Spring – East (RSSE)
21 (12%) vetted



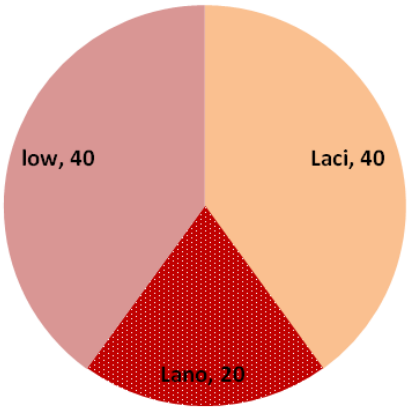
Rattlesnake Spring West (RSSW)
213 (10%) vetted



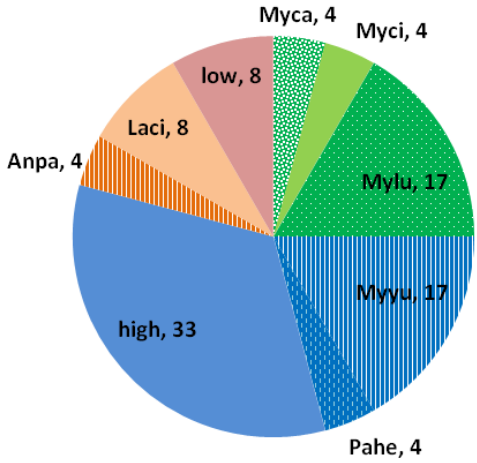
Rattlesnake Springs – Middle (RSSM)
20 (10%) vetted



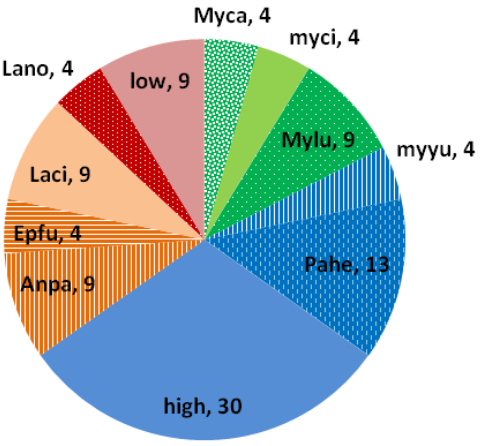
Ridge Spring #2 (RSP2)
5 (100%) vetted



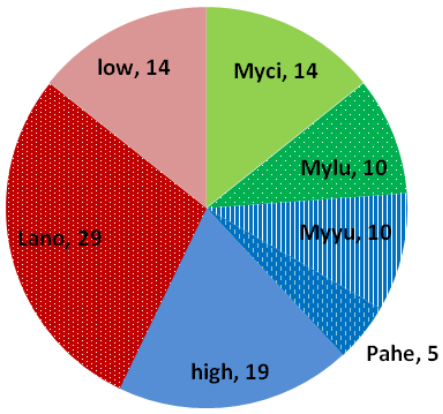
Ringold North (RINO)
23 (11%) vetted



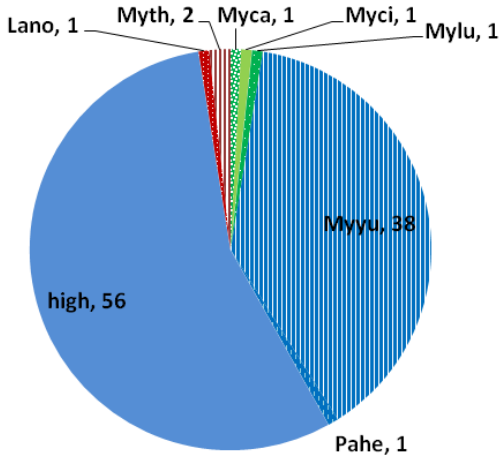
Ringold Powerline River Crossing (RPRC)
21 (16%) vetted



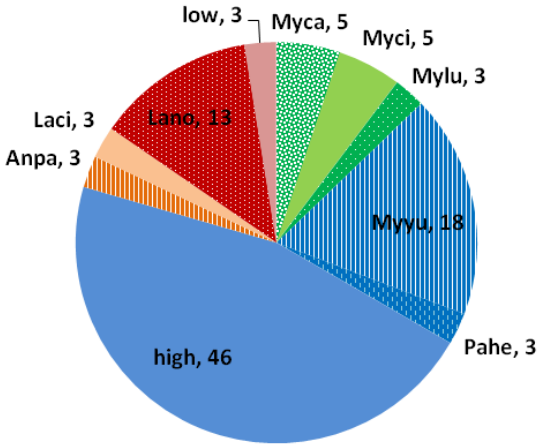
Saddle Mountain East (SMEA)
21 (40%) vetted



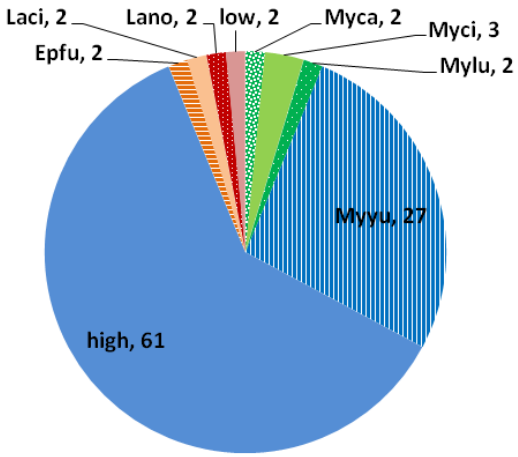
Saddle Mountain Lake Culvert (SMCU)
102 (11%) vetted



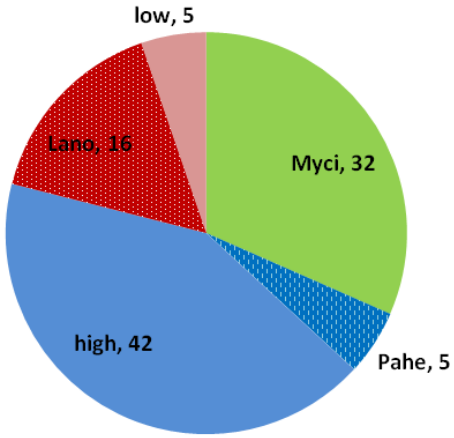
Saddle Mountain Lakes – Center (SMLC)
33 (12%) vetted



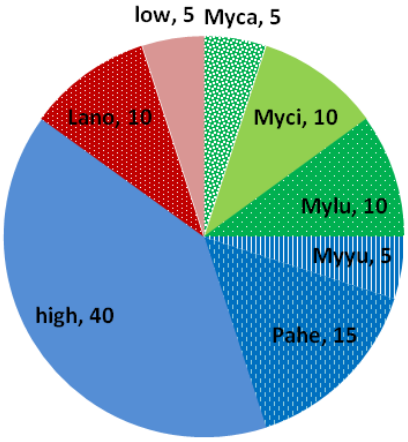
Saddle Mountain Lakes West (SMLW)
51 (11%) vetted



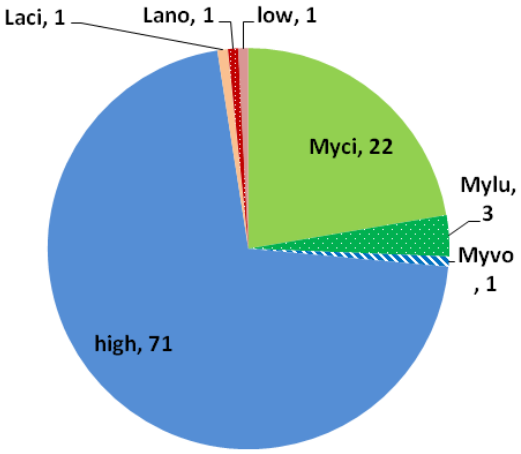
Saddle Mtn Canal – west (SMCW)
19 (100%) vetted



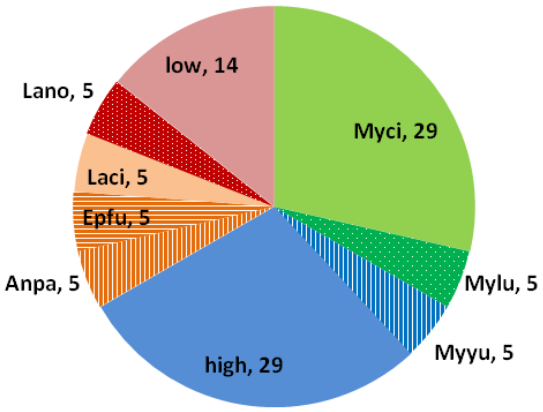
Saddle Mtn Road North (SMRN)
20 (26%) vetted



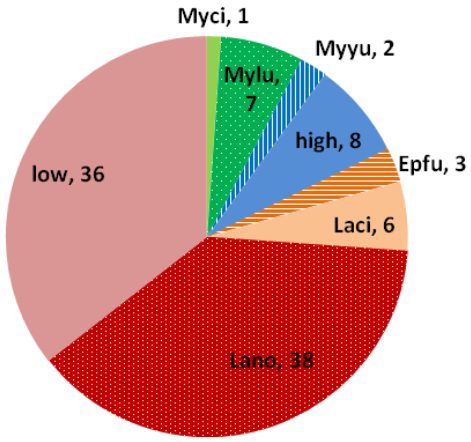
Snively Spring (SNSP)
113 (10%) vetted



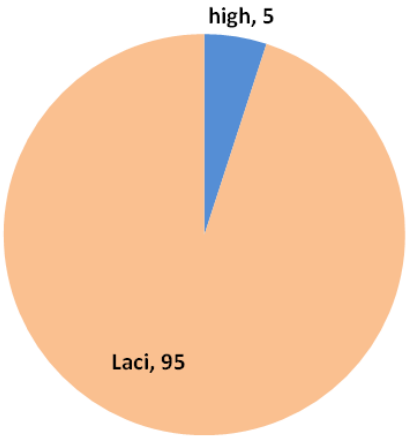
South Inflow Boundary (SIBO)
20 (22%) vetted



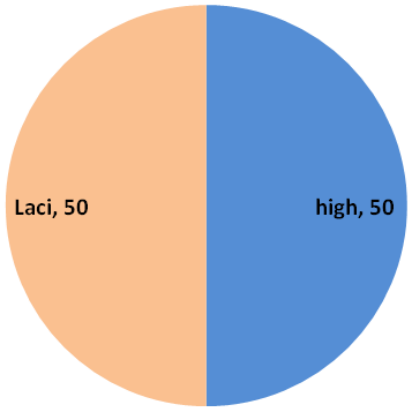
South Inflow Creek (SIBO)
144 (10%) vetted



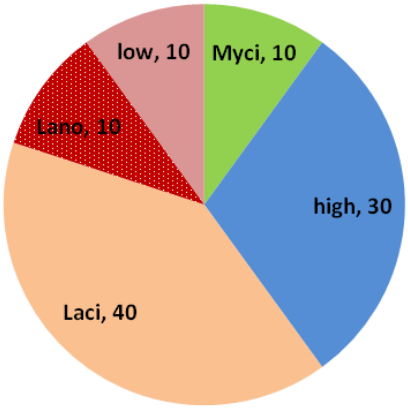
Thicket Spring (THSP)
20 (87%) vetted



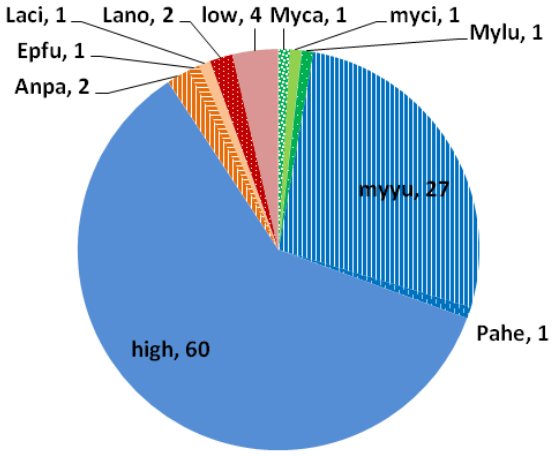
Unnamed Seep 100 (USEC)
4 (100%) vetted



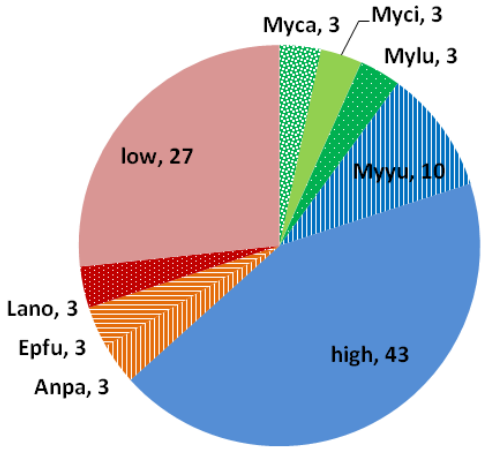
Upper Snively Spring (USNI)
10 (100%) vetted



