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Migratory Bird Monitoring Using Automated Acoustic Technologies – Continuation, Year 4

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Table of Contents

Executive Summary 3
Mexican Spotted Owl (SPOW) 5
Monitoring at Fort Huachuca 5
Deployments 5
Detecting and Browsing 6
Results 6
Discussion and Commentary 8
Recommendations 9
Calling routes and calling stations 9
Survey Methods 9
Timing of surveys 10
Determining status of SPOW 10
Detecting SPOW using acoustic technologies 11
Literature Cited 11
Acknowledgements 11
Eastern Whip-poor-will (EWPW) 12
Monitoring at Fort Drum 12
Deployments 12
Results 13
Detector Evaluation 14
Discussion and Commentary 14
Detecting EWPW using acoustic technologies 15
Recommendations 15
Literature Cited 16
Acknowledgements 17
Tables 18
Figures 19

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Executive Summary

In previous multi-year projects (Department of Defense Legacy Resource Management Program (Legacy) projects 05-245, 06-245, 07-245) the Cornell Lab of Ornithology (Lab) developed and then expanded DoD capacities to monitor migratory birds using acoustic and Internet technologies. Some of these technologies were also developed under Strategic Environmental Research and Development Program (SERDP) projects CS-1185 and SI-1461. As a continuation of this multi-year effort, we proposed to use acoustic technologies to monitor species of concern, as described in the larger Department of Defense Coordinated Bird Monitoring Plan (DoD CBMP). In this document, monitoring is explicitly acknowledged as an integral element of bird management and conservation, and our proposal for using acoustic technologies provides effective means to 1) refine DoD abilities to detect species of concern, and 2) provide a tool for generating baseline data necessary for producing inventories on DoD installations in an efficient and cost effective manner.

We focused on two broad sets of goals in the most recent and final project in the acoustic monitoring scope of our work (10-245): to assess calling phenology of two target species on two DoD installations, and to assess the behavior of the autonomous recording units (ARUs) and sound analysis software (Raven, XBAT) used in previous research funded under SERDP projects CS-1185 and SI-1461 and Legacy projects 05-245, 06-245, and 07-245. To achieve both of these goals, we deployed ARUs over periods of weeks or months to survey two species of concern, “Mexican” Spotted Owl (*Strix occidentalis lucida* ;SPOW) and Eastern Whip-poor-will (*Caprimulgus vociferus* ;EWPW), to document vocal phenology at breeding location, with preference given to areas where local bird abundance was known and visual surveys could occur with ease, and when and where relevant in relation to environmental factors.

We collected data invaluable for assessing and refining protocols and applied conservation planning, for understanding novel biological information about species behaviors and communication, and for reviewing future automated deployments and their benefits to the military mission. Specifically, we report details in these three areas:

1. Field Testing: We continued evaluation of autonomous recording units (ARUs) and of detection and classification software for use with ARUs to a) conduct ground-based acoustic censusing of migratory bird species and species of concern and b) provide critical data to improve the accuracy of acoustic monitoring.

2. Target species monitoring protocol: We devised potential protocols for data collection, processing, and analysis to aid in implementing acoustic technologies, with a specific focus on applying hardware and software to monitoring target species of concern. This was done on an installation-by-installation basis, focusing on EWPW at Ft Drum and SPOW at Ft Huachuca.

3. Enhanced Monitoring Capabilities: We refined analysis capabilities for large acoustic monitoring datasets, including improved automation procedures and deployment strategies. This represents a critical step in connecting the scale of the recordings and amount of data we can collect with our abilities to process and to analyze such massive datasets.

In our collaboration at Ft Huachuca with Sheridan Stone and Deborah Becker, temporal patterns of SPOW seasonal and hourly calling as detected by ARUs suggest a need to broaden the seasonal window for monitoring while reducing the need for extensive nightly monitoring. We collected a total of nearly 12,000 hours of audio recordings among 9 different locations, analogous to almost 500 24-hour days of SPOW data. We detected over 31,000 SPOW calls representing at least 10 different types of vocalizations. Roughly 17,000 calls related to territorial behaviors, whereas approximately 13,000 related to pair-bonding behaviors. Just over 25% of all calls were recorded in the first hour after sunset across the entire season, suggesting a simple modification to protocol that could greatly enhance data collection and analysis effort. Modifications to existing monitoring protocols for this species would greatly enhance the current application of human observer time, which is severely limited. Moreover, deployment of ARUs in conjunction or in place of human observers could greatly benefit monitoring.

Additionally, in our collaboration at Ft Drum with Chris Dobony, Ray Rainbolt, and Jeff Bolsinger, temporal patterns of EWPW seasonal and hourly calling as detected by ARUs also suggest a potential need to review monitoring protocols. We found agreement with current monitoring protocols and published work that suggests that EWPW monitoring is useful and efficient. Calling peaked in late May through mid to late June. Periodicity in the calling data certainly relates to lunar illumination, meteorology, and potential other factors which we continue to investigate. However, we also found, as we did in previous studies, that EWPW vocalization continues in periods outside of typical monitoring protocols. Additional analysis of our data will likely suggest a solution for how best to approach applying new protocols that account for hours of the night and time of the month outside of the typical lunar illumination restrictions.

At the completion of Legacy project #10-245, we have shown proven applicability for monitoring two target species, one a threatened migratory breeding bird and the other a threatened resident and for enhancing DoD ability to evaluate and monitor avian resources on and off DoD lands. These approaches represent cost effective methods for surveying, saving valuable human and financial resources without compromising collection of data crucial for maintaining mission readiness on DoD installations. This powerful system for monitoring can target species of concern, particularly those that might be elusive, rare, or difficult to survey, to monitor these species in a cost effective way. We foresee the continued development of protocols for applying acoustic technologies as crucial for future uses of such technologies with numerous opportunities for public outreach and engagement. In addition, the research proposed has great potential for transfer to interested installations.

Mexican Spotted Owl (SPOW)

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Monitoring at Fort Huachuca

Deployments

In mid February 2011 we deployed seven autonomous recording units (ARUs; Song Meter SM2+ with a single SMX-II weatherproof microphone, Wildlife Acoustics, Inc., http://www.wildlifeacoustics.com/) near Fort Huachuca in Sierra Vista, AZ. Five units were deployed in active protected activity centers (PACs) to collect information about the calling phenology of SPOW, and two units were deployed to prospect in an area suspected to contain a pair. One recording setup was held to use later in the season to prospect in other canyons. Three units were deployed in Lower Huachuca Canyon near a known nesting area; two units were deployed in Scheelite Canyon where the owls are known to be active. The additional units were used to prospect canyons (Rock Springs and Cave Springs) that had past activity or were suspected to hold paired owls but may not be adequately monitored by traditional methods. McClure Canyon was also included in a second round of deployments in June and July. Figures 1a and 1b show the locations of 2011 SPOW ARU deployments near Sierra Vista. Table 1 shows the deployment schedule by location and date. Nights with no recordings did occur during the deployment date range. Table 2 shows the dates during the month when recordings were expected but not made, either due to the unit's failure to record (likely a power issue or media was full) or due to the unit being temporarily removed due to the Monument wildfire (starting 19 June, returned approximately 20 July).

Recording units were strapped 1 - 1.5 meters high on trees away from trails so visitors would not notice them, but where they could be easily reached for servicing. Each unit was programmed to record each evening from local sunset to local sunrise throughout the duration of the entire breeding season. We define a recording as equivalent to a single night of data collection, from local sunset to local sunrise (Table 1). Four, onboard alkaline D-cell batteries powered all of the recording units that were

easily accessible. Base biologists serviced these units approximately every three weeks to change the batteries and to insert fresh SD cards throughout the season (Table 3). Deployments that were difficult to access on a regular basis used an external, longer-lasting power supply of D cells that was set on the ground under the recording unit. Regardless of power type, all recording units wrote WAV files to 32GB SD cards, which were collected periodically and shipped to Ithaca for processing.

Detecting and Browsing

We used Raven Pro Sound Analysis Software (1.4 beta, Bioacoustics Research Program 2011) to process and analyze the recordings. A Band-limited Energy Detector was used to detect all sounds within a specific frequency range. Detector parameters were configured as follows, with one exception noted below:

Target Signal	Signal-to-Noise Ratio	Noise Power Estimation
Frequency 600 to1400Hz	Min. Occupancy 20%	Block Size 998 ms
Duration 21.7 to 603 ms	SNR Threshold 5.0 dB	Hop Size 250.8 ms
Separation 21.7 ms		Percentile 50

We ran this detector in batch mode using the default settings as the "View." For Cave Spring files, where running water yielded abnormally high detection numbers, we changed the Duration values to 60ms (minimum duration) and 602.5 ms (maximum duration). Each generated selection table was browsed by analysts who coded each detected SPOW call-by-call type, which were derived from Forsman et al. (1984). Additionally, analysts reviewed SPOW and other owl vocalizations during the process of categorizing call types, including data from Gutierrez et al. (1995) and Vyn (2006). Sound Window parameters used during browsing were Window Type and Size:

Hann 256 samples	Hop Size 20 samples	Contrast 71
3 dB filter	DFT 256 samples	Window Length 6-15 sec
Bandwidth 135 Hz	Grid spacing 93.8 Hz	
Overlap 92.2 %	Brightness 43	

Additional details for this methodology can be found in previous Legacy Final Project Reports for 05-245, 06-245, and 07-245 (posted on www.denix.osd.mil, Natural Resources program tab), as well as Charif et al. (2010). The results were imported to an Excel spreadsheet to generate phenology patterns and further analysis.

Results

We recorded a total of 31,226 calls at nine recording locations in the Fort Huachuca vicinity. Table 4 summarizes the distribution of these calls by location. Note that 2 PACs (Lower Huachuca Canyon – ARUs FTHUA01, 02, 03; Scheelite Canyon – ARUs SCHE01, 02) represent approximately 75% of the total calls recorded during our project. Note that overlap in calling monitoring among ARUs FTHUA1, 2, and 3 are accounted for in this assessment. The additional locations designated as prospecting ARUs outside of known PACs but in areas where SPOW were suspected to occur did represent a small portion of the calling activity. This is particularly true of McClure

Canyon, where 1166 calls were recorded. However, only 20 calls were recorded at Rock Springs, suggesting transient individual owls may be passing through the area. No calls were recorded at Cave Spring.

Figure 2 shows the hourly temporal pattern of SPOW calling in raw calls and as a percentage of total calls. When nocturnal duration is not considered, the hour beginning with local sunset is the period with the greatest total call count (7911 or approximately 25% of all calls recorded). However, standardizing for nocturnal duration into four groups – 9-, 10-, 11-, and 12-hour nocturnal periods, we see a slightly different pattern emerge. Figures 3a, b, c, and d show 9-, 10-, 11-, and 12-hour nights, respectively. The hour with the highest call count is not the hour beginning with sunset in 9-hour nights, but for 10-, 11-, and 12-hour nights this hour is the peak for total calls. Additionally, note the pattern for high total call counts in the hours just prior to sunrise. In 9-hour nights, the peak for total calls occurs in the last hour of night; this is also the hour for a second highest call total for 11-hour nights. For 10- and 12-hour nights, the penultimate hour contains the second highest call total. Figure 4 shows the mean calls per hour and standard deviation for 9-, 10-, 11-, and 12-hour nights. Note the large standard deviation for average calls in the last hour of the night across all duration nights; additionally, note wide variation in the first hour's average call counts as well. In general, the first and last hours of a night, although exhibiting the greatest variation in calling, represent periods of very high call counts and average call counts.