Wahluke Townsite (WATO)
90 (10%) vetted



WB10 Ponds (WB10)
29 (17%) vetted



White Bluffs Boat Launch (WBBL)
46 (12%) vetted

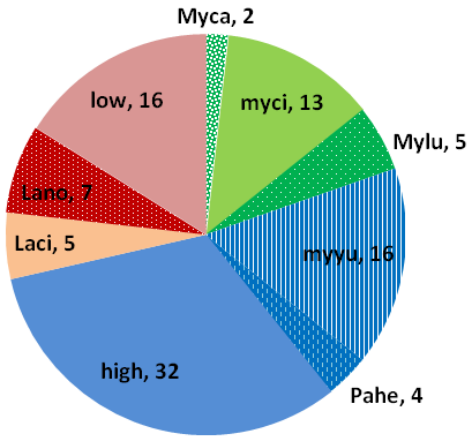
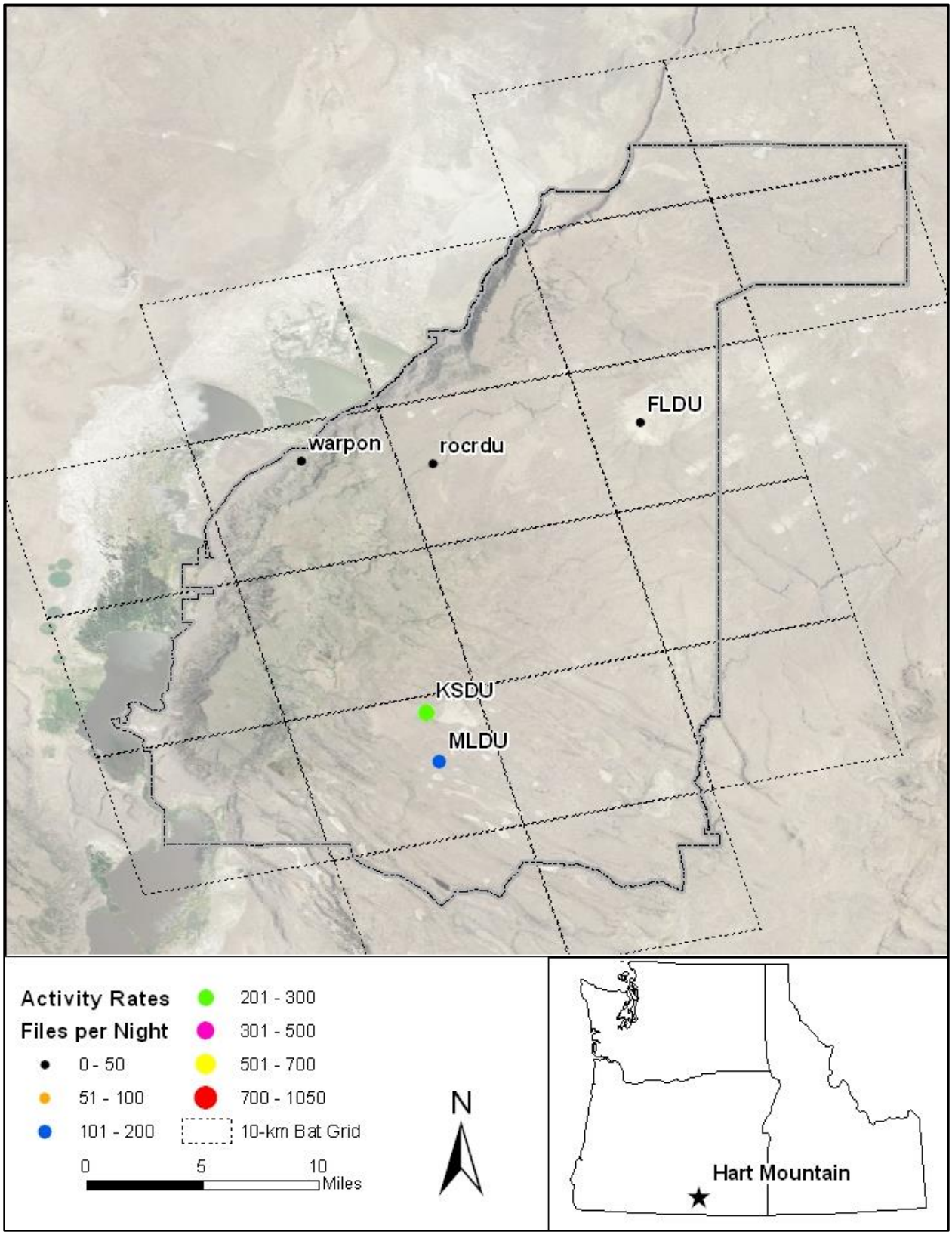
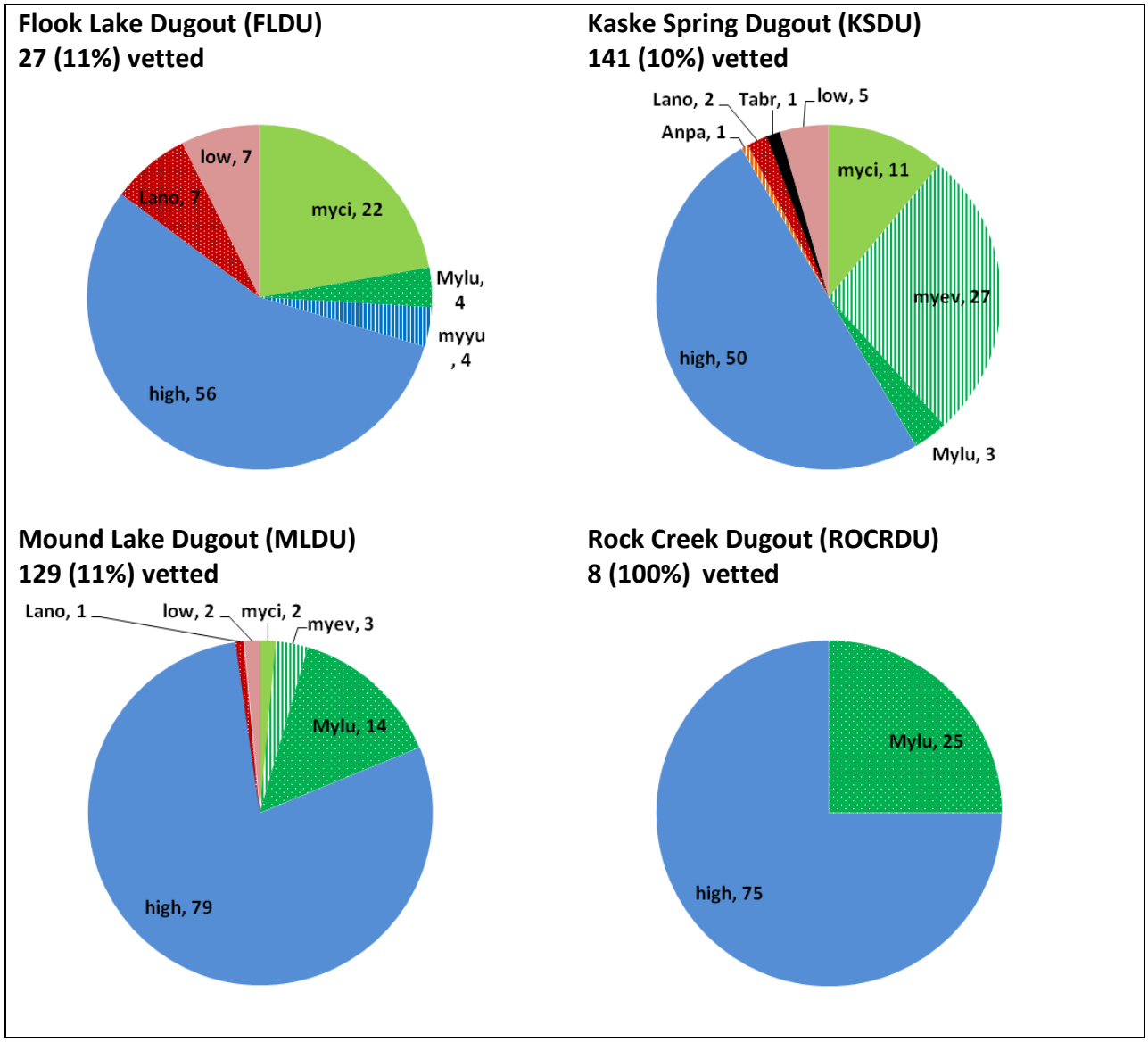


Figure 20. Hart Mountain National Antelope Refuge - Sample Sites (Short Name) and Activity Rates from the Region 1 Acoustic Bat Inventory.



Five sites were sampled at Hart Mountain National Antelope Refuge, 2 in 2012 and 3 in 2013. Activity was high at Kaske Spring Dugout (224 files per night) and Mound Lake Dugout (172 files per night) but low at the other 3 sites. Long-eared myotis was detected at 2 sites, but comprised 27 percent of the sample at Kaske Spring Dugout. Overall, little brown myotis was the most common species on the refuge. Brazilian free-tailed bat was detected at Kaske Spring Dugout, the only detection of that species during the project. Spotted bat was recorded during additional surveys performed independent of the inventory (USFWS, unpublished data).

Figure 21. Hart Mountain National Antelope Refuge - Species composition from 5 sites. Data were collected during the Region 1 Acoustic Bat Inventory. Vetted files were inspected in SonoBat software by an expert in bat call identification to verify automatic species classification. The values for vetted represent total numbers of files vetted and percent of call files vetted, respectively.



Warner Pond (WARPON)
8 (100%) vetted

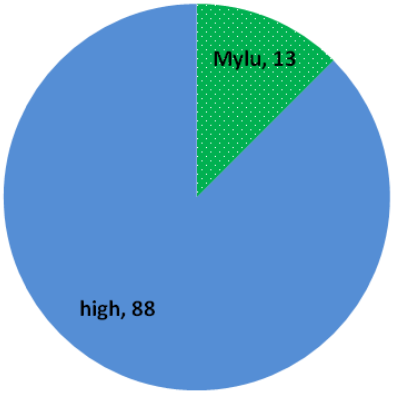
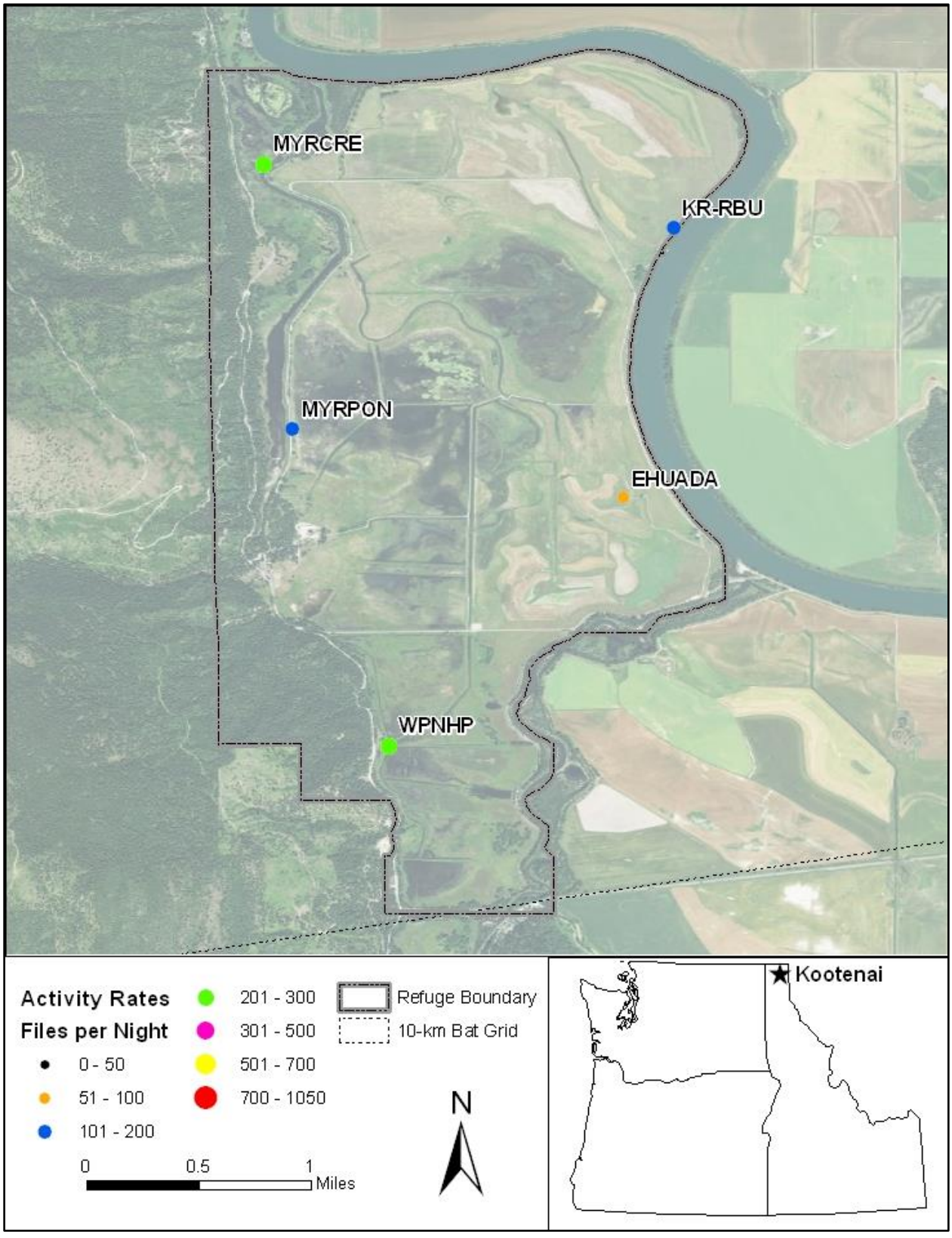
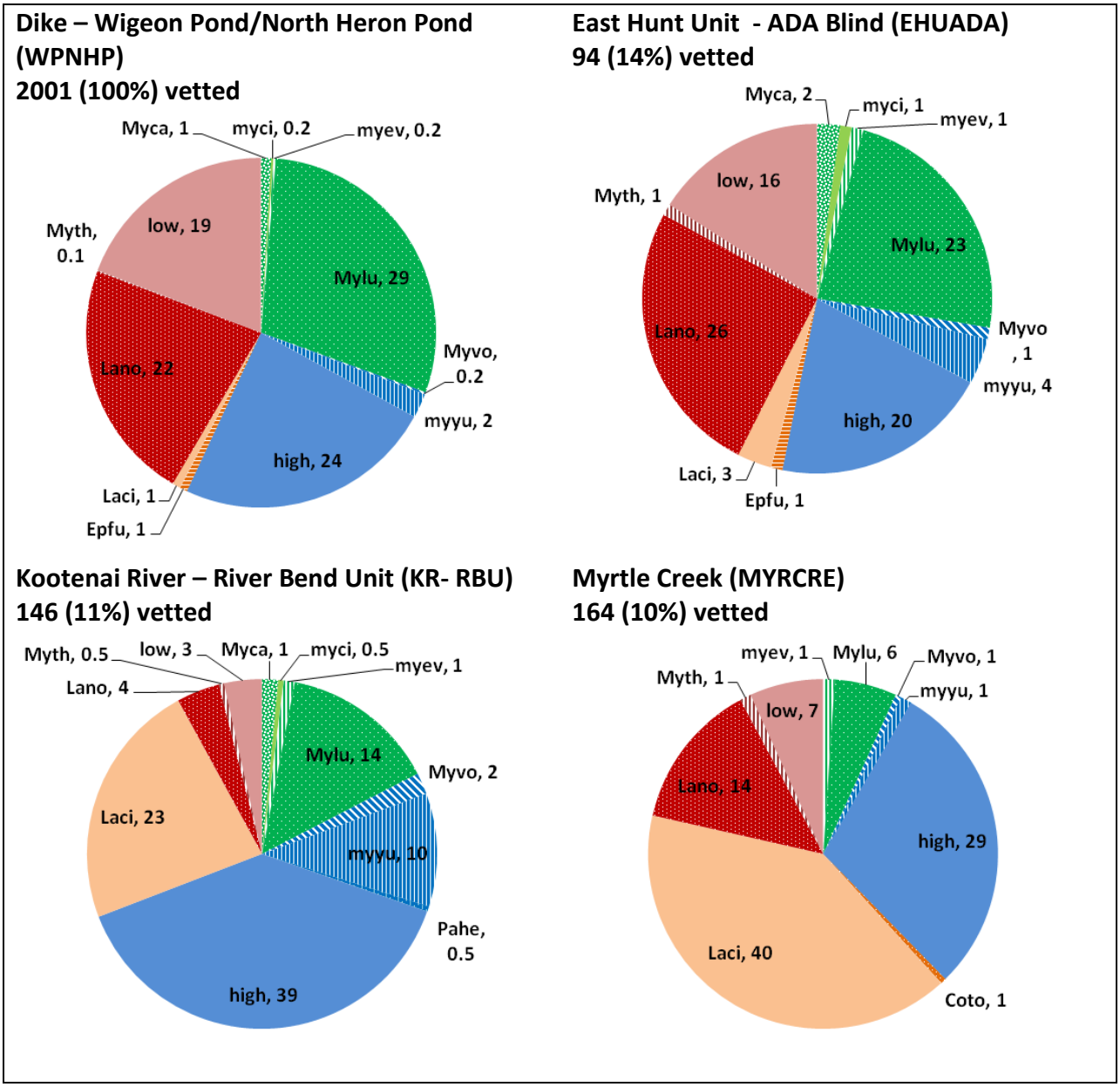


Figure 22. Kootenai NWR - Sample Sites (Short Name) and Activity Rates from the Region 1 Acoustic Bat Inventory.



A total of 5 sites were sampled on Kootenai Refuge in 2012. Overall, species richness and activity were relatively high. Activity rates exceeded 200 files per night at 2 sites (Myrtle Creek [227 files per night] and Dike – Wigeon Pond/North Heron Pond [286]) and 100 calls per night at 2 sites (Kootenai River – Rivers Ben Unit [192] and Myrtle Pond [124]). A total of 12 species were detected, tied with Toppenish for the second highest number of species. Only pallid bat was not detected. The significance of the canyon bat detection was discussed above. Despite the high number of species, 8 species were rare, comprising 1% or less of the sample over the entire refuge. Little brown myotis, Yuma myotis, silver-haired bat, and hoary bat comprised significant amounts of the sample

Figure 23. Kootenai NWR - Species composition from 5 sites. Data were collected during the Region 1 Acoustic Bat Inventory. Vetted files were inspected in SonoBat software by an expert in bat call identification to verify automatic species classification. The values for vetted represent total numbers of files vetted and percent of call files vetted, respectively.



Myrtle Pond (MYRPON)
94 (11%) vetted

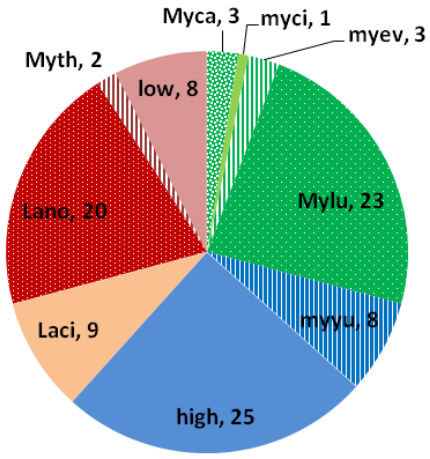
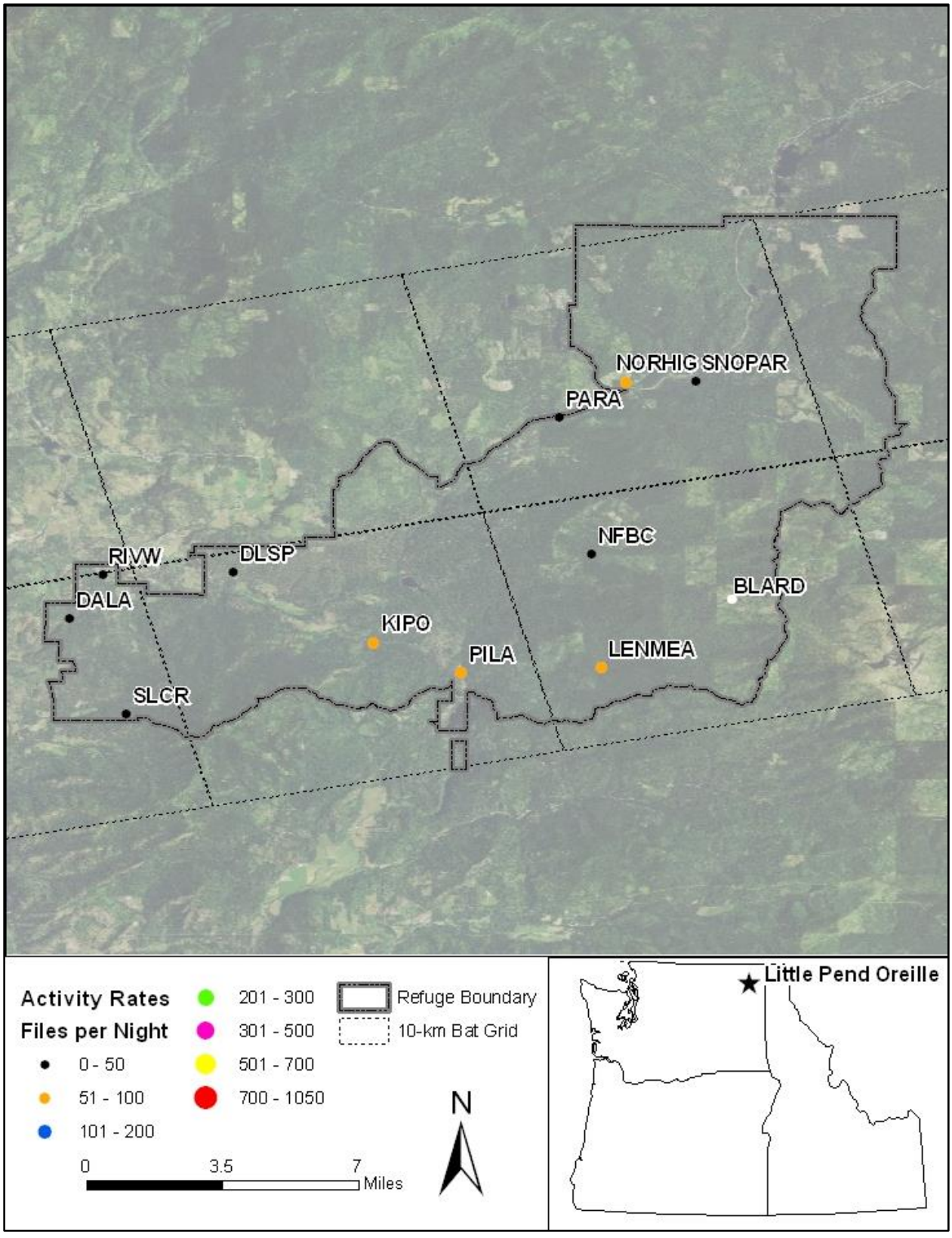


Figure 24. Little Pend Oreille NWR (Main Refuge) - Sample Sites (Short Name) and Activity Rates from the Region 1 Acoustic Bat Inventory.



Samples were collected on Little Pend Oreille (LPO) in 2012 and 2013. The main refuge is relatively large, but 2 very small units south of the main unit are managed by the refuge as well. The results from the small, remote units follow the results for the main refuge.

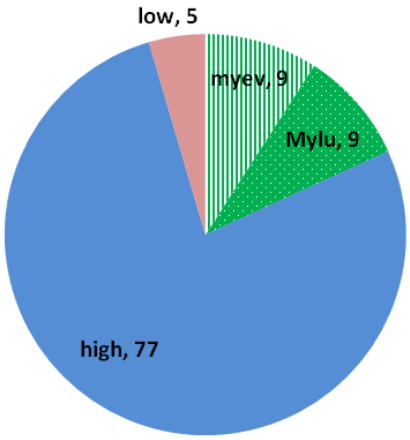
Equipment malfunctioned at 2 sites at LPO, so 12 are reported from the main refuge. No bats were detected at Blacktail Road. We know equipment was working properly because the data cards filled with noise files. An unusually high percentage of noise files were collected at LPO compared to other refuges, and a higher proportion of call files were unidentifiable to species, the majority of them high-frequency bats. Overall activity rates were relatively low with only 3 sites having more than 50 files per night. Eight species were detected on the main refuge. Long-legged myotis was detected on the main refuge, but not on the remote units. It comprised 5 and 3 percent of the sample at Slide Creek and Park Rapids, respectively. California myotis and long-eared myotis comprised 16 to 24% of the sample at Slide Creek and Snow Park sites. Fringed myotis was not a common bat on any refuge (<1%), but comprised 15% of the sample at Slide Creek, the only site where it was detected on the main refuge.

Figure 25. Little Pend Oreille NWR – main refuge - Species composition from 12 sites. Data were collected during the Region 1 Acoustic Bat Inventory. Vetted files were inspected in SonoBat software by an expert in bat call identification to verify automatic species classification. The values for vetted represent total numbers of files vetted and percent of call files vetted, respectively.

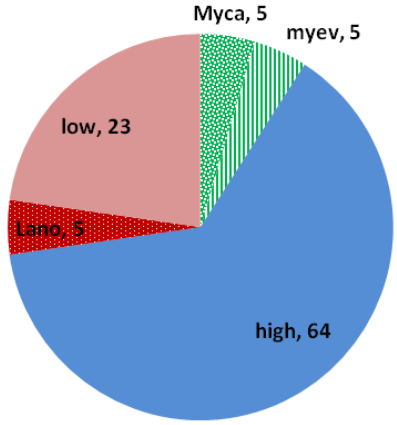
Blacktail Road (BLARD)

No bats detected

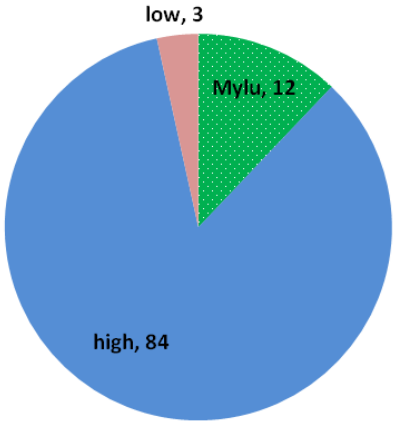
Daily Lake (DALA)
22 (50%) vetted



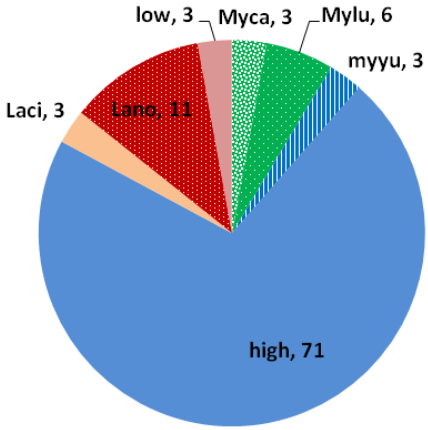
Durland Springs (DLSP)
22 (100%) vetted



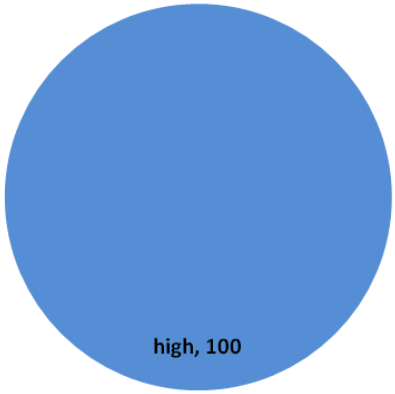
Kidney Pond (KIPO)
58 (11%) vetted



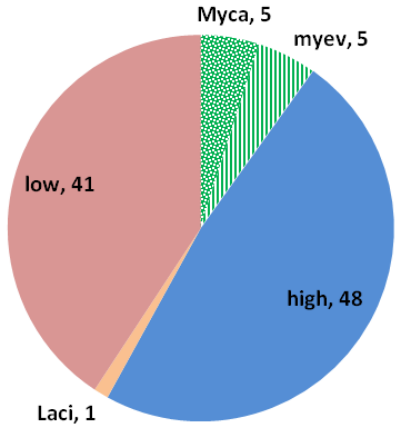
Lenhart Meadows (LENMEA)
35 (12%) vetted



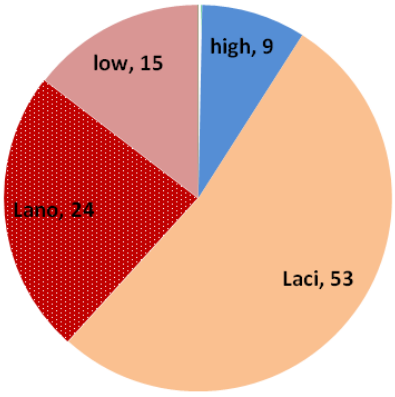
LPO River West (RIVW)
1 (100%) vetted



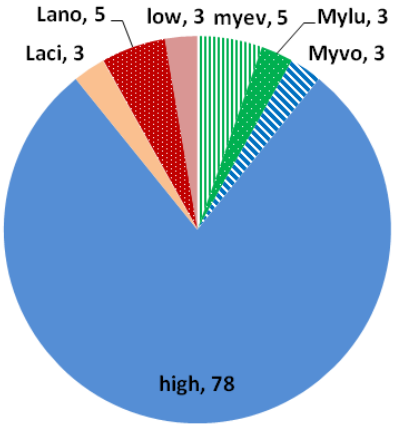
North Fork Bear Creek (NFBC)
73 (100%) vetted



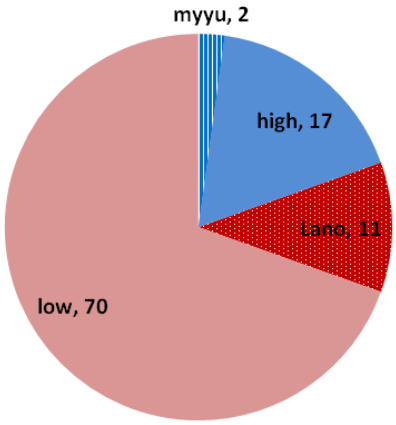
North Highway (NORHIG)
591 (100%) vetted



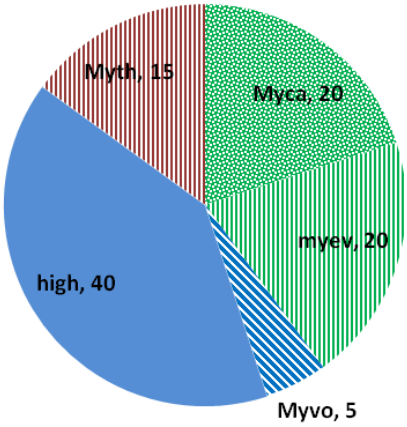
Park Rapids (PARRAP)
36 (12%) vetted



Pierce Lake (PILA)
41 (11%) vetted



Slide Creek (SLCR)
20 (14%) vetted



Snow Park (SNOPAR)
22 (12%) vetted

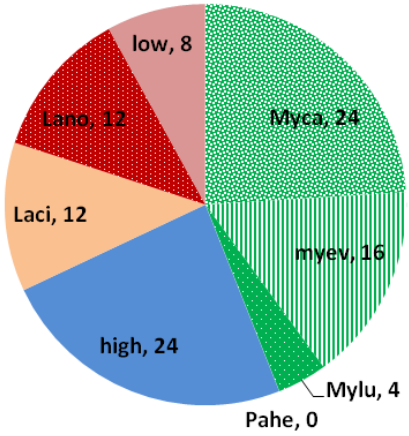
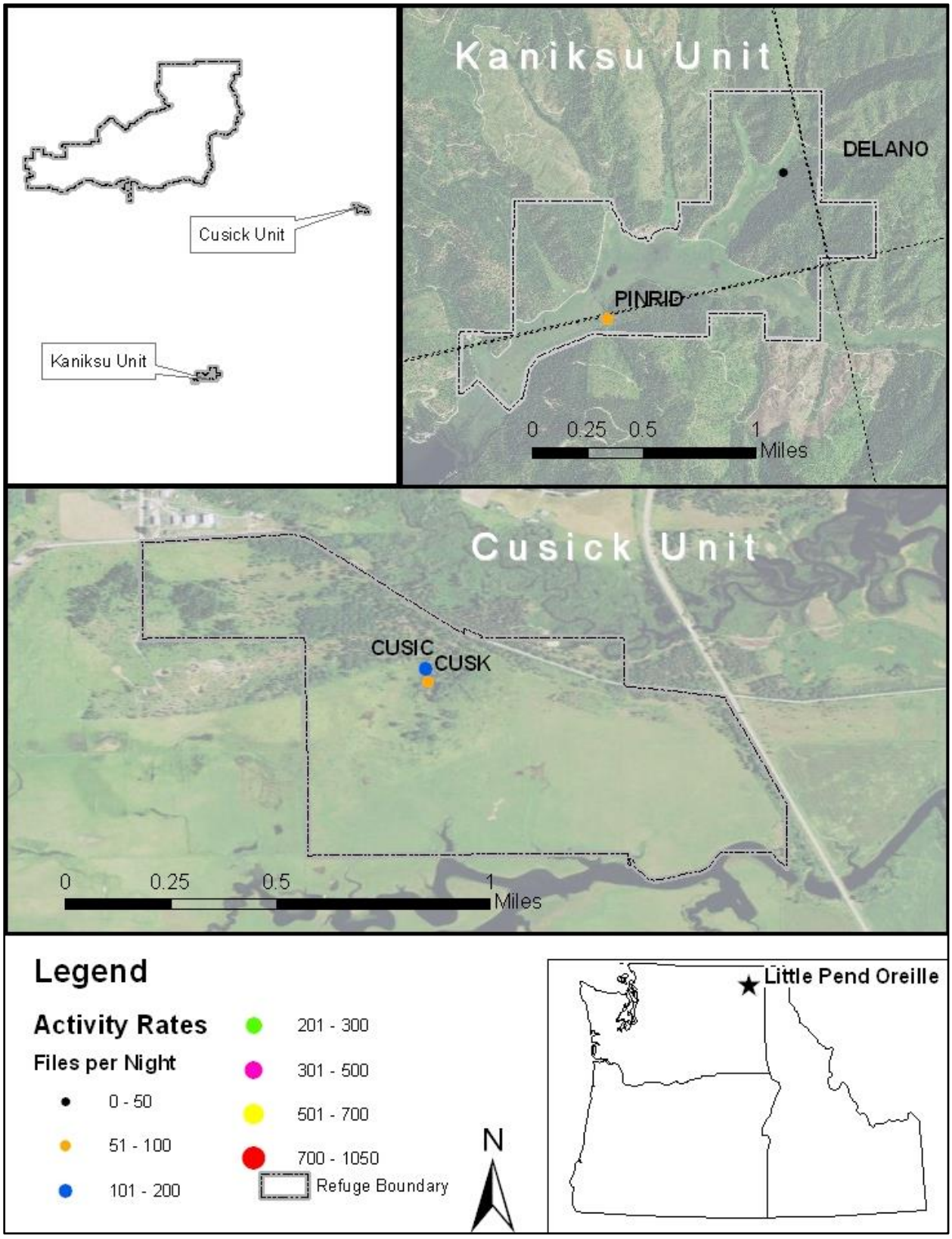


Figure 26. Little Pend Oreille NWR (Remote Units) - Sample Sites (Short Name) and Activity Rates from the Region 1 Acoustic Bat Inventory.