10 of the call types described by Forsman et al. (1984) were noted, and we summarize these in Table 5a and Figures 5 and 6:

1. Four-note Location Call (FLC)
2. Agitated Location Call (ALC)
3. Series Location Call (SLC)
4. Bark Series (BS)
5. Contact Call (CC)
6. Agitated Contact Call (ACC)
7. Nest Call (NC)
8. Cooing Call (COO)
9. Juvenile Begging Call (JBC)
10. Chitter (CHI)

Table 5a also shows the total number of territorial calls and bonding calls, as this breakdown is meaningful for understanding SPOW behavior at the sites where we deployed ARUs. Note that the call type 'SPOW' represents an unknown call type, either in being too faint to classify with certainty or a novel sound not reported in Forsman et al. (1984). Several features of interest are immediately apparent in these summaries - CC vocalizations are well represented in the hour beginning with sunset and in the hours ending the night. Also, the hour after sunset is diverse from the perspective of SPOW vocalizations, as are the last hours of the night. Almost 4000 more territorial vocalizations were recorded than bonding vocalizations; the pattern of total territorial and total bonding calls is presented in Figure 7. Table 5b shows a breakdown of call types by deployment. Contact calls were the most abundant call type of all from a single

station, with FTHUA01 recording 6931 calls. Also, of interest, high territorial calling activity with FLC vocalizations occurred at SCHEE01 and SCHEE02 and FTHUA01, 02, and 03, with totals of 3417, 2439, 1641, 1511, and 1679 calls counted, respectively. This suite of ARUs were deployments in close proximity, suggesting a high level of activity by SPOW in these areas as well as a high level of overlap in the individuals recorded on respective ARUs; recall that these are known PACs.

Discussion and Commentary

Based on acoustic monitoring we confirmed the presence of SPOW in three of the PACs (Lower Huachuca, Scheelite, and McClure) but could not confirm residence in Rock Springs; we did not encounter any SPOW vocalizations in the Cave Springs recordings. Generally, the deployments in Lower Huachuca and Scheelite Canyons were extremely active throughout the season, as expected given the presence of long-standing SPOW territories known to be in the PACs as well as numbers of SPOW present in the vicinity. FTHUA01, as it was located near the nest, not only recorded advertising and territorial calls (FLC, ALC, SLC, BS, ACC) but also bonding calls (CC, NC, COO, CH) and interactions with juvenile(s) (JBC). The Scheelite Canyon deployment (SCHEE02) was not known to be near a nest, but possible NC vocalizations were tentatively identified, along with territorial and bonding calls. No juvenile calls were noted. Only two nights contained calls in Rock Springs, consisting of five FLCs recorded by ROSP01 on 7 May between 3:40 and 4:05 local time (8-9 hours after sunset), then three more FLCs also on ROSP01 on 10 Jun shortly after local midnight.

This recording campaign is a solid example of substantial advances, enhancements, and improvements to the acoustic monitoring methodology we began to apply nearly 7 years ago. Recording hardware, ARUs in particular, are now smaller, more efficient, and smarter than at any previous point in our deployment histories. Additionally, software for sound analysis has improved speeds of detection and review, in some cases by factors of 200-300X and 5-10X, respectively. We can generalize experiences monitoring target species acoustically with the current hardware platform as effective, stable, and easy to deploy. We recorded only 77 technical failures, usually a function of diminished battery life from colder than expected temperatures, out of 1271 recording nights (approximately 6%). This is a huge improvement over previous, earlier years' deployments in which over 50% of the ARUs failed. This type of success stabilizing a platform means huge benefits in efficiency. Additionally, ease of deployment has improved greatly, with current model ARUs requiring less than 5 minutes to set up and deploy in many cases; this contrasts with up to an hour for previous units.

Despite the successes of this project's recording efforts, there are a number of areas in which improvement is likely and necessary. We still do not have easily deployable and manageable arrays for localizing and quantifying individuals. When this comes online, huge strides in acoustic monitoring potential will occur. Additionally, these units still require manual data download, as wireless transmission is simply not robust enough to transmit the current quantity of information collected; moreover,

onboard software is not sufficiently advanced to reduce data quantities to levels reasonable for wireless consideration.

Similarly, there are several sets of biological questions to which we likely can provide answers with a little more analysis time and effort. SPOW vocalizations appear to follow a similar periodicity to other nocturnal vocalizers in relating to lunar activity and meteorology and their interaction. We have compiled data sufficient to explore these relationships, and we plan to do so outside the realm of this project.

Recommendations

Calling routes and calling stations

SPOW monitoring currently requires designated calling routes and calling stations to locate owls. One primary problem is how to assess the value of creating new routes and stations in a cost-effective and meaningful way. Without question, great potential exists for ARUs to inform decisions about appropriate routes and stations. Specifically, our results suggest that the use of ARUs for prospecting is key for generating new routes and stations, in particular to find previously unknown locations with SPOW activity and to confirm the presence of SPOW in locations with suspected occupancy. Our current work suggests that applying acoustic technology to this prospecting could be informative of areas with high potential for SPOW, as well as providing insight for areas with little or no activity. We recommend regular deployments of ARUs for prospecting year-round, based on our results and previous work of Forsman et al (1984) and Ganey (1990), for the express purposes of highlighting additional routes and stations for monitoring SPOW.

Survey Methods

SPOW survey methodology suggests that observers focus on two optimal periods for monitoring owl calling: two hours after sunset and two hours prior to sunrise. Our results generally support this pattern of calling and this approach to monitoring, but we believe that some revision may be useful in situations where resources for monitoring may be limited. ARUs recorded temporal patterns suggest that the hour just after sunset can be generalized as the best time to monitor owls across multiple different durations of night (and hence across different parts of the season). If personnel hours are limited, monitoring sites for less time each night but focusing on the hour just after sunset will likely have potential benefits. However, we also found that variation in calling was not evenly distributed across entire evenings of recording and calling. For shorter nocturnal periods (e.g. summer), the greatest variance in calling occurred in the last hour of night; for longer nocturnal periods (e.g. winter), the greatest variance occurred during the 2nd to last hour of night, followed closely by the first hour of night. It is, therefore, possible that observers monitoring only single hours of night may experience wide variation in total calls recorded and possibly in call types, and this could have bearing on assessing behaviors occurring in PACs or suspected PACs.

We found that approximately 65% of the calls recorded were FLC, CC, and BS. This percentage differs substantially from previous estimates used in the SPOW survey methodology, suggesting approximately 86% of calling is represented by those three call types. There is some error in comparing these vocalization quantities, because the SPOW survey may have been referencing SPOW calling as calling bouts (Ganey 1990: any calling that happened with no breaks longer than 5 minutes between vocalizations). However, perhaps more valuable is our analysis of the distribution of call types by hour of night. The first hour of the night contained the greatest diversity of call types and the largest or some of the largest numbers of the call types. Our results suggest a need to train volunteers to recognize additional calls, and that this may add value to their survey abilities. This may be particularly useful in the earliest parts of the night, regardless of season, given the variation in call types we encountered in our recordings.

Timing of surveys

SPOW survey protocols suggest late March through late June as prime time for surveying owls. We agree that these dates are representative of periods with high calling in our sample of recordings. However, we suggest that expanding this period into late February will add value to surveys. Owl calling activity was highest in late February and early March, outside of the typical survey periods, for bonding calls. Additionally, territorial calling also peaked before the suggested window for surveying, with peak occurring in the same late February and early March period. We recommend increasing the seasonal window for surveying to include this period, as it is the most active for territorial and bonding calls in this part of Arizona. Also, potential value in extending the period later in the season may exist. Given continued calling activity well into the late summer months of August and even September, we suggest that longer surveys may result in additional valuable information collection potential even beyond the typical late June survey cutoff.

SPOW survey protocol also suggests that calling activity increases from March through May. Our results suggest otherwise, which may have bearing on the level of effort with which owl surveying occurs during the season. More effort earlier in the season would appear to facilitate the discovery of new SPOW locations, new pairs, or more information about existing pairs and existing PACs.

Determining status of SPOW

Perhaps the best logic for applying acoustic technologies to monitoring SPOW is that the status of breeding in an area, the presence of males and females interacting, and the presence of young are all potentially derived from automated recordings. We found 10 of the call types described by Forsman et al. (1984) suggesting that ARUs do a good job of acquiring information about the presence and absence of behaviors associated with the different call types. It is our opinion that ARUs may minimize disturbance to SPOW while providing equally valuable information about status in a given area.

Existing SPOW protocol dictates using presence/absence to lead to nest searching and monitoring (if/when found). Using acoustic technologies provides the

potential for finding nests efficiently by deploying ARUs and searching specifically for nestling and nesting vocalizations. This could be a major time saving change to protocols, and should be investigated further as a means to gather additional, more passive data effectively and efficiently and with substantially less interference to the owls.

Detecting SPOW using acoustic technologies

We believe that our approach to monitoring with automated acoustic technologies has tremendous value for SPOW monitoring. We had great success in detecting the presence and the behavior of SPOW at recording locations, and we did so by minimizing the human effort required to survey the same areas. Even with extensive manual review of collected acoustic data, the amount of time spent surveying these same sites with humans instead of ARUs would result in unattainable resource needs (e.g. person hours, travel time, access). Additionally, the recording environment in many of our study sites in the Huachucas was ideally suited for our hardware and software. Future consideration of acoustic monitoring for SPOW in these areas could take advantage of such favorable conditions when deploying, not only from the perspective of monitoring the species but also from a perspective of prospecting and defining interesting biological and behavioral questions.

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Eastern Whip-poor-will (EWPW)

Andrew Farnsworth, Michael Pitzrick, Michael Powers, Anne Klingensmith, Lewis Grove

Monitoring at Fort Drum

Deployments

On 5 May 2011, we deployed six autonomous recording units (ARUs; Song Meter SM2+ with a single SMX-II weatherproof microphone, Wildlife Acoustics, Inc., http://www.wildlifeacoustics.com/) at Fort Drum near Watertown, NY, along previously-established Nightjar Monitoring routes (Figure 8). Three units were deployed at standard survey stops in high-quality habitat, consisting of pine-oak woodlands with sandy soil, where EWPW are frequently detected during the breeding season (Figure 8, Route 1; hereafter RT1), three units were deployed at standard survey stops in low-quality habitat, dominated by secondary growth with a thick understory, where EWPW are rarely recorded (Figure 8, Route 2; hereafter RT2). On 26 May we deployed an additional unit along RT1 and an additional unit along RT2. In this report, we detail data from RT1 only, as RT2 analyses are still on going and part of direct discussions with Fort Drum personnel.