Four samples were collected from the remote units south of the main refuge. Cusick was sampled twice, once in 2012 and once in 2013. Two separate sites were sampled on the Kaniksu Unit. Activity rates were similar to slightly higher than the main unit. Activity rates were higher in Cusick in 2012 (152 files per night) compared to 2013 (98 call files per night), and twice as many species were detected in 2012 than in 2013 (8 and 4, respectively). A total of 10 species were detected on the remote units. Western small-footed myotis, Townsend's big-eared bat, and big brown bat were detected on the remote units, but not on the main refuge. California myotis comprised 20% of the sample on the site on Kaniksu unit, but 1% on Cusick. Fringed-myotis comprised 8% of the sample at Cusick in 2012.

Figure 27. Little Pend Oreille NWR – remote units - Species composition from 4 sites . Data were collected during the Region 1 Acoustic Bat Inventory. Vetted files were inspected in SonoBat software by an expert in bat call identification, to verify automatic species classification. The values for vetted represent total numbers of files vetted and percent of call files vetted, respectively.

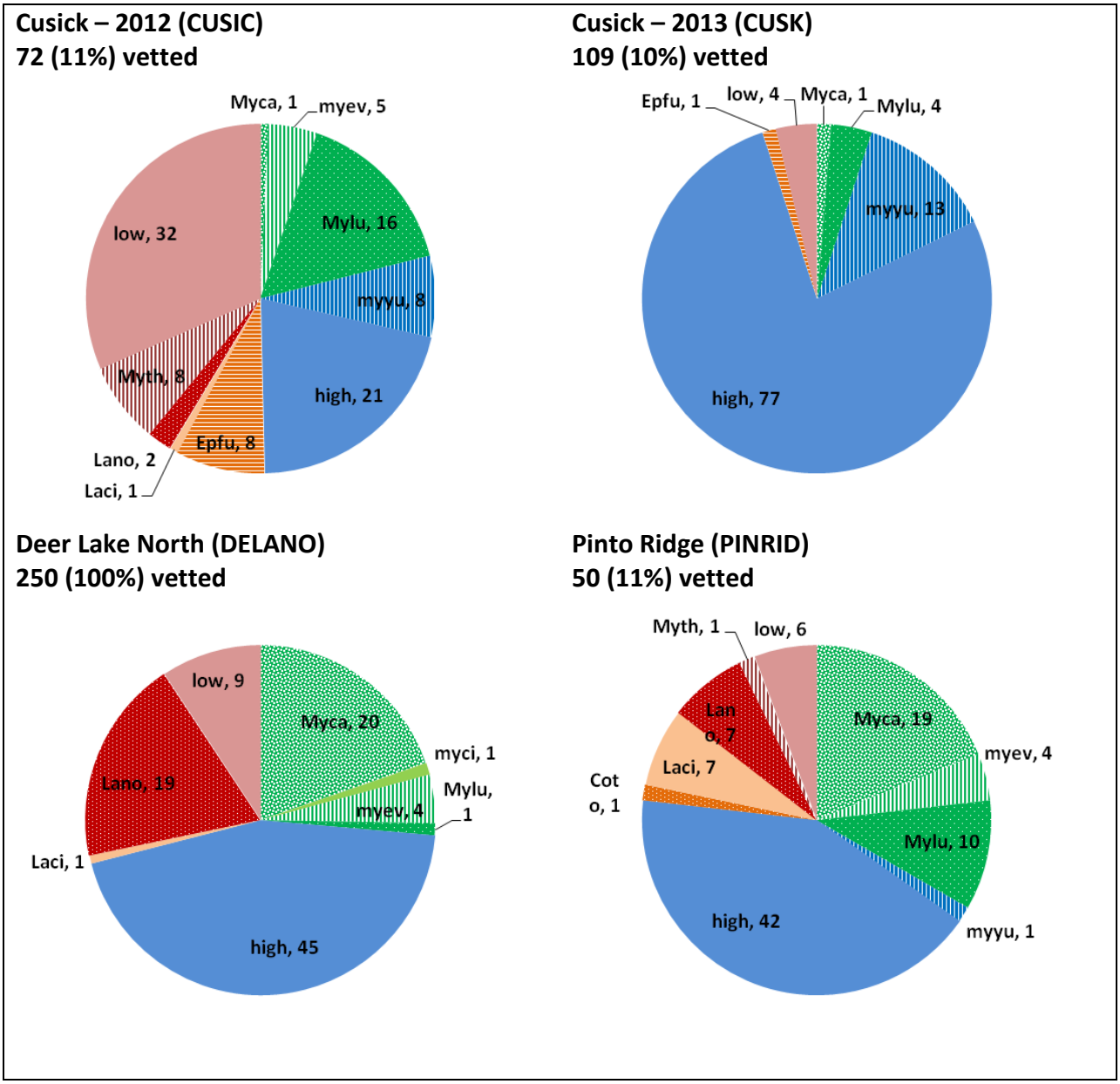
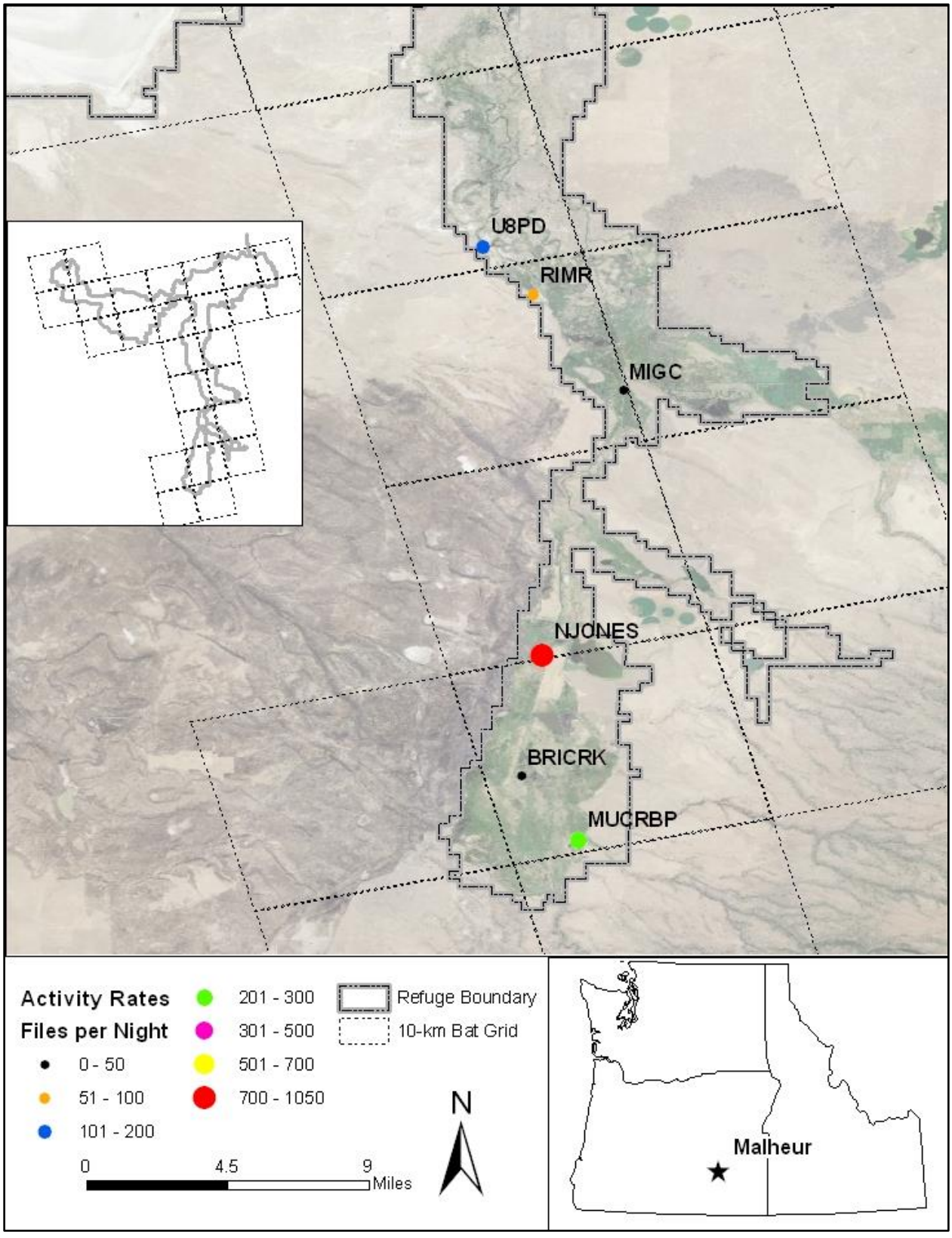
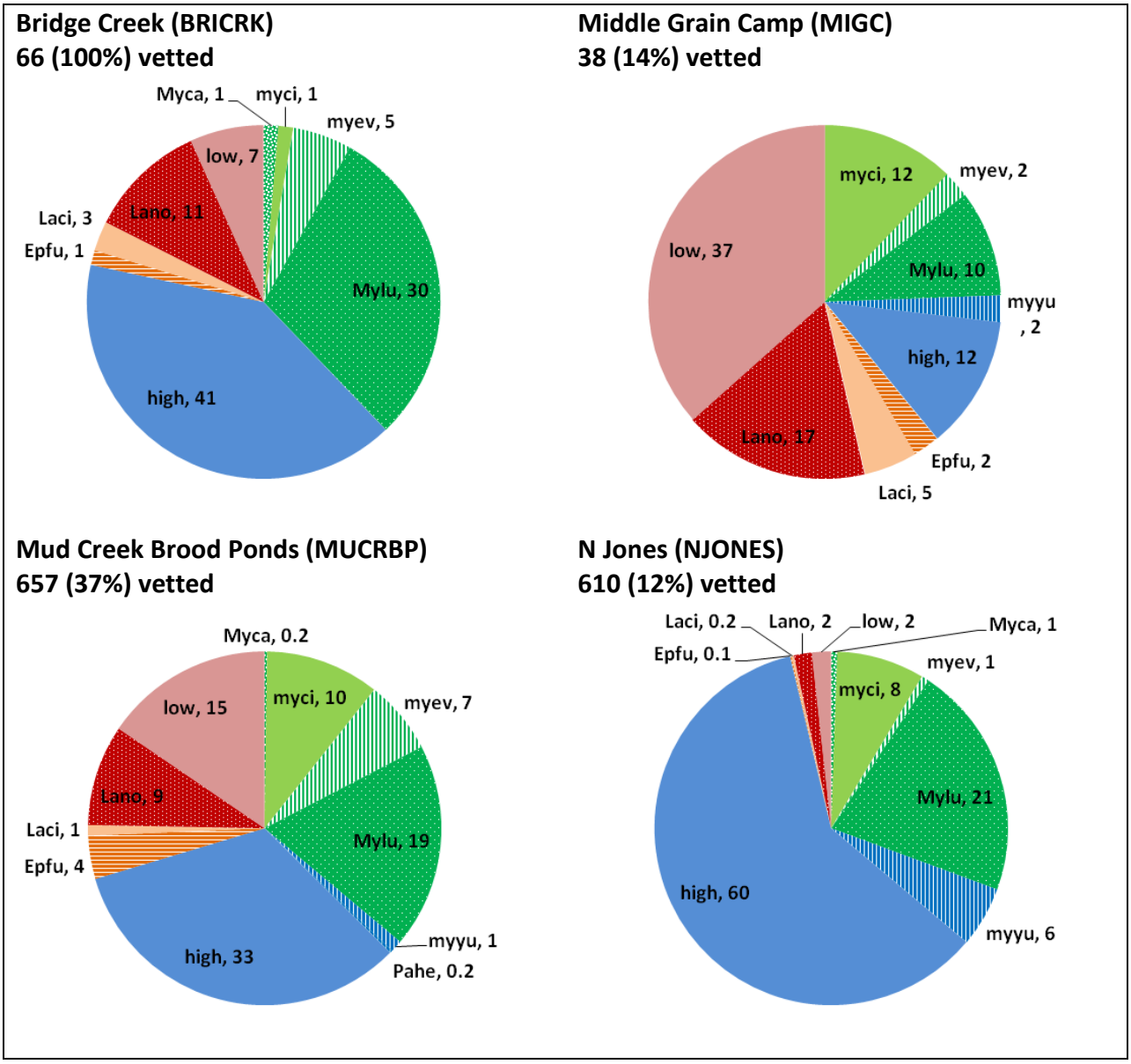


Figure 28. Malheur NWR - Sample Sites (Short Name) and Activity Rates from the Region 1 Acoustic Bat Inventory.

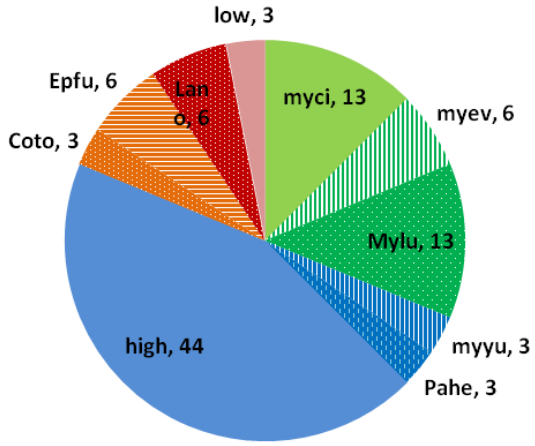


Six sites were sampled at Malheur, 3 in 2012 and 3 in 2013. Activity rates were highly variable, perhaps more variable than any other refuge. Rates ranged from 9 files per night (Bridge Creek) to 703 (North Jones). North Jones represented the third highest activity rate in the study. Canyon bat was detected at 3 sites, but comprised less than 4% of the sample. Townsend's big-eared bat was detected at 2 sites, also contributing less than 4% of the sample. Overall, little brown myotis, western small-footed myotis, and silver-haired bat were the most common species.

Figure 29. Malheur NWR - Species composition from 6 sites. Data were collected during the Region 1 Acoustic Bat Inventory. Vetted files were inspected in SonoBat software by an expert in bat call identification to verify automatic species classification. The values for vetted represent total numbers of files vetted and percent of call files vetted, respectively.