Recording units were strapped 1 - 1.5 meters high to trees between 10 and 25 meters from the road so they would not be noticeable to passers by but could be easily reached for servicing. The units were programmed to record each evening from local sunset to local sunrise throughout the duration of the entire breeding season. We serviced the units approximately every three weeks to change the batteries and to insert fresh SD cards throughout the season. Upon retrieval of the ARUs from the field, the sound data on the SD cards were transferred to XBAT v. R5 (Mills and Figueroa 2005, Mellinger et al. 2009, Figueroa 2010) libraries. We analyzed all recordings using XBAT, v. R5. All sounds were imported into XBAT libraries that were created based on the various retrieval dates. This approach served two purposes: it limited the amount of sound we analyzed at a given time, translating to outputs that were manageable, and it allowed us to begin analysis during the season as opposed to after the season ended. An automated EWPW sound detector was validated by statistical comparison to a random sample of the field recordings annotated by expert human analysts.

Analysts created guide logs for truthing to support hand browsing a random sample of fifteen one-second sound chunks per hour. We created logs with an appropriate number of one-second random samples using XBAT tools built to create these “truthed logs.” Our methodology relies on estimating True Positive Rate (TPR) and False Positive Rate (FPR) to select a Data Template Threshold at which we have very few false positives while having an acceptable detection rate. Expert analysts then tagged one-second sound chunks as “EWPW” or “noise” to create a truth set using Montage Tool in Sedna (Dugan et al. 2011). For the process of automated detection, we created an XBAT Data Template Detector (DTD) preset, WPWI_best5, with the best five

exemplars of hundreds of exemplars in Macaulay Library using Sound Xcorr Tool (K. Cortopassi, unpublished data). Detections were run using the following parameters:

- Fast Fourier Transform (FFT) Size: 512
- Advance: 0.5
- Window Type: Hann
- Window Size: 1

Most detections were run on a high performance computer server with 24 virtual processors, 48 GB RAM, and RAID 0 array.

We used Detector Validation v2 XBAT log action to estimate TPR, Positive Predictive Value (PPV), and Number of False Positives per Hour (FP/hr) for several correlation thresholds. Detector Validation revealed a number of EWPW vocalizations missed by expert analysts, so analysts were tasked with reviewing sound events for which they disagreed with the detector. Using the revised truth set, a set of conditions was selected that would result in a very low rate of false detections: threshold, 0.25; time exclusion, hours of daylight and civil and nautical twilight (sun higher than -18° altitude), as determined by U.S. Naval Observatory (http://aa.usno.navy.mil/data/docs/RS_OneYear.php). Although restrictive, and more so than in previous studies and projects, we needed to use this conservative level of light because of widespread contamination of the recordings with non-target species, primarily diurnal species of birds singing into the early evening hours (Mills 1986). Positive Predictive Value (PPV) was estimated at 99.5% (0.5% of detection events are on non-EWPW sounds). TPR was estimated at 30.0% (30% of EWPW vocalizations were successfully detected). We then determined what proportion of random spectrograms tagged “noise” overlapped detection events, and how many spectrograms tagged “EWPW” overlapped detection events over a series of spectrogram cross-correlation score thresholds.

We selected a cross-correlation score threshold of 0.25, describing the proportion of detection events overlapping with “EWPW” spectrograms among all detection events that overlapped any randomly-selected analyst-tagged spectrogram (Positive Predictive Value, or PPV). We removed detection events with selected cross-correlation scores below the selected threshold, then tabulated and plotted the number of detection events in three minute, one hour, and one day bins. We used Sedna Callcount Viewer (Dugan et al. 2011) to report the number of detection events each night for export into Excel worksheets and to generate representative PNG and FIG plots.

Results

We recorded a total of 10,710 hours across eight different locations at Fort Drum (Table 16). DTD found 10,041,314 events. Our results show a broad pattern common to EWPW calling phenology (e.g. Cink 2002). We found peak calling to occur in the hours just before dawn early in the breeding season (e.g. May), continuing this pattern through

mid-to-late July. We noted exceptions in several cases, with hours after astronomical twilight showing peak calls in a few instances of late May and June.

Temporal pattern data show that, interestingly, across all stations there is a pattern of calling during nautical twilight later in the season than calling during astronomical twilight. EWPW call earlier in the night longer into August and even September, whereas later evening calling peaks earlier in the season, by mid June. Total call count using astronomical twilight as the cutoff for a night was 136,716 across the four stations for the entire season. Peak call count when using astronomical twilight as a cutoff to begin night occurred in the 10PM-12AM hours, with 10-11PM peaking at 73,339 calls across the four stations. Peak calling in a 24-hour period occurred on 12 May, with 6,756 calls recorded across the four stations in that period. Of note, the range of dates recording EWPW across these stations during our deployment is 6 May - 30 September. Figure 9 shows this pattern graphically. Interestingly, the highest total hour of calling occurs in the second week of June.

Examining patterns at a slightly coarser scale by site, we generally see a similar pattern. Figure 10 a, b, c, and d show Ft. Drum stops 4, 5, 6 and 7, respectively. Stops 5 and 6 have the greatest density of calls. High call counts are apparent in the hours after dusk and before dawn in these stops, with the pattern still present but less extreme in stops 4 and 7. Of note is the prevalence for EWPW at stop 7 in particular to call much more frequently after midnight in the hours before dawn, with the exception of later season July calling.

Detector Evaluation

The automated analysis of EWPW data by DTD was effective and efficient. Our evaluations are presented in Table 7, where we present data on four different detection thresholds, four different nocturnal durations, and four different locations individually and pooled. The values for PPV range from 0.793-1.000 (mean 0.956, median 0.975, sd 0.048, cv 0.05), indicating that a high proportion, in fact all in some cases, of detections represents EWPW vocalizations. Note also a very low coefficient of variation, suggesting low variance in values reported across all deployments, all thresholds and all nocturnal duration regimes. Additionally, FP was generally low, ranging from 0-976 (mean 85.875, median 30.5, sd 158.35, cv 1.844), across TPR values of 0.125-0.814 (mean 0.496, median 0.498, sd 0.179, cv 0.361).

Discussion and Commentary

The railroad like appearance of the graphical figures appears to be due at least in part to false detections on songbirds at dusk. Although FP/hr is low when averaged across each site, it is about ten times higher during Nautical Twilight than Astronomical Twilight and nighttime (Table 7). It is clear that EWPW sings during civil and nautical twilight – hand browsing reveals them during this period – but it is unclear whether they sing more during civil and nautical twilight than during astronomical twilight or the adjacent time of night. Once Nautical Twilight and the associated railroad tracks are removed from the plots, the plots look quite different. Vocal activity is concentrated in

May and June, similar to many spring-breeding songbirds. July has varying amounts of activity, depending on site. Note that Route 1 Stop 6 recording starts 3 weeks later than the other plots, but is stretched out in the plot to occupy the same space. As we found in previous studies, there is periodicity in EWPW vocal activity, likely synchronized with the lunar cycle. Future work with this dataset will compare lunar and meteorological data with EWPW calling phenology.

Additionally of note is discussion of the performance of the detector and a hypothesis we believe may be valid that we can draw from this performance. Detector performance suggests that proportion of detection events that are not EWPW during the period of Nautical Twilight is only 0.009, one-tenth of a percent (PPV is 0.991). This is indicative of very good performance. Because there are also diurnal birds singing during Nautical Twilight, FP/hr goes up about 8 times. However, PPV is not that different compared with the darker part of the night because there are so many more EWPW events than noise events, even during Nautical Twilight (Table 7). This leads to an interesting hypothesis that EWPW sing later in the year during Nautical Twilight than they do during Astronomical Twilight and nighttime hours.

We also reviewed the behavior of reporting of false negatives, and these appear to be from several sources: low SNR signals, noise within bounds of template (e.g. other EWPW singing, frogs, birds), and reverberation (e.g. quiet, windless periods). However, we are not concerned with lower TPR values. We ran detector validation statistics at thresholds at 0.10, 0.15 and 0.20 so we have the option of reporting call counts with a higher TPR. PPV decreases with these changing detection thresholds, while number of detections frequently increases, so a tradeoff will exist in certain situations. Future work should examine the behavior of these patterns to determine if there is always an optimal set of parameters that minimizes total detections, maximizes PPV and maximizes TPR with as few false positives and false negatives as possible.

Detecting EWPW using acoustic technologies

Automated acoustic approaches to monitoring EWPW are effective. We believe that the techniques that we tested during the past year of this project and across all years of Legacy projects (05-245, 06-245, and 07-245) have provided sufficient results to suggest that using these methods would add great value to present monitoring schemes and more importantly save resources that are limited (i.e. human hours for observation). Although these monitoring schemes have all involved single sensor acoustic deployments, reporting on the presence/absence and prospecting for a given target species (in this case, EWPW) has been straightforward and efficient. In the future, it is clear that quantification, which is possible only in a broad sense presently (e.g. 1, 2, more than 2), is the next frontier.

Recommendations

Wilson and Watts (2006) suggest that detection probability of EWPW correlated positively to lunar illumination, and Hunt (2007) suggests that "*all surveys needed to occur at dates and times when the moon was at least 50% full, above the horizon, and*

not obscured by clouds." These studies recommend that all surveys be conducted on nights when the moon-face was > 50% illuminated to minimize variability among sites and improve statistical power. Based on our findings in this project and previous projects, we agree with this approach in general. However, we suggest that some review of this protocol may be necessary. Hunt (2007) expanded "*the allowable evening period to include surveys in the middle of the night or prior to dawn, as long as they met the lunar criteria. This allowed for a larger survey period."* This expansion fits well with the results we found, in that calling by EWPW beyond periods in the hours just after sunset is sufficiently common to warrant such an expansion. Furthermore, because we found that calling occurs later into the season, albeit at decreased levels, we suggest that some additional new protocols for prospecting, particularly with acoustic devices, may be in order; and considering expansion of the monitoring seasonally may be valuable.

One caveat suggested by our results and our discussions is that EWPW monitoring protocols driven by a function of lunar illumination may miss critical periods of high calling activity. A further detailed analysis is needed to determine whether, with current advances in acoustic monitoring, further revision to the restrictions set forth by Wilson and Watts (2006) and Hunt (2007) are warranted. Regardless of this investigation, to summarize, based on our findings, we believe that current monitoring protocols for human observation of EWPW vocal phenology are sufficient to capture necessary information about the species on Fort Drum. However, there is no doubt that the addition of acoustic technologies can and will enhance human observation studies and can and will create a new, complementary monitoring scheme for deployment in concert with human observers.

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Tables

Table 1 shows the deployment schedule by location and date.
Table 2 shows the dates during the month when recordings were expected but not made.
Table 3 shows replacement schedules for batteries and SD cards.
Table 4 summarizes the distribution of SPOW calls by location.
Table 5 shows 10 of the call types described by Forsman et al. (1984). Table 5a also shows the total number of territorial calls and bonding calls, as this breakdown is meaningful for understanding SPOW behavior at the sites where we deployed ARUs.
Table 5b shows a breakdown of call types by deployment.
Table 6 shows recordings made at eight different locations at Fort Drum.
Table 7 shows evaluations of the automated analysis of EWPW data by DTD on four different detection thresholds, four different nocturnal durations, and four different locations individually and pooled.

Figures

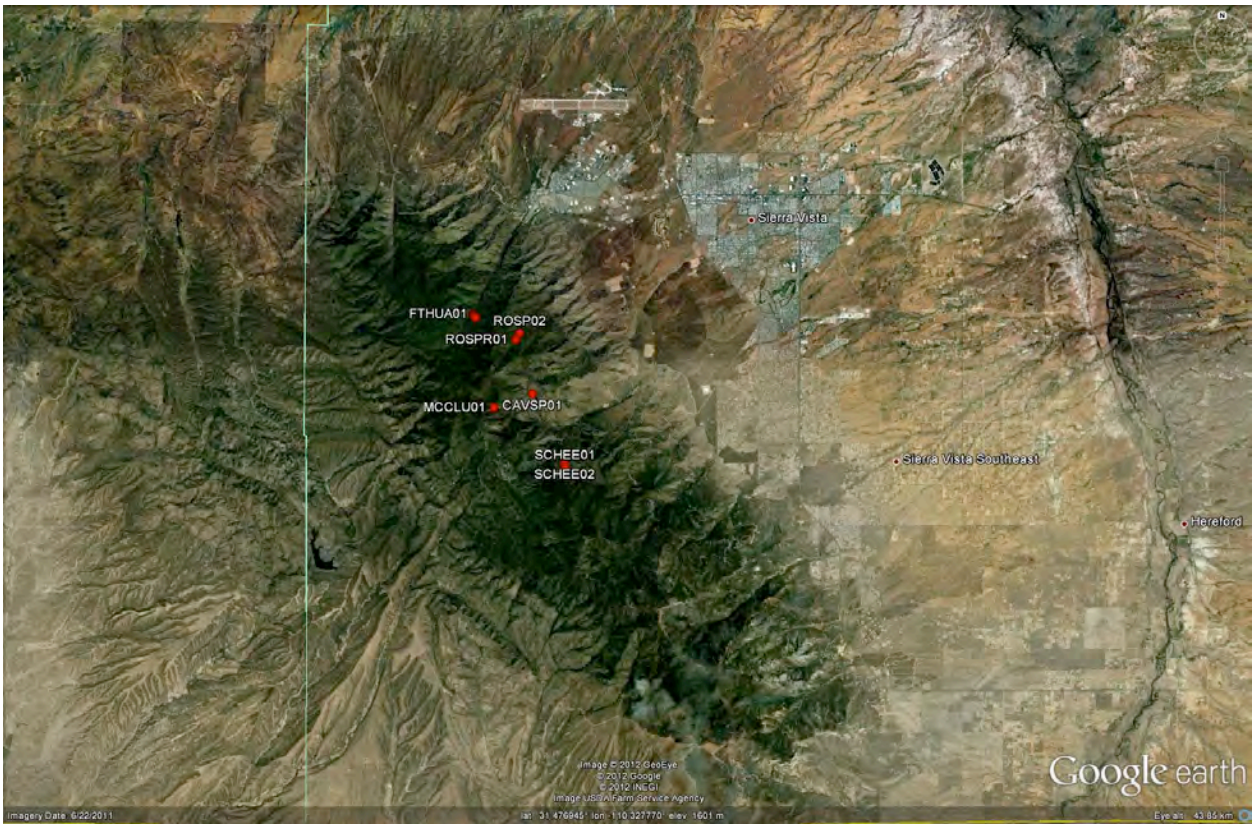

Figure 1a. The locations of 2011 SPOW ARU deployments near Sierra Vista.

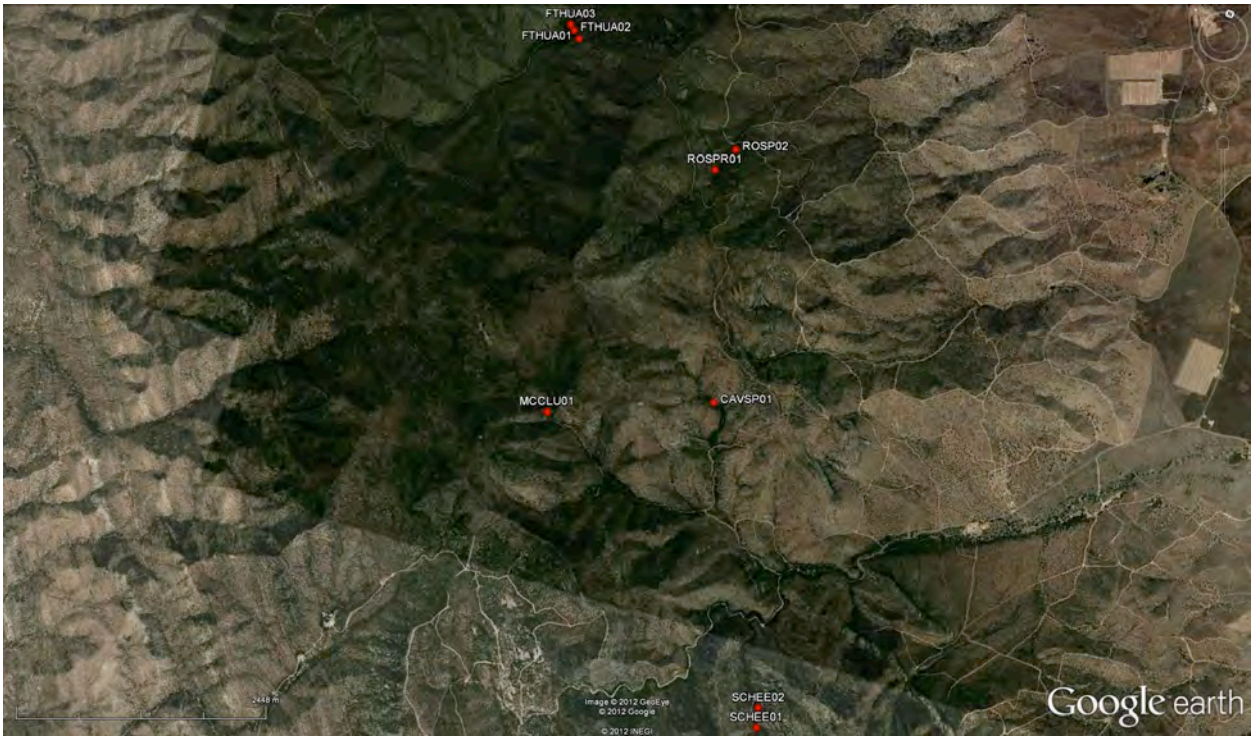

Figure 1b. The locations of 2011 SPOW ARU deployments near Sierra Vista.

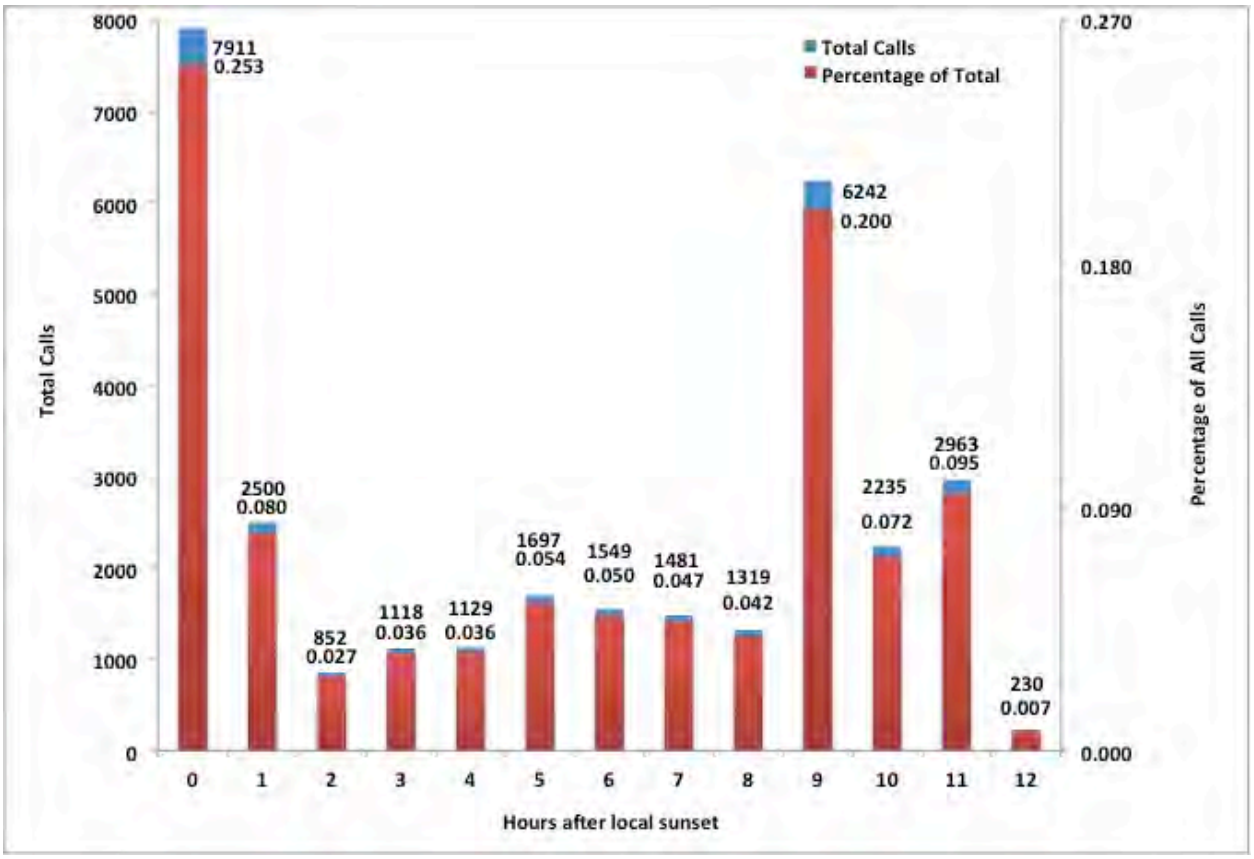

Figure 2a. Hourly temporal pattern of SPOW calling in raw calls and as a percentage of total calls.