Rimrock (RIMR)
32 (12%) vetted



Unit 8 Pond (U8PD)
77 (13%) vetted

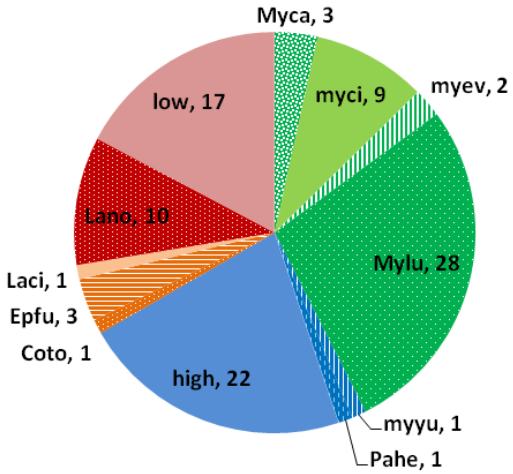
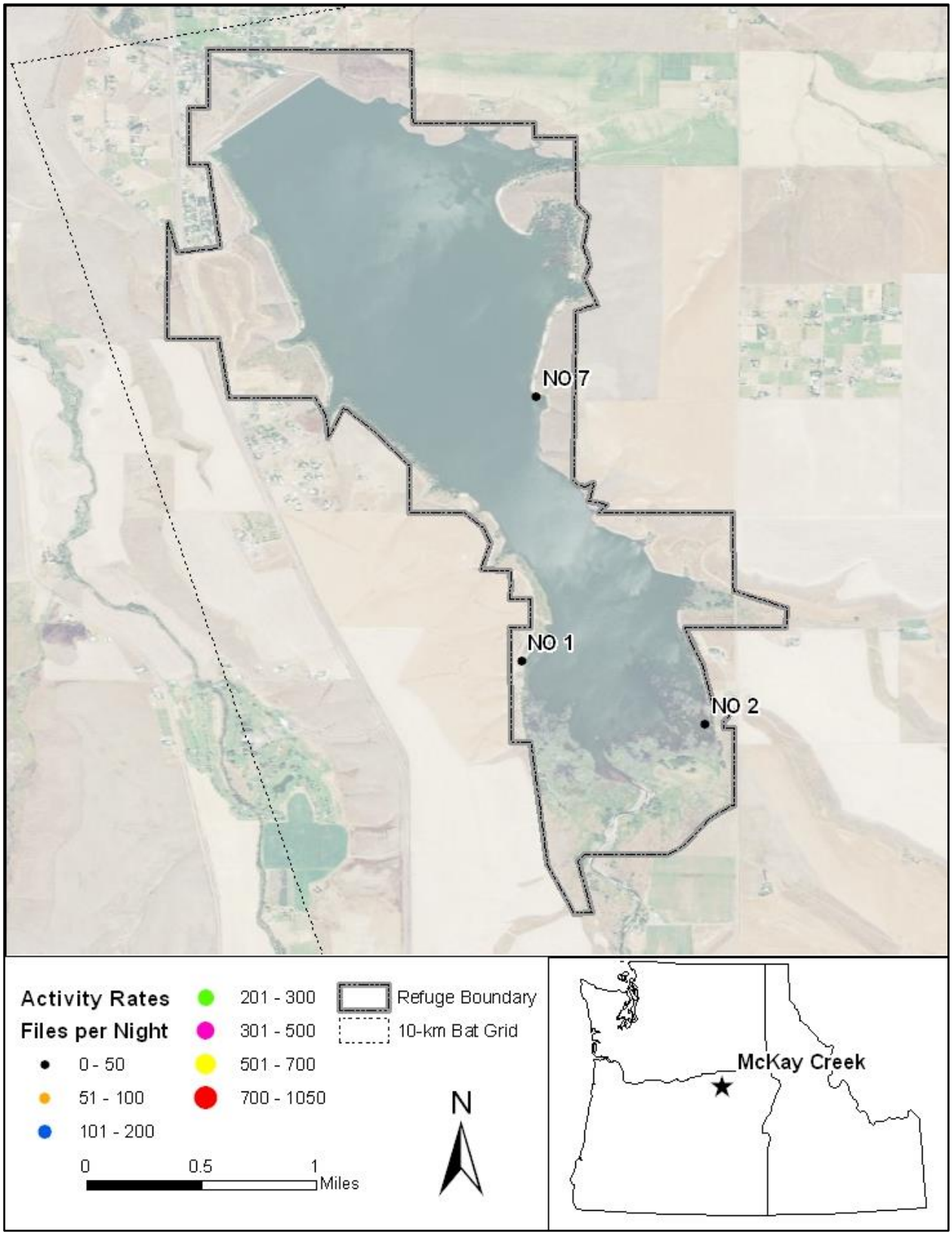


Figure 30. McKay Creek NWR - Sample Sites (Short Name) and Activity Rates from the Region 1 Acoustic Bat Inventory.



Activity rates at McKay Creek were low, but consistent (14 to 17 files per night). Species richness was relatively low, with 7 species detected. Low-frequency bat comprised almost half the total sample, with silver-haired bat contributing 29% and hoary bat 16% overall. Little brown myotis and Yuma myotis were the most common high-frequency bats.

Figure 31. McKay Creek NWR - Species composition from 3 sites. Data were collected during the Region 1 Acoustic Bat Inventory. Vetted files were inspected in SonoBat software by an expert in bat call identification to verify automatic species classification. The values for vetted represent total numbers of files vetted and percent of call files vetted, respectively.

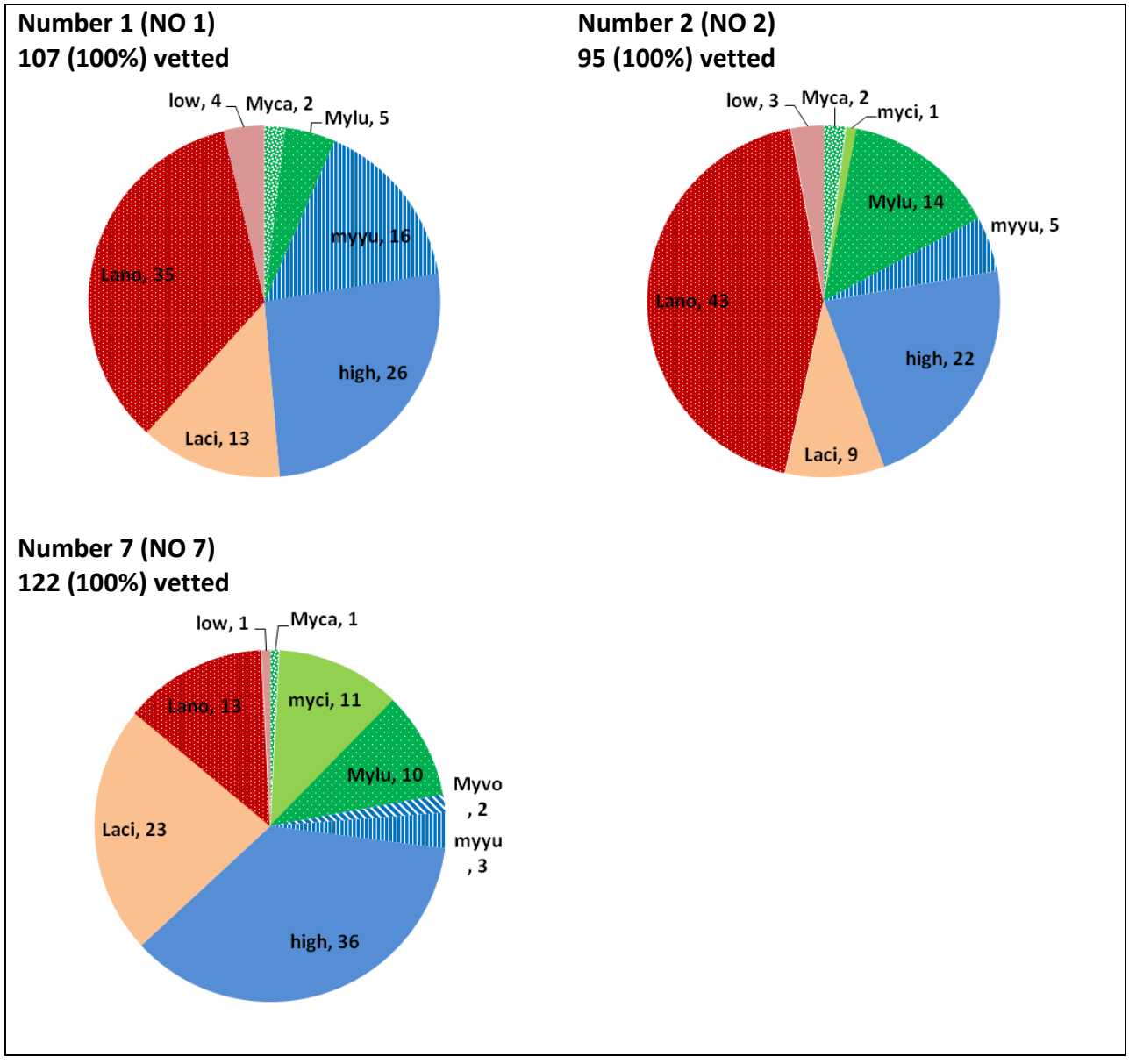
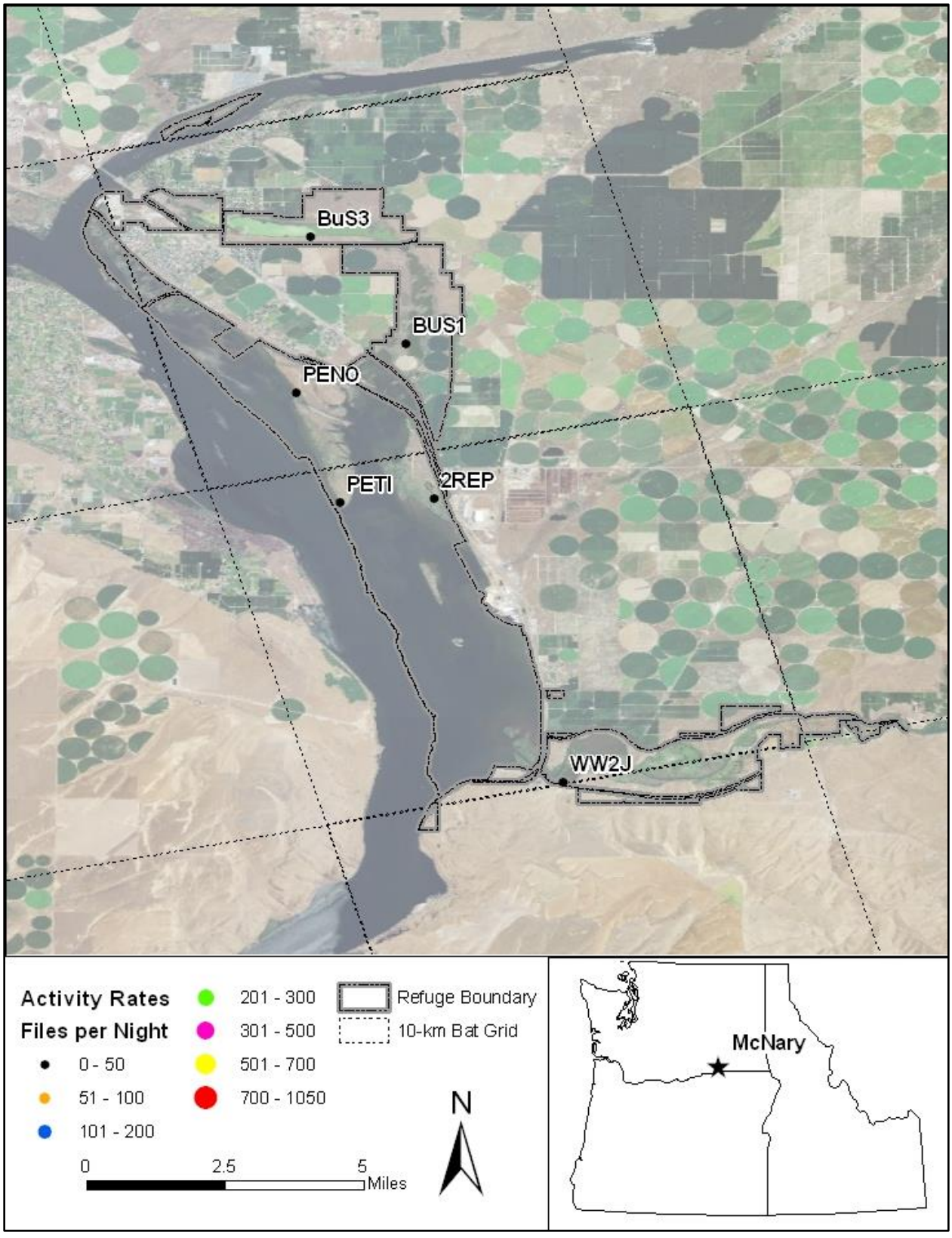
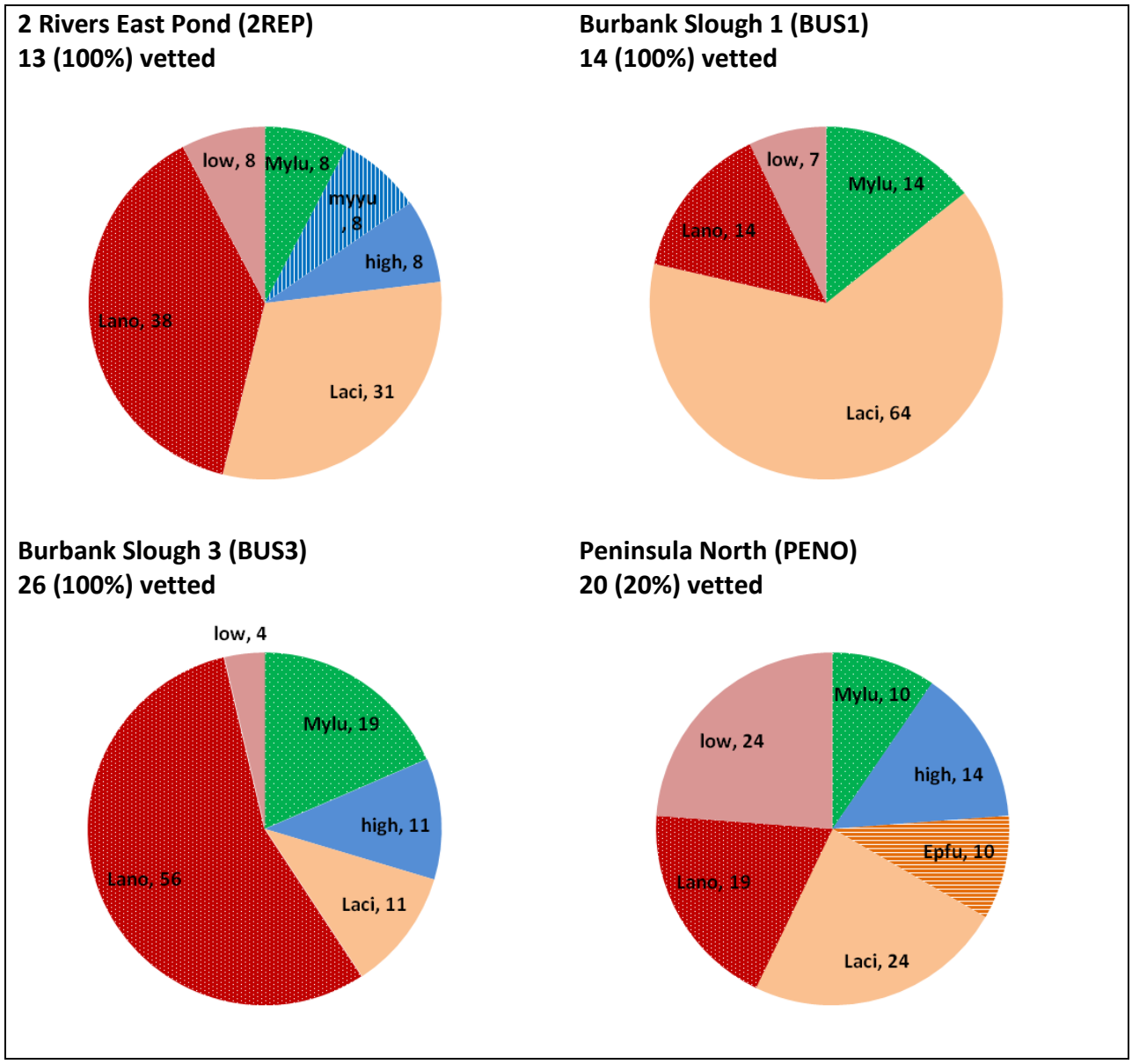


Figure 32. McNary NWR - Sample Sites (Short Name) and Activity Rates from the Region 1 Acoustic Bat Inventory.