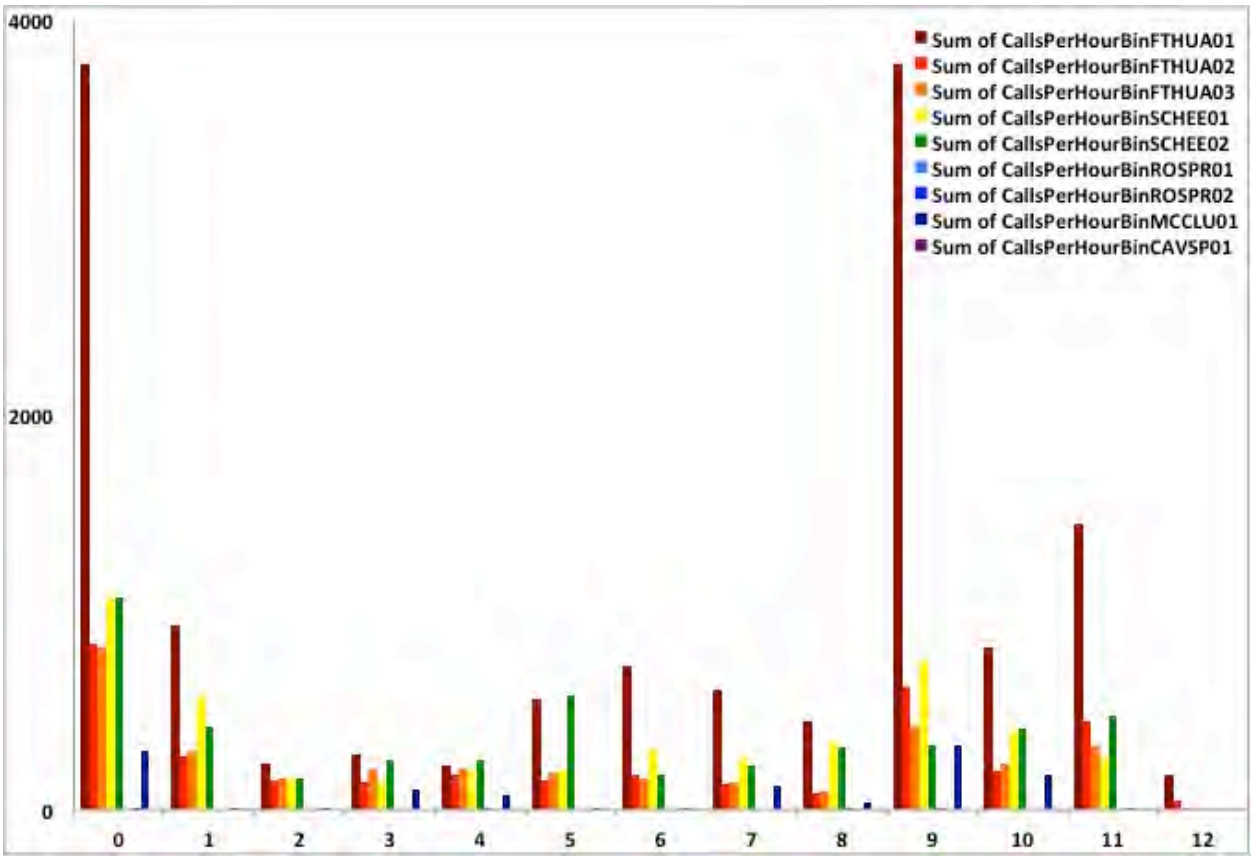

Figure 2b. Hourly temporal pattern of SPOW calling in raw calls among recording units.

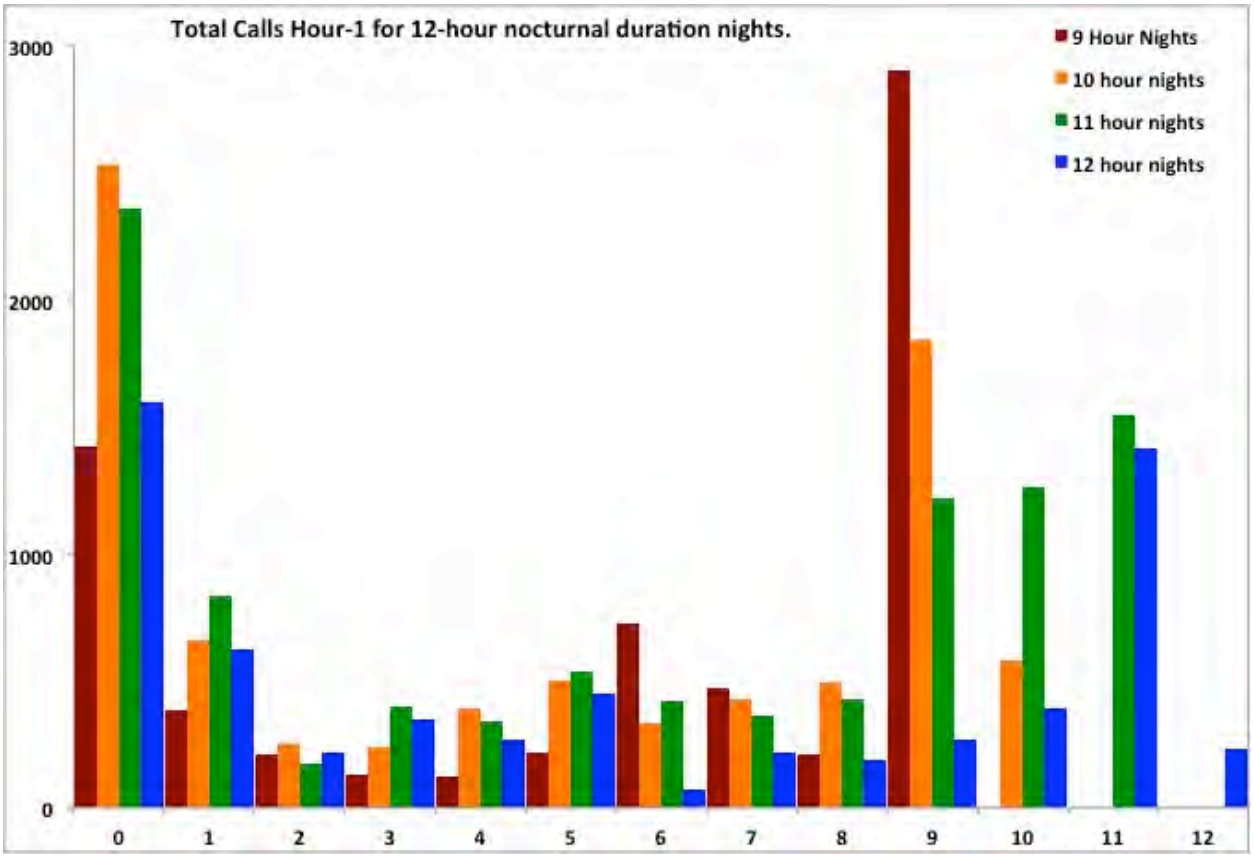

Figure 3. Call counts for all recording units by 9-, 10-, 11-, and 12-hour nights.

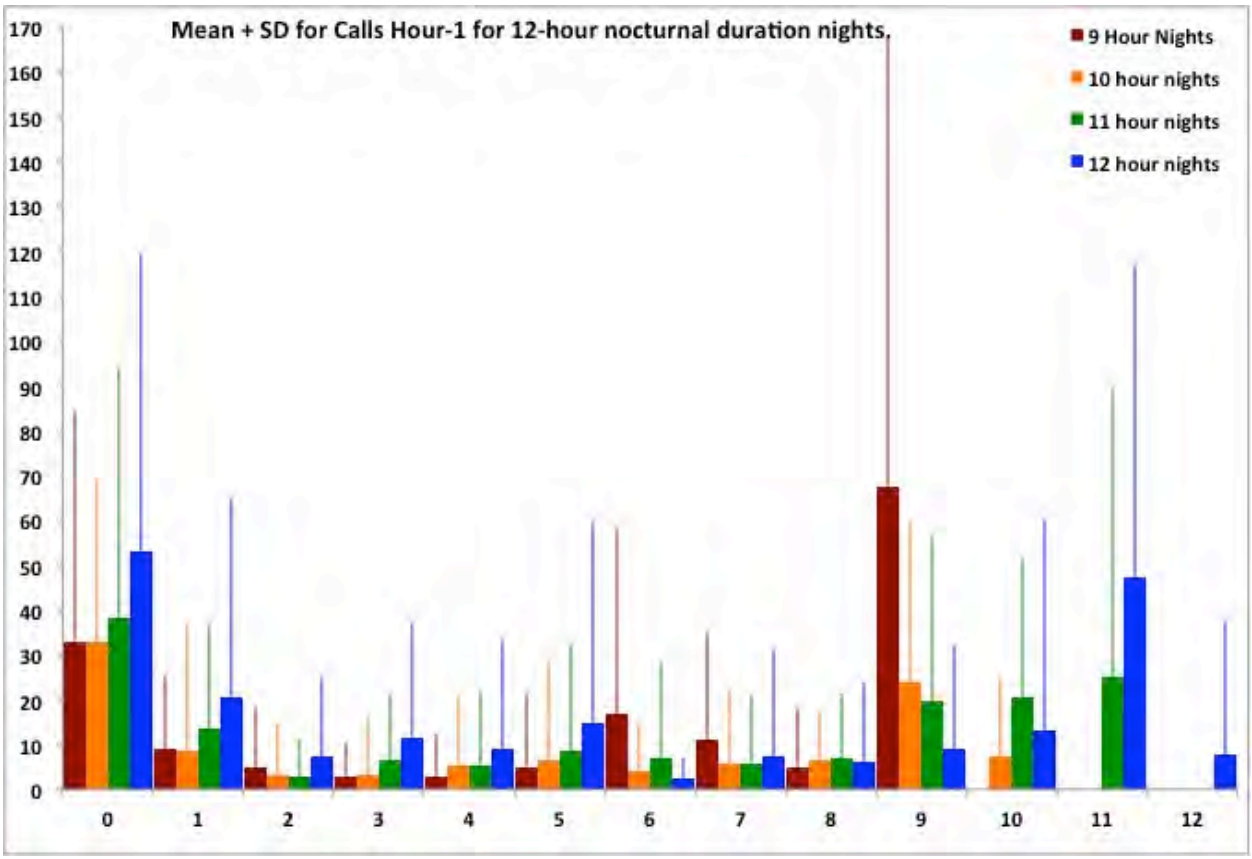

Figure 4. Mean calls per hour and standard deviation for 9-, 10-, 11-, and 12-hour nights.

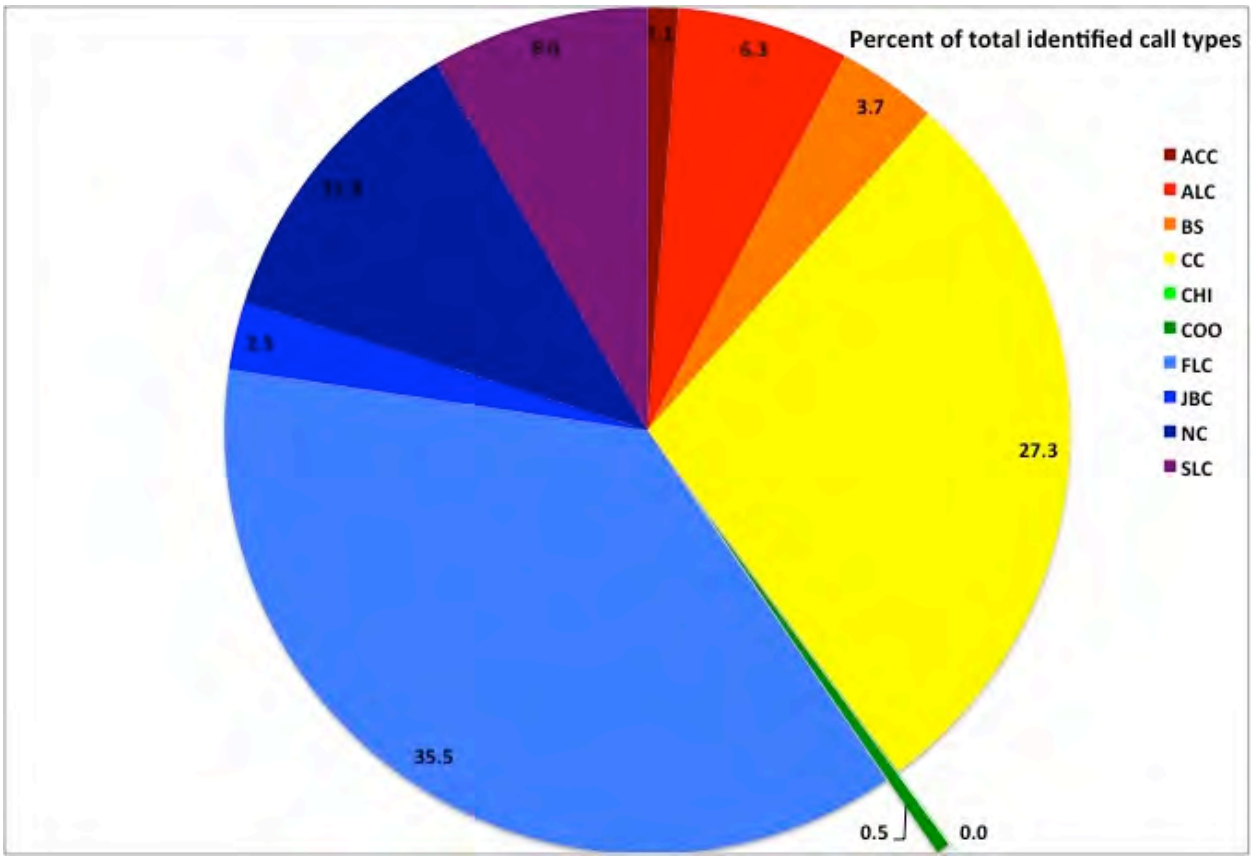

Figure 5. Percentage of total identified calls, after Forsman et al. (1984).

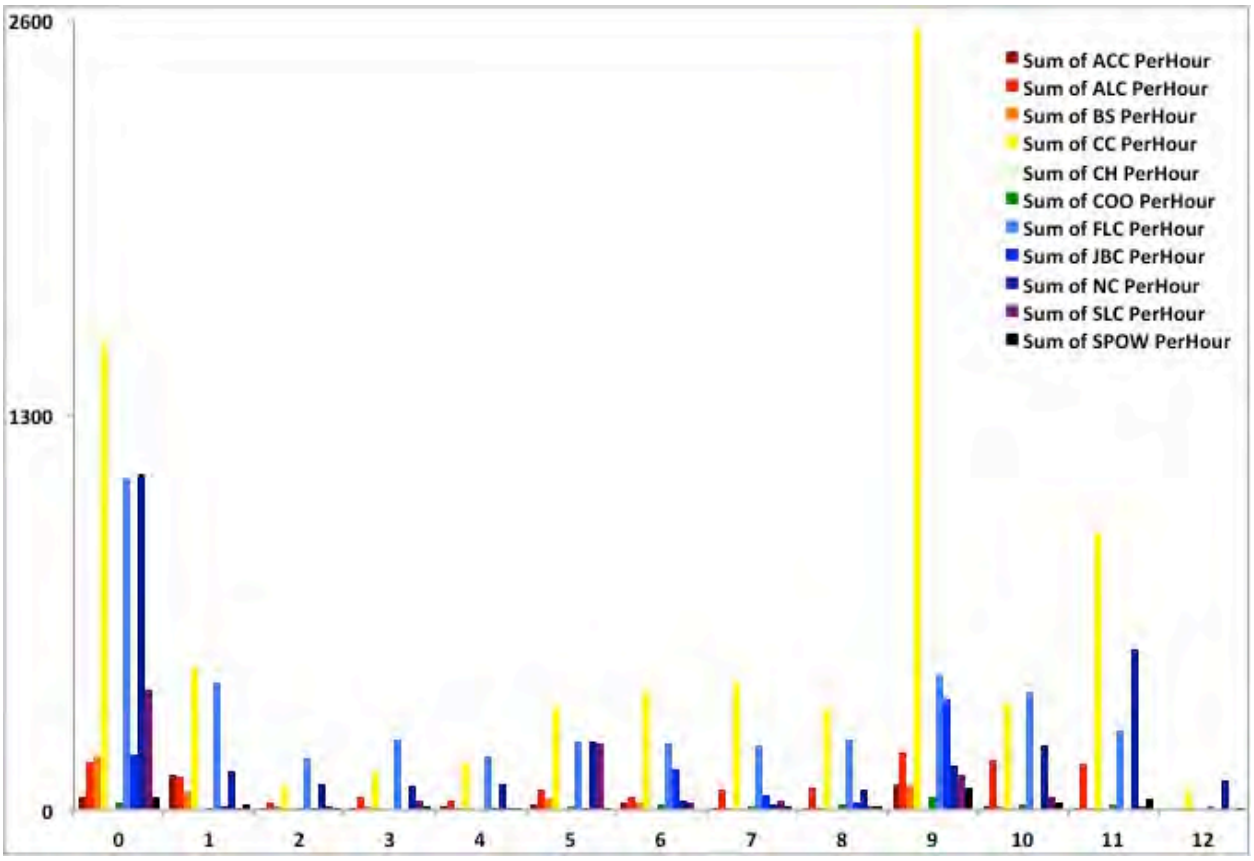

Figure 6. Total calls of 10 call types recorded during nocturnal periods across all recording stations.

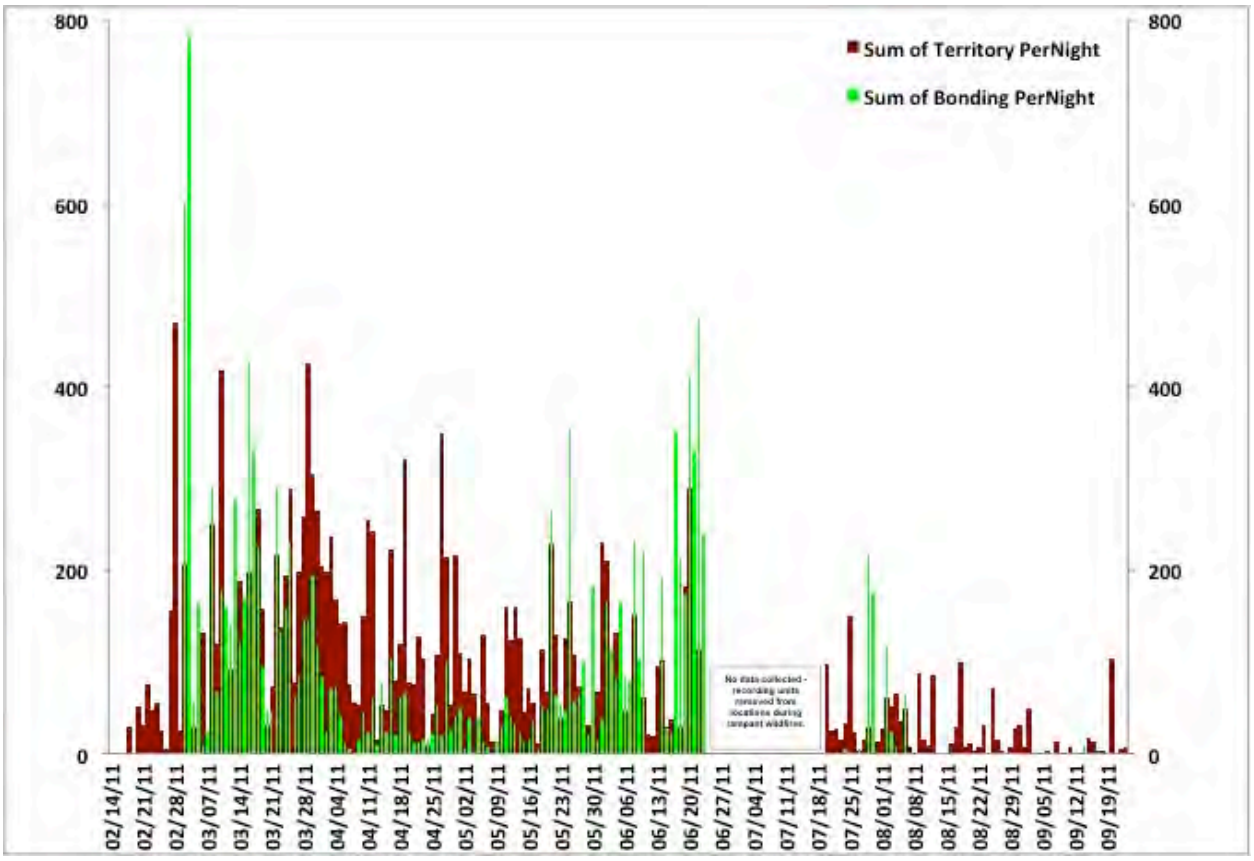

Figure 7. Total territorial and total bonding calls is presented

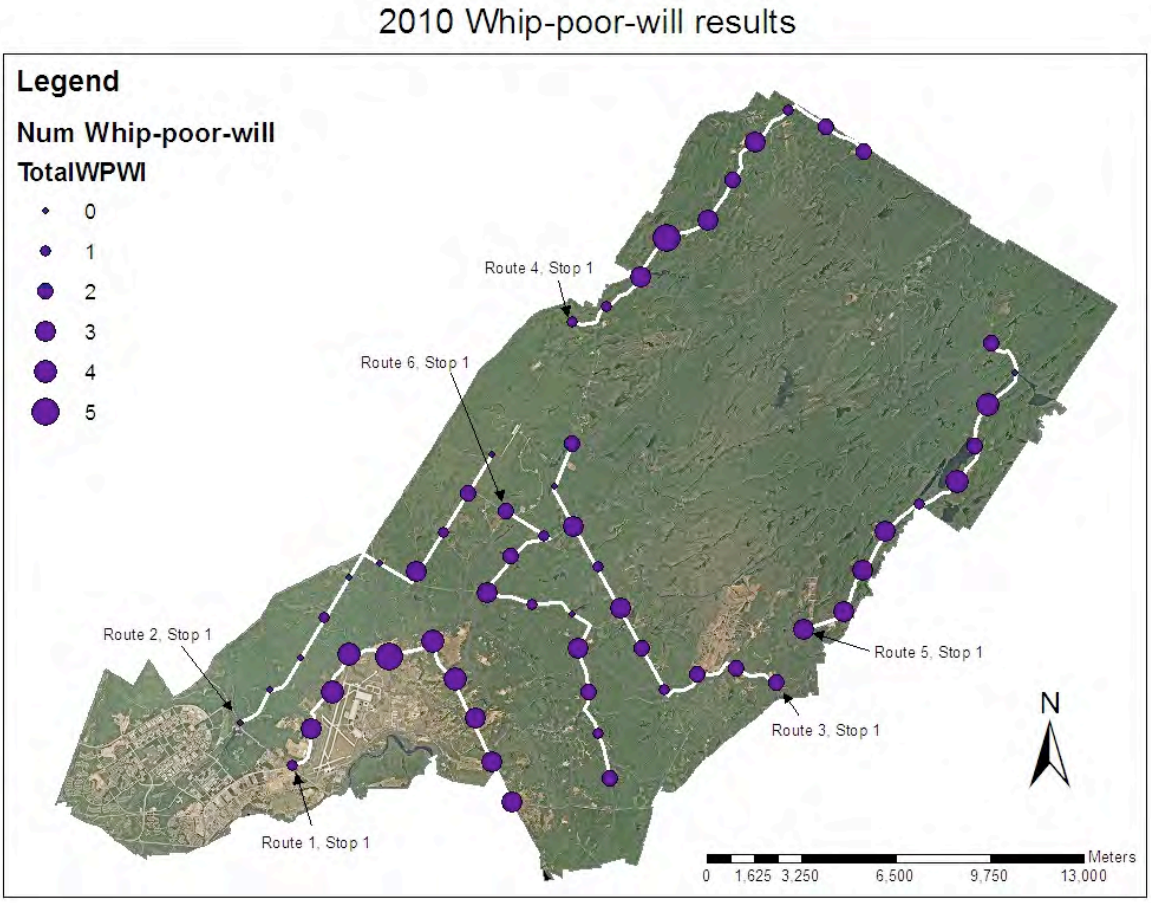

Figure 8. EWPW recording unit locations at Ft Drum, 2011.