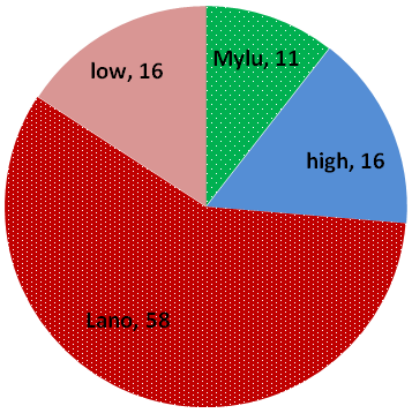


Overall, activity rates at McNary refuge were very low, never more than 15 files per night (Peninsula North). Species richness was relatively low, too, with 6 species detected. Low-frequency bats were most common at McNary. Across all sites, silver-haired bat comprised 33% of the sample and hoary bat 18%. Little brown myotis was the most common high-frequency bat. Western small-footed myotis comprised 45% of the sample at Walla Walla 2 Junction, the only site where it was detected. Year-round sampling at McNary Refuge in 2013 revealed high levels of bat activity in Spring and Fall with low levels in summer (USFWS unpublished data). Perhaps bats used these refuges during migration rather than breeding season.

Figure33. McNary NWR - Species composition from 6 sites. Data were collected during the Region 1 Acoustic Bat Inventory. Vetted files were inspected in SonoBat software by an expert in bat call identification to verify automatic species classification. The values for vetted represent total numbers of files vetted and percent of call files vetted, respectively.



Peninsula Tip (PETI)
19 (100%) vetted



WW2 Junction (WW2J)
20 (61%) vetted

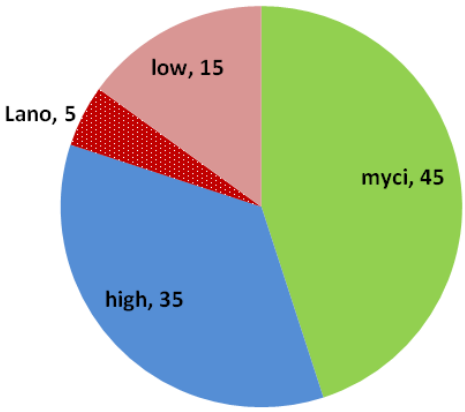
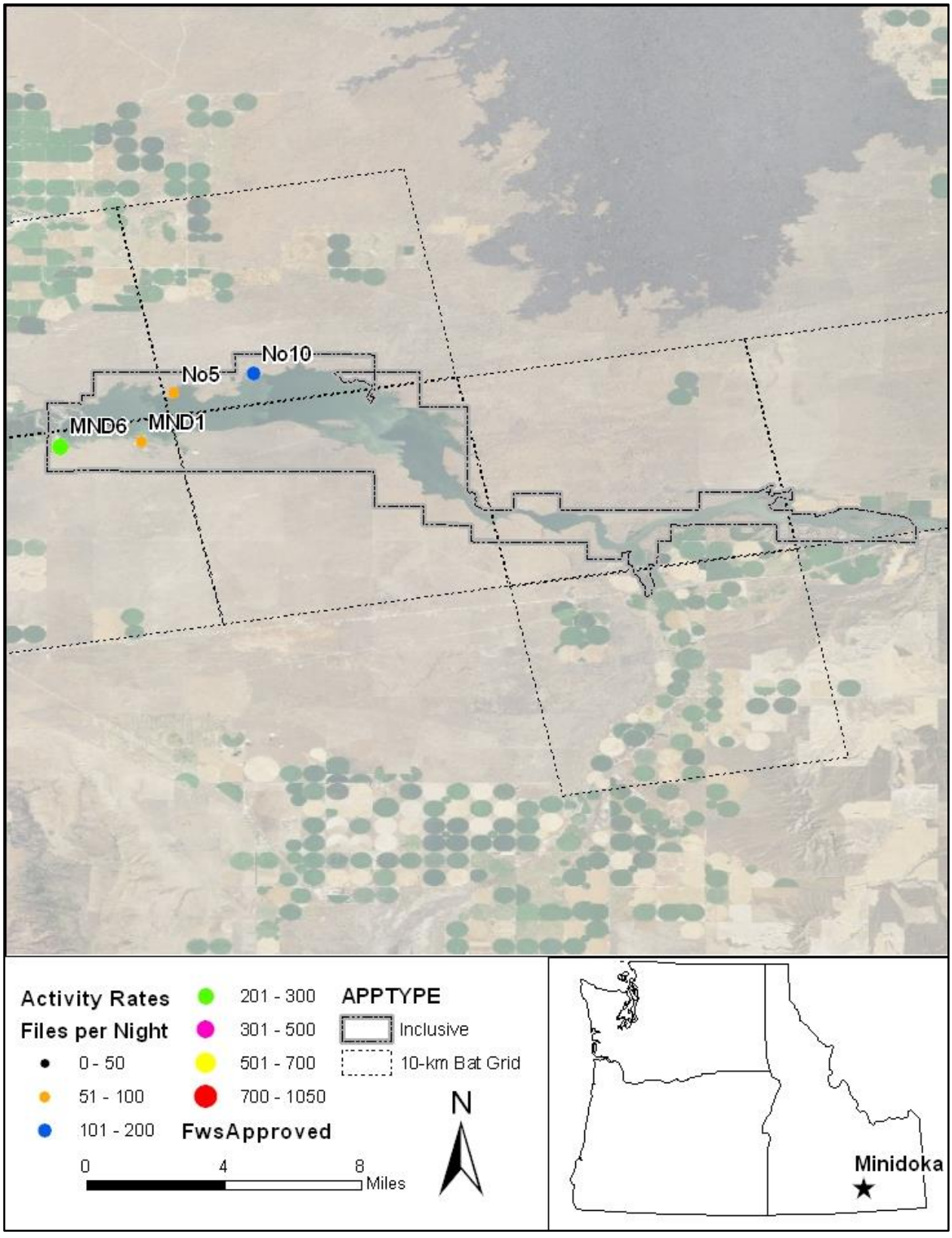


Figure 34. Minidoka NWR - Sample Sites (Short Name) and Activity Rates from the Region 1 Acoustic Bat Inventory.



Four sites were sampled at Minidoka, and activity rates were relatively high. Site Number 6 had 222 files per night and site Number 10 had 126. Ten species were detected. Overall, big brown bat and silver-haired bat comprised most of the sample. Six species contributed 2% or less of the overall sample, including California myotis, western small-footed myotis, Yuma myotis, Townsend's big-eared bat and fringed myotis.

Figure 35. Minidoka NWR- Species composition from 4 sites. Data were collected during the Region 1 Acoustic Bat Inventory. Vetted files were inspected in SonoBat software by an expert in bat call identification to verify automatic species classification. The values for vetted represent total numbers of files vetted and percent of call files vetted, respectively.

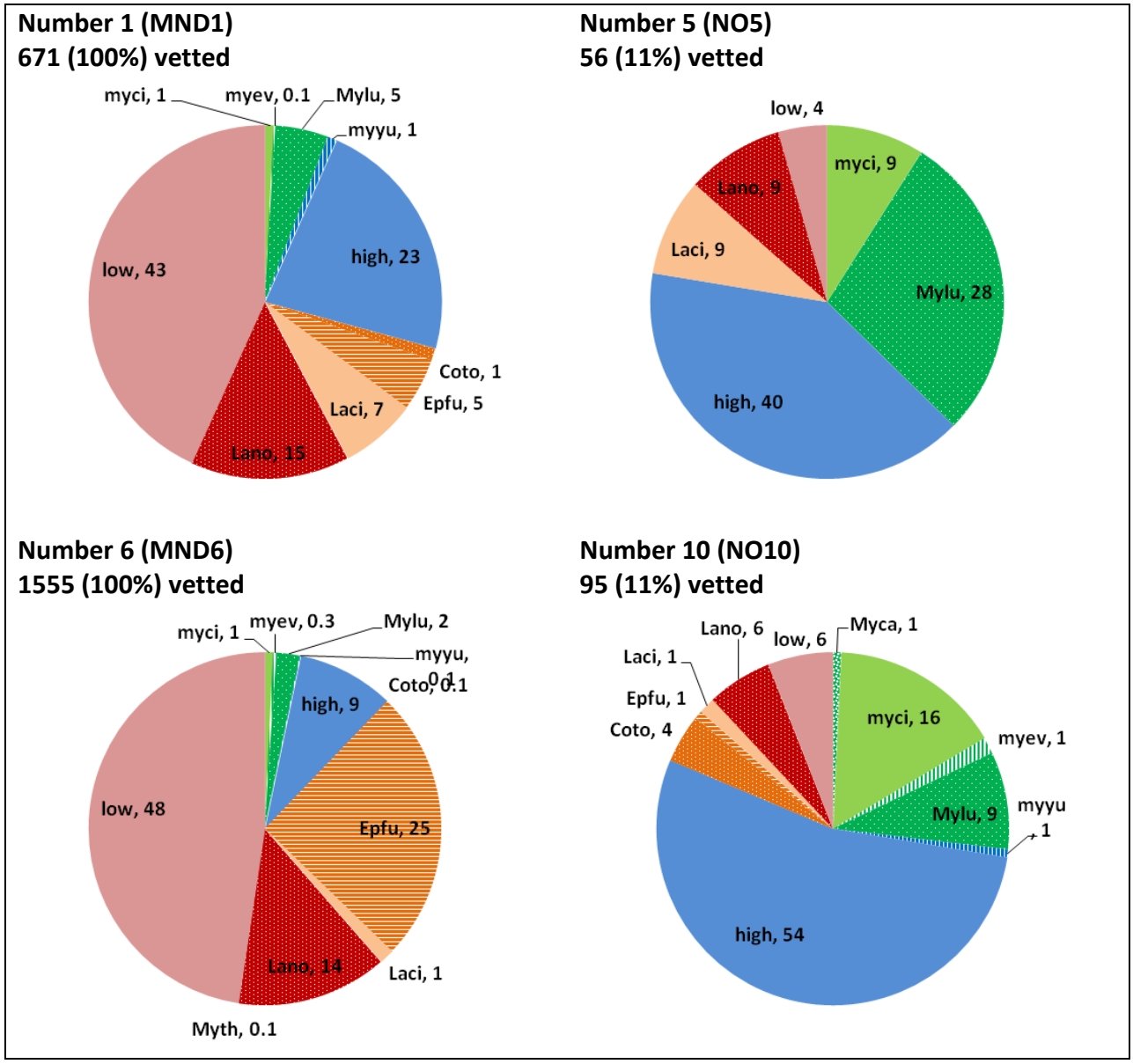
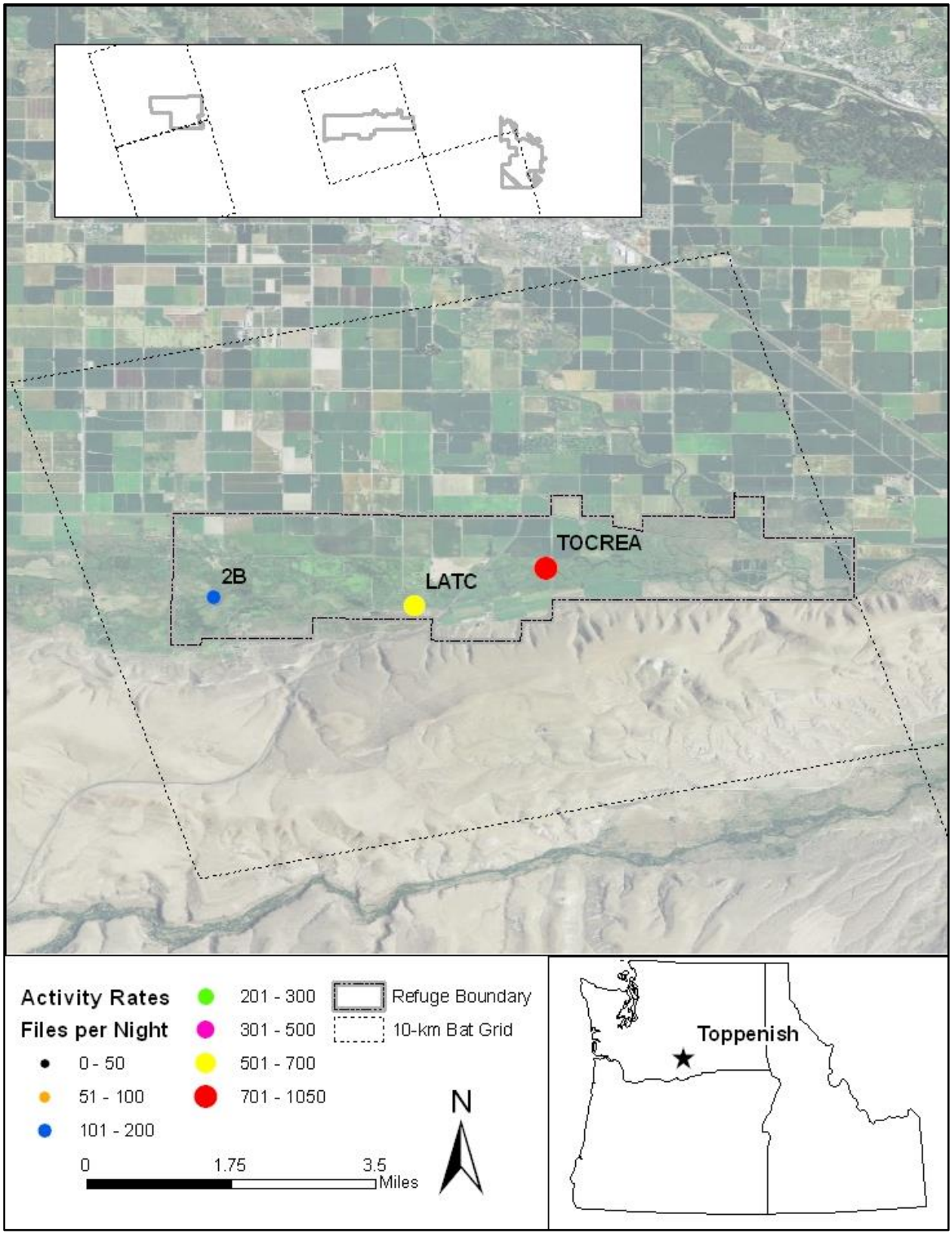


Figure 36. Toppenish NWR - Sample Sites (Short Name) and Activity Rates from the Region 1 Acoustic Bat Inventory.



Three sites were sampled at Toppenish, which proved to have high activity and high species richness. The highest activity rate in the study (1048 files/night) was recorded at Toppenish Creek East. Lateral C recorded 645 files per night. A total of 12 species was detected, the second highest richness in the study. Hanford Reach had 13 species, but these species were detected over the course of 193 survey nights at 28 sites. The 12 species at Toppenish were detected from 3 sites over a total of 21 survey nights. Yuma myotis and western small-footed myotis were the most common species. Overall, 91% of the sample was high-frequency bats. Only pallid bat was not detected on Toppenish.

Figure 37. Toppenish NWR - Species composition from 3 sites. Data were collected during the Region 1 Acoustic Bat Inventory. Vetted files were inspected in SonoBat software by an expert in bat call identification to verify automatic species classification. The values for vetted represent total numbers of files vetted and percent of call files vetted, respectively.

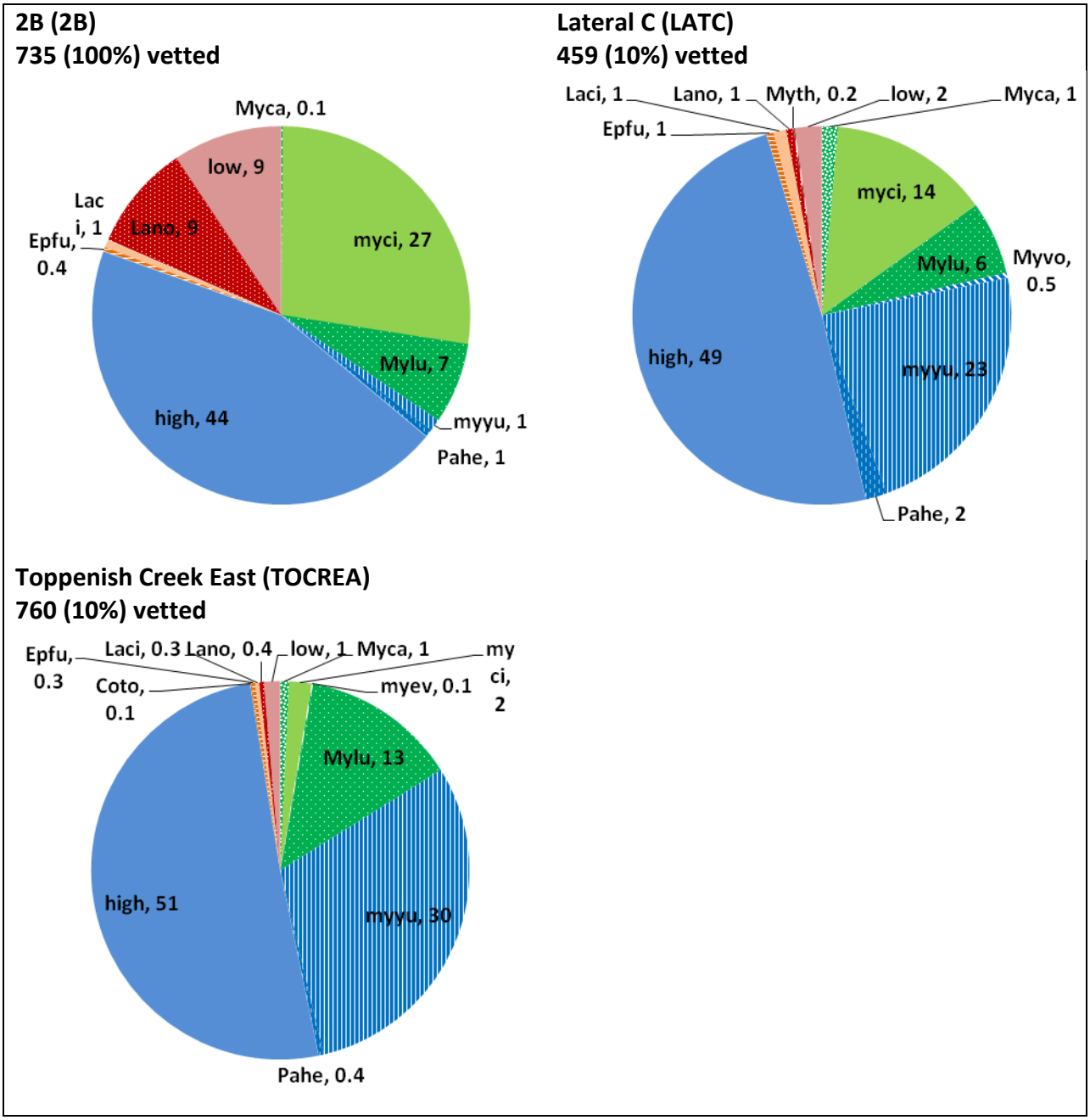
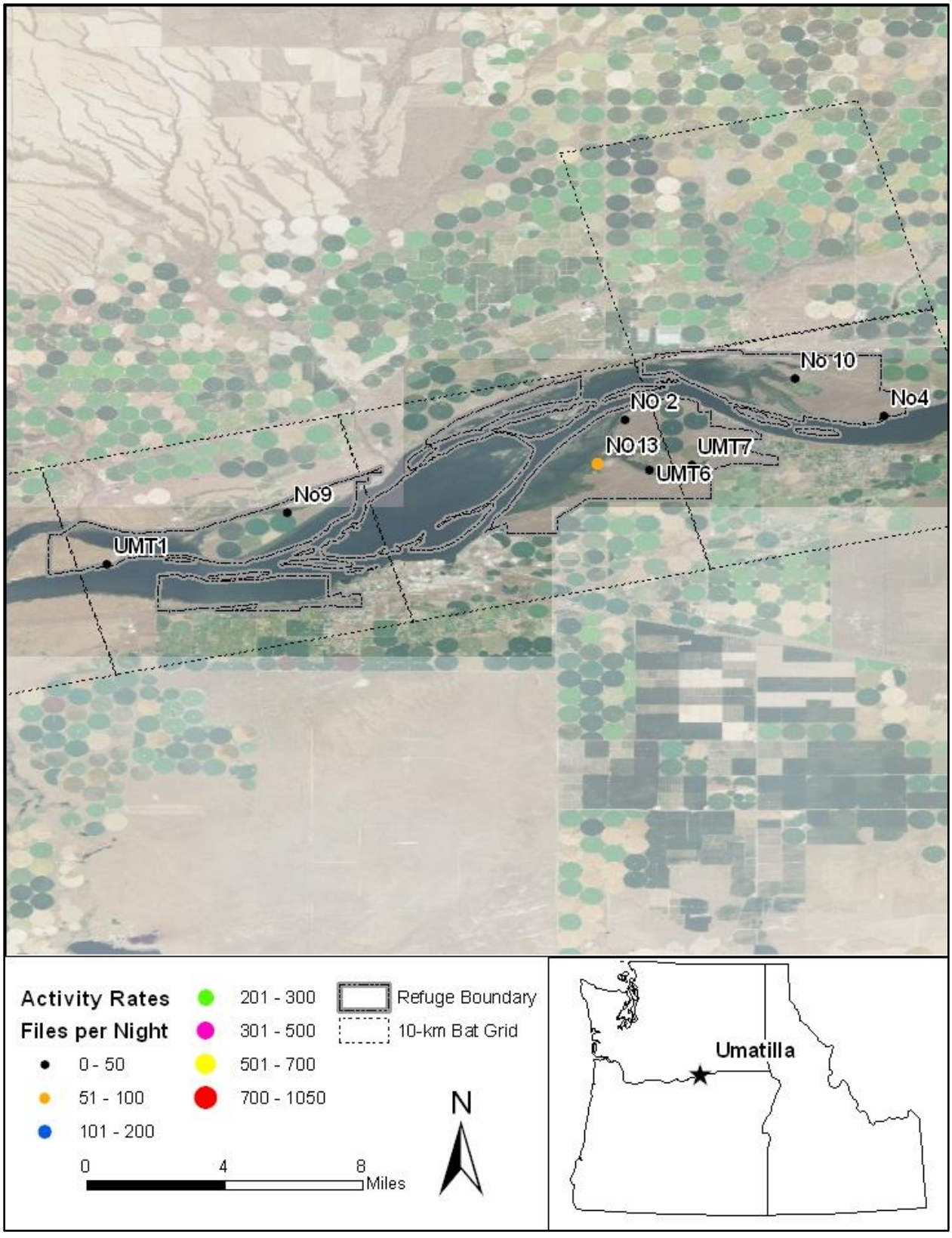
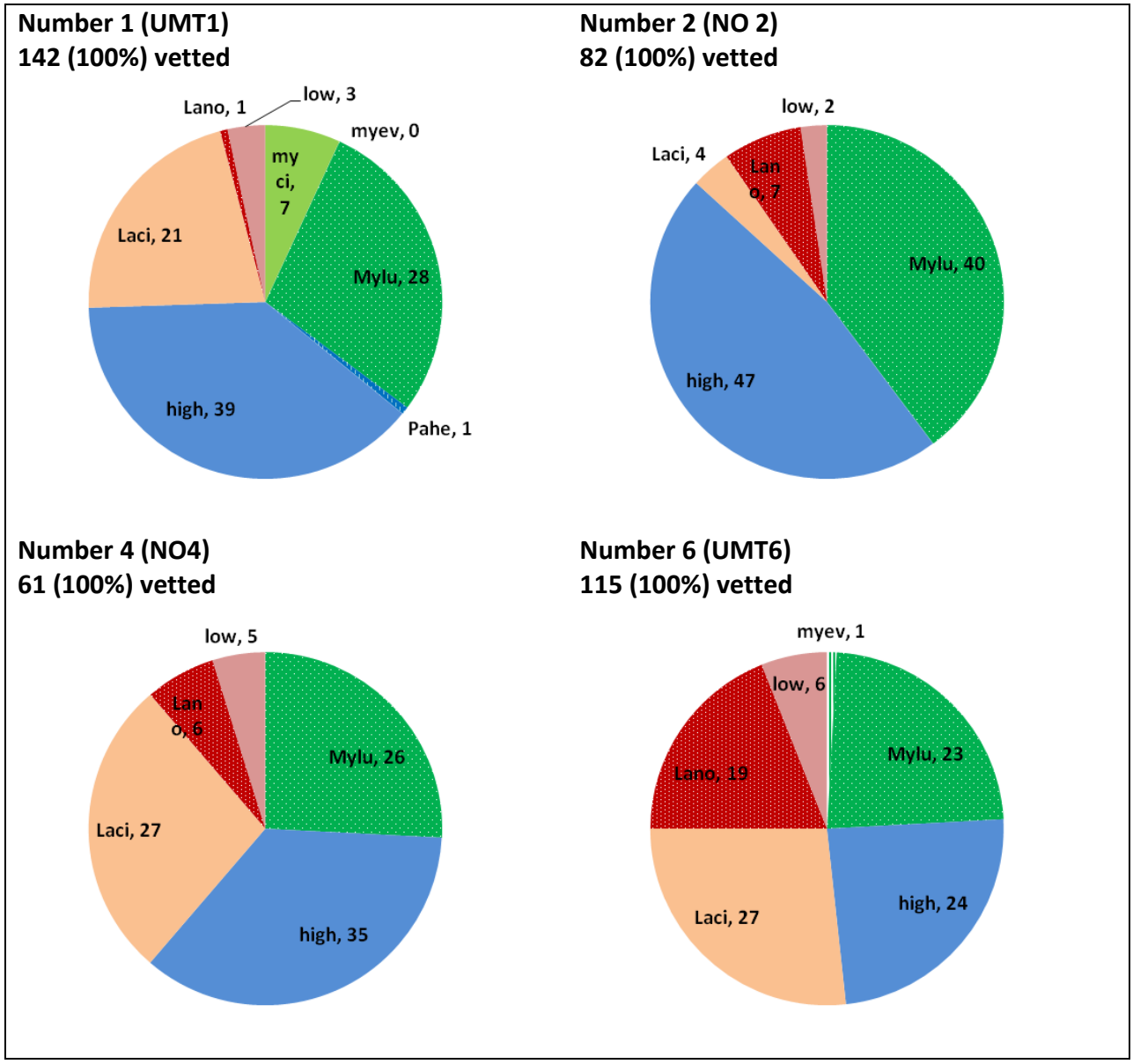


Figure 38. Umatilla NWR - Sample Sites (Short Name) and Activity Rates from the Region 1 Acoustic Bat Inventory.

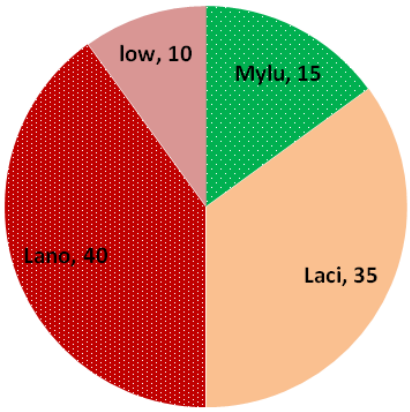


Nine sites were sampled at Umatilla, but at one site (Number 12), the detector filled with noise files in 2 nights. Results are reported from 8 sites. Activity rates were relatively low, ranging from 6 (Site Number 9) to 53 (Site Number 13) files/night. A total of 7 species were detected. Little brown myotis was the most common bat, followed by hoary bat and silver-haired bat. California myotis, canyon bat, long-eared myotis and western small-footed myotis were recorded in small numbers.

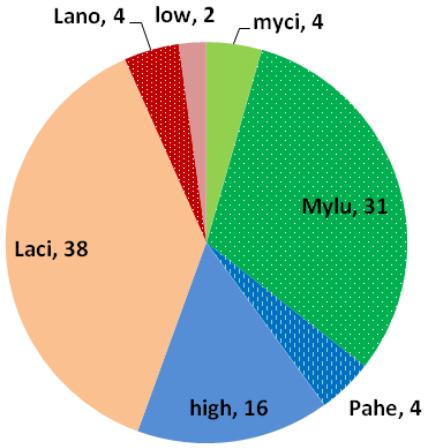
Figure 39. Umatilla NWR - Species composition from 8 sites. Data were collected during the Region 1 Acoustic Bat Inventory. Vetted files were inspected in SonoBat software by an expert in bat call identification to verify automatic species classification. The values for vetted represent total numbers of files vetted and percent of call files vetted, respectively.



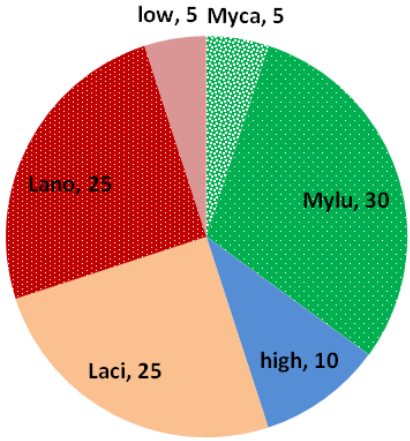
Number 7 (UMT7)
19 (13%) vetted



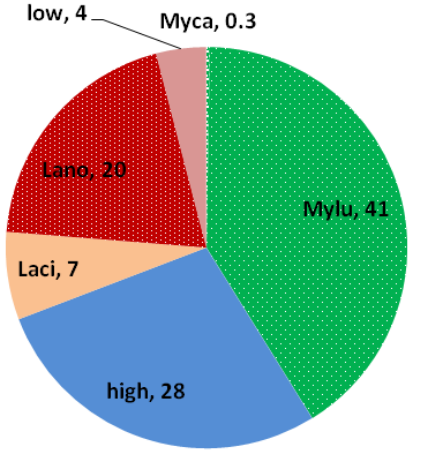
Number 9 (NO9)
45 (100%) vetted



Number 10 (No10)
20 (14%) vetted



Number 13 (NO13)
374 (100%) vetted



DISCUSSION and FUTURE MONITORING

This project is the first inventory of bat species on many National Wildlife Refuges in the eastside zone of Region 1. Acoustic inventory was chosen due to efficiency and cost effectiveness, however, it was recognized that acoustic-only inventory had some limitations. Several studies noted that a combination of mist-netting and acoustic detection maximized species detection (Bucci et al. 2010; Manley et al. 2006; Flaquer et al. 2007), with rare species most likely to be missed when single methods are used. Manley et al. (2006) found that high-flying bat species (such as spotted bat) were more likely to be missed by mist-netting while quiet bats (such as Townsend's big-eared bat) were more likely to be missed by acoustic methods.

Compared to mist-netting, acoustic surveys were relatively inexpensive, simple to conduct and require no special training or vaccinations. Experienced bat biologist must vet the calls files, but no special skill was required to place equipment at sampling sites. Acoustic survey could be conducted in areas where mist-netting was not feasible, and allowed for sampling more locations and sampling more frequently (Rodhouse et al. 2011).

Baseline bat inventory was consistent with goals and objectives of the USFWS I&M Initiative including providing baseline data needed to inform planning and assessments, conduct baseline biotic surveys, and develop species lists for refuges (USFWS 2013). This project aimed to provide baseline data on bat populations in addition to inventory. Acoustic monitoring was being used for a variety of purposes, including assessment of activity patterns (Brooks 2009), documenting winter bat activity (Schwab and Mabee 2014; Lausen and Barclay 2006), and occupancy modeling (Gorresen et al. 2008).

This inventory may be used as a baseline for future monitoring. In the Eastern US, populations of some bat species have undergone steep declines due to White-nose Syndrome. Using acoustic methods, Ford et al. (2011) documented significant declines in summer activity of little brown myotis, northern bats (*Myotis septentrionalis*) and Indiana bats (*M. sodalis*) at Fort Drum, New York. At the same time, silver-haired bat activity increased. At the New Boston Air Force Station, New Hampshire, researchers documented shifts in the species composition of bat community through acoustic samples, with decreases in Myotis species, which were susceptible to White-nose Syndrome (North East Ecological Services 2011). Biologists in Great Britain were using acoustic surveys conducted by citizen scientists to track long-term trend of bat populations (Rainey et al. 2009). White-nose Syndrome has not come to the Pacific Northwest, but this inventory provided a solid baseline against which to assess future population change.

Gorresen et al. (2008) assessed the feasibility of using acoustic survey to measure bat occurrence and activity. They used data collected over several nights to estimate detection probabilities and occupancy. Our design of 7 nights consecutive sampling at three locations within a 10-Km bat grid cell could be used in a similar way.