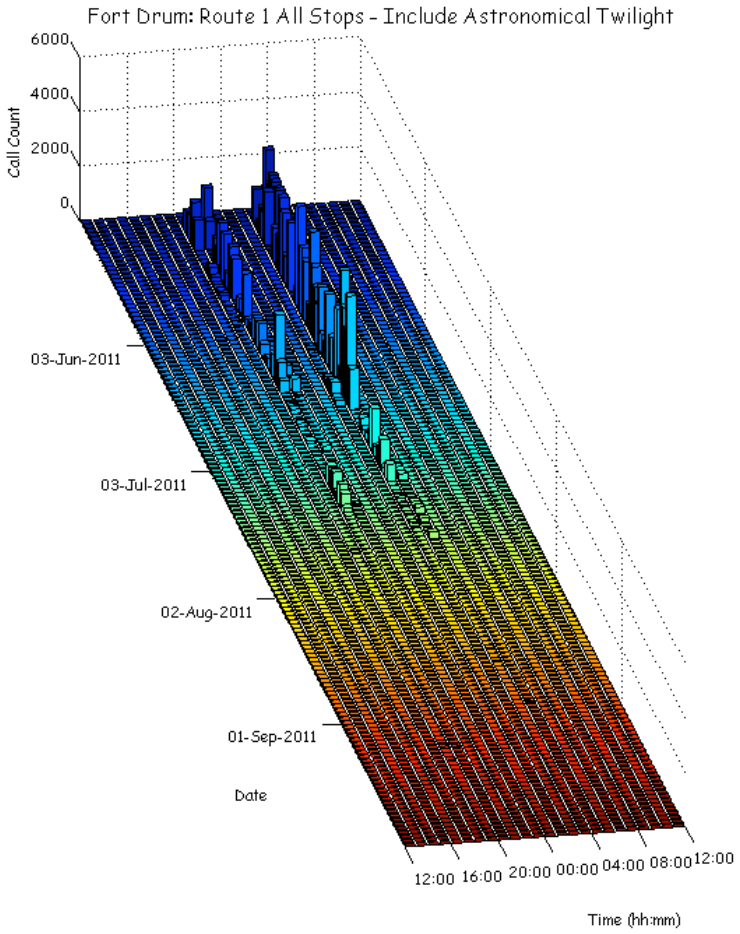

Figure 9. Call counts for EWPW at Ft Drum, all stops on Route 1, at astronomical twilight.

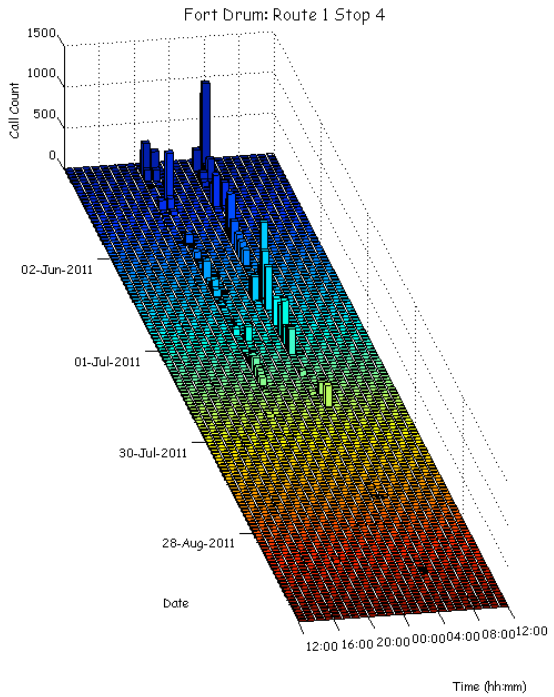

Figure 10a. Call counts for EWPW at Ft Drum, stop 4, Route 1, at astronomical twilight.

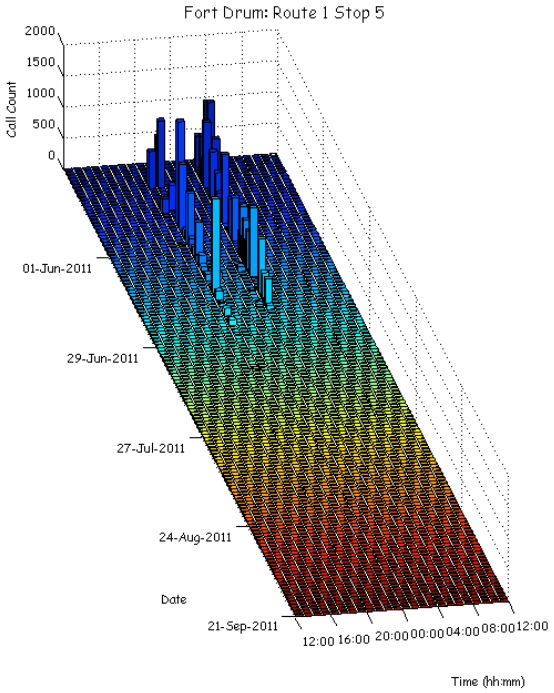

Figure 10b. Call counts for EWPW at Ft Drum, stop 5, Route 1, at astronomical twilight.

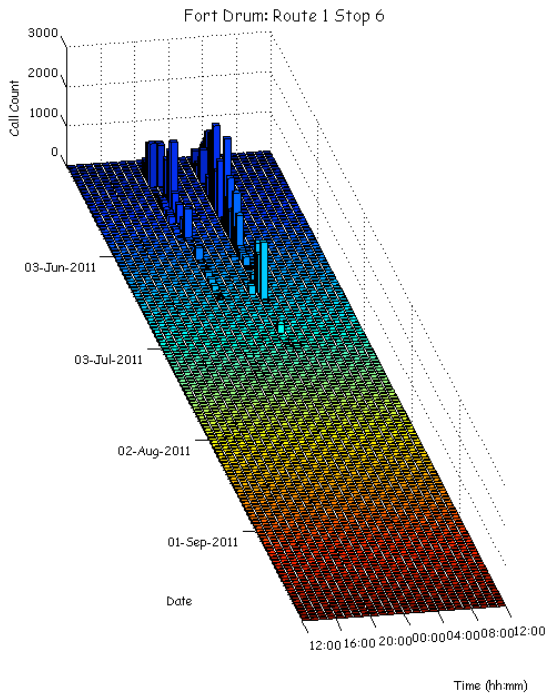

Figure 10c. Call counts for EWPW at Ft Drum, stop 6, Route 1, at astronomical twilight.

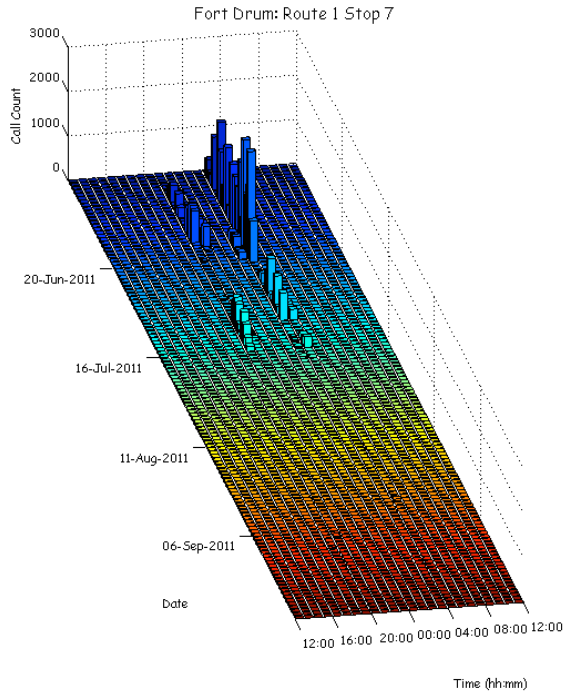

Figure 10d. Call counts for EWPW at Ft Drum, stop 7, Route 1, at astronomical twilight.

Appendix 1. Transition plan: quick start instructions for acoustic monitoring

We have chosen a plan for acoustic monitoring that allows for off-the-shelf recording units, web-accessible software downloads, and standardized approaches for displaying data. We suggest the following process for planning a deployment and analyzing data acquire during a deployment.

Location and Hardware Choice

- Choose a location
    - For most target species monitoring we suggest that recording units be strapped 1 - 1.5 meters high on trees away from trails and roads to avoid human interference and minimize the likelihood of rodent interference. Note that nocturnal migration monitoring devices should not be placed in trees, rather in open areas with at least 15-20 meters of open ground surrounding the unit.
    - If possible, housing the cables for any recording unit in tight wire mesh is recommended to avoid rodent-related failures from gnawing on cables.
    - Minimizing background noise is critically important. When possible, try to select locations that are as quiet as possible, removed from anthropogenic noise sources, away from water, high wind, and crickets and orthopteran insects that can pose challenges. Be aware that running water and wetlands alike can pose major challenges for later analysis, from stream sound and amphibians, so avoiding these locations if possible is desired.
- Choose a hardware platform and configure it properly
    - SM2 Song Meters (http://www.wildlifeacoustics.com) are our current unit of choice, as it is off the shelf, portable, field condition hardened, complete with detailed instruction manual, and has received substantial in field-testing from Lab staff. In addition, several Lab staff working on nocturnal flight call monitoring assisted with the development of the microphone configured for use and available from Wildlife Acoustics for the SM2 system.
    - Other ARUs may be acceptable, although at present we cannot recommend any comparably priced and effectively similar systems that are field ready. Cornell Lab of Ornithology is developing a similar but lower priced system that will be smaller and more flexible than current SM2, but this is not slated for deployment until 2015.
    - Programming of the unit for recording depends on the target species. For nocturnal species, we suggest beginning recordings at local sunset and continuing through local sunrise. Programming these units is a simple

task, covered in the SM2 manual: http://www.wildlifeacoustics.com/wp-content/uploads/2011/08/SM2plus1.pdf.

- For battery power, we suggest that deployed units are serviced with new batteries approximately every three weeks, inserting fresh SD cards during these visits. Deployments that are more difficult to access on a regular basis can use an external, longer-lasting power supply of D cells that set on the ground under the recording unit.
- We suggest that all recording units write WAV files to 32GB SD cards.
- We suggest that all recording devices have at least 128GB of memory (for example, in and SM2, this is 4, 32GB SD cards).