The study occurred over a wide geographical range and was designed to apply at multiple scales. Most of the results were presented by refuge, but basing sampling design on the Bat Grid should facilitate roll-up of data for larger-scale analysis.

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Appendix A. Sample Site Locations from the Region 1 Acoustic Bat Inventory, 2012 and 2013.

Site Name	Site Short Name	10-km Bat Grid Cell	Latitude	Longitude	Date Start	Date End	Functional Sample Nights[a]	Comments
BEAR LAKE NWR								
Site 1-15	1-15	90396	42.20753	-111.34433	7/22/2013	7/25/2013	0	No data. Equipment malfunction
2-2	2—2	89934	42.12776	-111.26357	8/5/2013	8/13/2013	7	
2-6	2—6	89934	42.11924	-111.27718	8/13/2013	8/22/2013	7	
Number 1	NUM1	90396	42.15847	-111.34925	6/10/2013	6/17/2013	7	
Number 6	NUM6	90396	42.17640	-111.34715	6/17/2013	6/24/2013	7	
Site 2-1	S2-1	89934	42.12182	-111.30376	7/25/2013	8/5/2013	7	
CAMAS NWR								
2	2	99562	43.91078	-112.24992	6/28/2012	7/5/2012	6	
3	3	100115	43.97143	-112.25462	7/5/2012	7/12/2012	7	
4	4	100116	43.93034	-112.22856	7/12/2012	7/20/2012	7	
8	8	99652	43.90533	-112.27887	6/21/2012	6/28/2012	7	
Camas Creek 8	CAC8	100116	43.90384	-112.28168	6/10/2013	6/17/2013	7	
Camas Outlet 9	CAO9	99652	43.90382	-112.28170	6/3/2013	6/10/2013	7	
Center 5	CEN5	100115	43.94581	-112.26139	6/24/2013	7/1/2013	7	
Independence Ditch 18	ID18	100115	43.92469	-112.29279	7/1/2013	7/8/2013	7	
Sandhole 9	SAN9	100116	43.93124	-112.23196	6/17/2013	6/24/2013	7	
COLD SPRINGS NWR								
5	5	114883	45.87043	-119.11673	7/16/2012	7/23/2012	7	
No 1	CSP1	114883	45.86055	-119.14249	7/9/2012	7/16/2012	7	
6	CSP6	114883	45.84881	-119.13157	7/23/2012	7/30/2012	7	
COLUMBIA NWR								
Crab Creek Ranch Pond	CCRP	119977	46.86880	-119.31062	7/9/2013	7/15/2013	6	
Cliff Pond	CLPD	119978	46.90008	-119.25584	7/22/2013	7/29/2013	7	

Site Name	Site Short Name	10-km Bat Grid Cell	Latitude	Longitude	Date Start	Date End	Functional Sample Nights[a]	Comments
Crab Creek	CRCK	119977	46.89532	-119.30621	6/25/2013	7/1/2013	6	
Coyote Creek Crossing	CYCC	119978	46.88169	-119.25183	7/15/2013	7/22/2013	7	
Heron Lake Road	HELR	120441	46.97766	-119.27950	6/3/2013	6/10/2013	7	
Potholes Canal East	PHCE	119978	46.91355	-119.16711	7/29/2013	8/5/2013	7	
Potholes Canal	POCA	120441	46.97686	-119.25401	6/17/2013	6/25/2013	7	
Shiner Lake	SHLK	119977	46.87919	-119.28638	7/1/2013	7/9/2013	7	
W of Soap Lake	WSOL	120441	46.96436	-119.24674	6/10/2013	6/17/2013	7	
CONBOY LAKE NWR								
C&H	C&H	117182	45.98204	-121.32198	7/20/2012	7/27/2012	7	
Chapman North	CHNO	117181	45.94322	-121.33263	6/7/2013	6/14/2013	3	Wildlife tampering
Conboy East	CONEAS	117182	45.97434	-121.27124	7/13/2012	7/20/2012	7	
Dean Meadow	DEAMEA	117182	45.97198	-121.29673	7/27/2012	8/3/2012	7	
HQ North	HQNO	117181	45.97248	-121.33926	8/30/2012	9/6/2012	7	
Laurel W	LAUW	117181	45.93114	-121.38013	5/31/2013	6/7/2013	7	
Willard	WILL	117181	45.97877	-121.33839	7/31/2013	8/10/2013	7	
DEER FLAT NWR								
Carter's Corner	CARCOR	101006	43.51900	-116.61550	6/21/2012	6/29/2012	7	
Dam Marsh	DAMMAR	101006	43.56387	-116.65337	8/29/2012	9/5/2012	7	
EE Building	EEBLDG	101469	43.59150	-116.71927	7/23/2012	7/30/2012	7	
North of Field 5	NOFLD5	101469	43.58472	-116.68510	7/13/2012	7/23/2012	7	
GRAYS LAKE NWR								
Bear Is ROW (NW)	BEIROW	95028	43.06200	-111.40205	7/17/2012	7/24/2012	3	Wildlife tampering
Bear Is ROW - site 2	BIROW2	95028	43.05900	-111.40203	8/2/2012	8/10/2012	7	
Eagle Creek Diversion Flume	ECDF	95028	43.06083	-111.38000	8/22/2012	8/31/2012	7	
Hawkins Creek	HAWCRE	95028	43.08630	-111.37492	8/10/2012	8/22/2012	7	

Site Name	Site Short Name	10-km Bat Grid Cell	Latitude	Longitude	Date Start	Date End	Functional Sample Nights[a]	Comments
HANFORD REACH NATIONAL MONUMENT/SADDLE MOUNTIAN NWR								
Burrowing Owl Springs	BOSP	118122	46.44979	-119.64025	8/12/2013	8/19/2013	7	
B-Reactor Tree Gap - try 2	BRD2	119048	46.64697	-119.64394	8/22/2013	8/29/2013	7	
East Boundary, S of HWY 24	EB24	119513	46.73347	-119.35977	6/14/2013	6/21/2013	7	
Hanford River Bullfrog Puddle	HRBP	119048	46.66312	-119.59629	7/22/2013	7/29/2013	7	
Lower Ridge Spring 1	LRS1	118122	46.40688	-119.59539	8/5/2013	8/12/2013	7	
Powerline Pond	POPO	119512	46.68465	-119.57654	7/9/2013	7/15/2013	6	
Powerline Spring	POSP	117659	46.39202	-119.57268	8/15/2013	8/22/2013	7	
Ringold North	RINO	118587	46.57480	-119.34573	7/19/2013	7/26/2013	7	
Ringold Powerline River Crossing	RPRC	118587	46.59438	-119.37733	8/1/2013	8/8/2013	7	
Ridge Spring #2	RSP2	118122	46.40641	-119.60675	8/19/2013	8/26/2013	7	
Rattlesnake Spring - East	RSSE	118584	46.50523	-119.68398	8/15/2013	8/22/2013	7	
Rattlesnake Springs - Middle	RSSM	118584	46.50764	-119.69968	8/22/2013	8/29/2013	7	
Rattlesnake Spring West	RSSW	118584	46.50391	-119.70963	8/8/2013	8/15/2013	7	
South Inflow Boundary	SIBO	118587	46.62949	-119.33247	7/26/2013	8/1/2013	6	
South Inflow Creek	SICK	119050	46.64624	-119.33782	7/5/2013	7/12/2013	7	
Saddle Mountain Lake Culvert	SMCU	119511	46.70286	-119.62056	7/15/2013	7/22/2013	7	
Saddle Mtn Canal - west	SMCW	119512	46.76545	-119.52724	6/21/2013	7/1/2013	7	
Saddle Mountain East	SMEA	119513	46.76555	-119.44469	6/7/2013	6/14/2013	7	
Saddle Mountain Lakes - Center	SMLC	119511	46.68956	-119.64112	7/12/2013	7/19/2013	7	
Saddle Mountain Lakes West	SMLW	119511	46.68567	-119.67134	7/26/2013	8/1/2013	6	
Saddle Mtn Road North	SMRN	119513	46.76603	-119.47952	5/31/2013	6/7/2013	7	
Snively Spring	SNSP	118121	46.45234	-119.71468	8/19/2013	8/26/2013	7	
Thicket Spring	THSP	117659	46.39855	-119.59770	8/1/2013	8/8/2013	7	
Unnamed Seep 100	USEC	117569	46.39428	-119.60090	8/8/2013	8/15/2013	7	
Upper Snively Spring	USNI	118121	46.42467	-119.72214	8/26/2013	9/3/2013	7	
Wahluke Townsite	WATO	119512	46.70845	-119.53944	7/1/2013	7/9/2013	7	

Site Name	Site Short Name	10-km Bat Grid Cell	Latitude	Longitude	Date Start	Date End	Functional Sample Nights[a]	Comments
WB 10 Ponds	WB10	119050	46.66667	-119.36353	6/28/2013	7/5/2013	7	
White Bluffs Boat Launch	WBBL	119050	46.67916	-119.44536	6/21/2013	6/28/2013	7	
HART MTN NATL ANTELOPE REFUGE								
Flook Lake Dugout	FLDU	98666	42.57591	-119.53085	7/6/2013	8/7/2013	7	
Kaske Spring Dugout	KSDU	97738	42.39511	-119.66452	6/5/2013	6/11/2013	6	
Mound Lake Dugout	MLDU	97738	42.36452	-119.65601	6/11/2013	6/25/2013	7	
Rock Creek Dugout	ROCRDU	98665	42.54972	-119.66021	7/9/2012	7/18/2012	7	
Warner Pond	WARPON	98664	42.55159	-119.74225	6/5/2012	6/8/2012	7	
KOOTENAI NWR								
East Hunt Unit - ADA Blind	EHUADA	126948	48.71143	-116.39194	7/2/2012	7/9/2012	7	
Kootenai River - Rivers Bend Unit	KR-RBU	126948	48.72872	-116.38872	7/16/2012	7/23/2012	7	
Myrtle Creek	MYRCRE	126948	48.73277	-116.41509	7/9/2012	7/16/2012	7	
Myrtle Pond	MYRPON	126948	48.71579	-116.41322	7/23/2012	7/30/2012	7	
Dike between Wigeon Pond and North Heron Pond	WPNHP	126948	48.69543	-116.40706	6/25/2012	7/2/2012	7	
LITTLE PEND OREILLE NWR								
Aspen Creek	ASPCRK	126938	48.49237	-117.67249	8/21/2012	8/28/2012	0	no data. Equipment malfunction
Blacktail Road	BLARD	126476	48.46188	-117.56117	7/16/2012	7/31/2012	7	
Cusick	CUSIC	126015	48.38820	-117.32238	8/10/2012	8/17/2012	7	
Cusick	CUSK	126015	48.38775	-117.32230	8/1/2013	8/8/2013	7	
Daily Lake	DALA	126474	48.45458	-117.80741	7/8/2013	7/15/2013	7	
Deer Lake North	DELANO	125086	48.14605	-117.53807	8/2/2012	8/8/2012	6	
Durland Springs	DLSP	126475	48.47222	-117.74667	7/23/2013	7/31/2013	7	
Kidney Pond	KIPO	126475	48.44579	-117.69428	9/4/2013	9/13/2013	7	
Lenhart Meadows	LENMEA	126476	48.43650	-117.60969	7/11/2012	7/18/2012	5	

Site Name	Site Short Name	10-km Bat Grid Cell	Latitude	Longitude	Date Start	Date End	Functional Sample Nights[a]	Comments
Narcisse	NARCIS	126475	48.48056	-117.73181	8/28/2012	9/4/2012	0	No data. Equipment malfunction
North Fork Bear Creek	NFBC	126476	48.47890	-117.61360	7/3/2012	7/10/2012	7	
North Highway	NORHIG	126939	48.54239	-117.60047	7/31/2012	8/8/2012	7	
Pierce Lake	PILA	126475	48.43446	-117.66160	8/12/2013	8/23/2013	7	
Pinto Ridge	PINRID	124623	48.13651	-117.55499	8/23/2012	8/31/2012	7	
LPO River West	RIVW	126474	48.47109	-117.79512	7/15/2013	7/23/2013	7	
Slide Creek	SLCR	126474	48.41920	-117.78603	8/26/2013	9/3/2013	7	
Snow Park	SNOPAR	126939	48.54303	-117.57467	8/9/2012	8/16/2012	7	
Park Rapids	PARRAP	126939	48.52968	-117.62536	8/16/2012	8/23/2012	7	
MALHEUR NWR								
Bridge Creek	BRICRK	99598	42.86396	-118.88593	8/14/2012	8/23/2012	7	
Middle Grain Camp	MIGC	100524	43.04200	-118.83905	6/5/2013	6/12/2013	7	
Mud Creek Brood Ponds	MUCRBP	99598	42.83422	-118.85980	8/6/2012	8/14/2012	7	
N Jones	NJONES	99598	42.91930	-118.87670	8/23/2012	9/4/2012	7	
Rimrock	RIMR	100987	43.08597	-118.88078	6/12/2013	6/17/2013	5	
Unit 8 Pond	U8PD	100987	43.10799	-118.90408	6/20/2013	6/25/2013	5	
MCKAY CRK NWR								
Number 1	MCK1	113033	45.57086	-118.77975	7/9/2012	7/16/2012	7	
Number 2	NO2	113033	45.56691	-118.76821	7/23/2012	7/30/2012	7	
Number 7	MCK7	113033	45.58752	-118.77882	8/22/2012	8/29/2012	7	
MCNARY MWR								
2 Rivers East Pond	2REP	115811	46.13085	-118.93683	6/21/2013	6/28/2013	7	
Burbank Slough 1	BUS1	116274	46.17122	-118.94451	7/5/2013	7/12/2013	7	
Burbank Slough 3	BUS3	116274	46.19918	-118.96931	6/28/2013	7/5/2013	7	
Peninsula North	PENO	116274	46.15847	-118.97289	7/12/2013	7/19/2013	7	

Site Name	Site Short Name	10-km Bat Grid Cell	Latitude	Longitude	Date Start	Date End	Functional Sample Nights[a]	Comments
Peninsula Tip	PETI	115811	46.12965	-118.96143	6/3/2013	6/14/2013	7	
WW2Junction	WW2J	115811	46.05686	-118.9034	6/14/2013	6/21/2013	7	
MINIDOKA NWR								
Number 1	MND1	94084	42.66070	-113.45186	7/24/2012	7/31/2012	7	
Number 10	NO10	94548	42.68921	-113.40466	8/17/2012	8/27/2012	7	
Number 5	NO5	94548	42.68088	-113.43813	8/7/2012	8/17/2012	7	
Number 6	MND6	94084	42.65818	-113.48613	7/31/2012	8/7/2012	7	
TOPPENISH NWR								
2B	2B	118116	46.30991	-120.37399	8/3/2012	8/10/2012	7	
Lateral C	LATC	118116	46.30836	-120.33879	8/10/2012	8/17/2012	7	
Toppenish Creek East	TOCREA	118116	46.31487	-120.31586	8/17/2012	8/24/2012	7	
UMATILLA NWR								
Number 10	NO10	115343	45.92914	-119.52321	8/27/2012	9/4/2012	7	
Number 2	N0 2	115342	45.91195	-119.59460	7/12/2012	7/17/2012	5	
Number 1	UMT1	115341	45.85151	-119.81174	8/6/2012	8/13/2012	7	
Number 12	NO12	115341	45.83614	-119.78828	8/13/2012	8/20/2012	0	no data. Equipment malfunction
Number 13	N013	115342	45.89357	-119.60578	7/24/2012	7/31/2012	7	
Number 4	NO4	115343	45.91345	-119.48596	8/13/2012	8/20/2012	7	
Number 6	UMT6	115342	45.89066	-119.58395	7/17/2012	7/24/2012	7	
Number 7	UMT7	115343	45.89281	-119.56660	8/29/2012	9/5/2013	7	
Number 9	NO9	115341	45.87282	-119.73627	8/6/2012	8/13/2012	7	

[a]functional sample nights = number of nights sampled during the study. Accounts for incomplete sample nights due to a variety of reasons.