Deployment, Notes, Troubleshooting of the SM2

- All commands and current status updates will appear in the LCD.
- DO NOT remove the 2AA clock batteries.
- Internal batteries to be used are 4 D-batteries (alkaline are preferred, but fully charged rechargeable batteries can be used). They are a tight fit, and may need to be rotated or spun in place for a good connection.
- If for some reason you are still not getting power, check the “Power Selection Jumper” and make sure that the jumper is in the lower two pins as this is the internal battery setting.

All you should need is an appropriate-sized screwdriver, either a large flat- or Phillips-head to open the SM2 unit. If you use a Phillips-head for the unit you will need a second flat-head screwdriver to open/close the plumber collars (if you use the attachment piece). Everything else should be able to be handled without additional tools. Each unit should be programmed with the lat/longs of each location (used for looking up sunrise/sunset times), as well as the name of the location, which will be included on the file names.

The Equipment

The microphones are from Wildlife Acoustics, Inc. They are a flat plate made of Plexiglas, roughly 14"x14", with the microphone in the middle. The plate has two bolts with wing-nuts attached, and these allow attachment to an L-bracket for mounting to a post, pole etc. The mic element is waterproof, but if placed in standing water the water will eventually migrate across the membrane.

The SM2 recording unit is also from Wildlife Acoustics, Inc. When you open it you'll find a series of jumpers for filtering and adjusting gain, four slots that SD cards to store recordings, an LCD screen that displays information and allows programming the unit, and a battery tray.

Deploying

The internal clock is set to CST (GMT -06). We always use standard time, so if you're in an area that recognizes Daylight Savings Time the unit's internal clock will be one hour behind any other your time piece (cell phone, wrist watch, GPS, etc). The unit is programmed with a recording schedule that will begin recording 30 minutes after local sunset and to stop recording 30 minutes before local sunrise.

To successfully deploy the recording units: Select a site for the microphone, ideally a quiet location with a broad, open view of the sky (that is, away from trees, shrubs, tall grass, insect noise, anthropogenic sounds such as cars, voices, dogs barking). You can lay the unit flat on a rooftop, so long as there aren't any mechanical noises that will be introduced (e.g., vents, fans) and the mic is place such that it will not end up sitting in a pool of water. If that's not an option, hammering a stake or post in the ground and attaching the mic by the plumber collar or the bracket directly works well.

NOTE: the microphone, placed in the wire "cage" and surrounded by foam, should be pointing up towards the sky! It may seem counter-intuitive to expose it to the weather, but placing it below the plate (pointing towards the ground) will yield recordings of surface-dwelling insects, not birds on migration.

Once the microphone is in place, open the SM2 unit using an appropriate-sized flat-head or Phillips-head screwdriver. Please be careful not to use too much force: it is unnecessarily easy to strip the plastic screws!

Next, insert four D-cell batteries into the battery tray. Please note:

* The battery trays are tight, and therefore you may need to apply some force to get the batteries into the tray. PLEASE BE CAREFUL doing this: I broke two of the slots while inserting batteries this season.

* The unit should turn on once power is achieved (the final battery is in, you shouldn't need to push the "WAKE/EXIT" button to power it up, but try pushing it if power does not come on automatically). When the unit powers up you'll notice the LCD screen displaying a start-up sequence during which the unit will scan the card slots and display the space available on any cards found, along with the current date and time. PLEASE NOTE: we have found the batteries often need to be "massaged" into place to ensure they are making connection. If the screen does not come alive once the batteries are in place, try twirling the batteries in the compartment to ensure they make a connection. Oftentimes I have found the batteries are noticeably separated from one another, so sliding them back and forth so they make contact may be necessary. Pay close attention to the spaces between the spring and the negative end of the first

battery, between the two batteries, and between the positive end of the second battery and the tray. Take them out and re-insert them if necessary.

Next, insert the SD cards. The unit will scan each card to determine available space; the LCD screen will display the results for each card. Once complete, press the “WAKE/EXIT” button (up and to the left from the LCD screen). The screen should display that the unit is “going to sleep,” and also the date/time of the next recording session (30 minutes post sunset on the current date). If correct, you can close the unit and attach the microphone.

Place the lid on top with the small, opaque plastic "window" (looks like a transparent button) in the upper right quadrant. (This window will blink every few seconds while recording.) Please be careful when tightening the plastic screws, they can strip awfully easily with too much force.

The microphone attaches via a three-pin connector, and it's imperative the cable is connected to the correct port on the SM2. The units are programmed to record only to the left-channel ("mono-L"). This port is on the left side of the unit, meaning your left as you look down into the unit with the LCD screen at the top and battery tray at the bottom. There are two black plugs available on that side, the one adjacent to the battery tray is for external power (which we're not using this time), the plug adjacent to the jumpers and pins is the microphone port. Unscrew and remove the protective cap that should be on the microphone port, then attach the mic's cable and secure it by screwing it on. Please save the cap to protect the port after the mic is removed following the deployment. (NOTE: you can view a labeled diagram in the user manual if necessary to see where the mic ports are).

This is a basic outline of what must be done to operate these units for recording in the field.

1. **First** place four 32GB SD cards (these are provided with each unit) and place one card in each.
2. In order to deploy these units, you will need **4 size D batteries**. Place the batteries into the unit.
3. Once the batteries are in place and there is a good connection, the LCD display will register and the unit will read the size of available space for each SD card in each slot of the unit. (The LCD should read “A: 32GB, B: 32GB, C: 32GB, D: 32GB”) – If for some reason this is not what it says or does not load, just press the “Reset” button in the upper right corner.
4. Once you place the batteries in and see the beginning LCD screen with SD card size, press the “Select” button, then press the “Down” button until you get to the “Utilities”, then press select. At this screen press select

again on the option “Go to sleep.” Once the LCD screen turns off, you can seal it back up and deploy the unit in the field without worry of the unit recording inadvertently.

5. Once in the field, **attach the microphone/s** then open the unit again and press the “Wake/Exit” button. It should start up again and display the size of the SD cards again. Any announcement recording (the “Indicator LED” will be blinking if it is recording) should include at the very minimum, **date, time, name of deployment person, GPS location, local name for the location, and the unit’s serial number** located on the label of each unit. In addition, you may want to give additional information on the local habitat and conditions of the surrounding area (things like sloughs, maybe close to areas where ducks are located, maybe pigs, etc). Pending numerous factors you can consider 100m as a rough estimate of bird song recording range.
6. It is recommended that the unit be watched to make sure the words “will go to sleep until XXX” where XXX is the date and time of the first recording the NEXT morning (roughly 30 minutes before sunrise).

- Data management, access, and storage
    - Raven software can be downloaded from the Cornell Lab of Ornithology at http://www.birds.cornell.edu/brp/raven/ravenoverview.html. The latest version of the software is available here, as is a manual that is detailed and comprehensive.
    - We suggest that current operating systems are best for storage, management, and analysis of data and be used for all sound analysis with Raven. Macintosh and Windows are both acceptable and can run Raven software.
    - Ideally, a system with at least 4 TB of memory for storage is ideal.
    - We suggest that at least 2-3 external drives that are 2-3 TB each would be ideal.
    - We suggest that data be removed from memory cards as quickly as possible and stored in two places at least: a computer’s local drive for easy sound analysis and on a separate hard drive as back up, preferably in a different location.
- Review and analysis of data
    - Raven software is easy to use. We suggest opening audio files in 10-20 second pages using the default window settings as a guide.

Hann 256 samples	Hop Size 20 samples	Contrast 71
3 dB filter	DFT 256 samples	Window Length 6-15
Bandwidth 135 Hz	Grid spacing 93.8 Hz sec	
Overlap 92.2 %	Brightness 43	

- Detector settings will vary by species and by application, but we suggest using the following as a guide. The Lab is happy to provide additional current presets and instructions for operating presets as well:

Target Signal	Signal-to-Noise Ratio	Noise Power Estimation
Frequency 600-1400Hz	Min. Occupancy 20%	Block Size 998 ms
Duration 21.7-603 ms	SNR Threshold 5.0dB	Hop Size 250.8 ms
Separation 21.7 ms		Percentile 50

- Additional details for this methodology can be found in previous Legacy Final Project Reports for 05-245, 06-245, and 07-245 (posted on www.denix.osd.mil, Natural Resources program tab), as well as Charif et al. (2010).
- We do not suggest using XBAT for analysis, given the expense of MATLAB platforms and the challenges of using the software. However, note the following if interested in the software: XBAT R6 is an open-source extensible sound analysis application and MATLAB platform for developing sound analysis tools. It has been developed primarily for research support of the Cornell Bioacoustics Research Program (BRP) through on-going interaction with conservation scientists and animal communication researchers. XBAT R6 was designed to satisfy the diverse sound analysis needs of scientists who deal with large-scale data sets from both marine and terrestrial environments. The current release of XBATR6 will continue to be made available in the hope that it will be useful to acoustic researchers. However, our lab's resources are limited and we cannot provide support for XBATR6 at this time. The xbat.org web site is owned and operated by an external organization is not affiliated in any way with Cornell University.

- Reporting of data
  - We suggest that all target species acoustic monitoring results be reported in vocalizations per unit time. This is a standard for comparison, and reporting data as such is straightforward 1) using a basic Excel spreadsheet for calculating date and time, or 2) using an upcoming release of Raven that contains all date and time information in a data file associated with the detections.

Site	Recordings begin	Recordings end	Nights unit was in field	Total nights accounted for	Total Recordings, pre-fire	Hours recorded, pre-fire	Total Recordings, post-fire	Hours recorded, post-fire	Total number of recordings	Total number of hours recorded
Lower Huachuca 01	14-Feb	11-Sep	209	209	127	1397:06:44	47	504:59:00	174	1902:05:44
Lower Huachuca 02	14-Feb	12-Aug	179	179	111	1237:50:46	20	206:45:00	131	1444:35:46
Lower Huachuca 03	14-Feb	10-Sep	208	208	119	1328:05:26	45	482:50:00	164	1810:55:26
Scheelite 01	14-Feb	24-Sep	222	222	123	1367:54:27	58	632:19:00	181	2000:13:27
Scheelite 02	15-Feb	17-Jun	122	122	122	1355:04:41	0	0:00:00	122	1355:04:41
Rock Springs 01	16-Feb	22-Jun	126	126	118	1310:44:48	0	0:00:00	118	1310:44:48
Rock Springs 02	16-Feb	21-Jun	125	125	116	1288:18:56	0	0:00:00	116	1288:18:56
Cave Springs	10-Jun	11-Aug	62	62	30	295:30:00	22	227:17:00	52	522:47:00
McClure Canyon	20-Jul	7-Aug	18	18	0	0:00:00	18	184:54:00	18	184:54:00
	Total Deployments	**Unique Protected Activity Centers (PACs)**								
Total effort:	**9**	**5**	**1271**	**1271**	**866**	**9580:35:48**	**210**	**2239:04:00**	**1076**	**11819:39:48**

Total nights missing, pre-fire, technical	Total nights missing, post-fire, technical	Total nights missing, technical	Total nights missing, fire	Total nights missing, deployment	SM2#	Unit Removed	Redeployment Date	dd or UTM Easting	dd or UTM Northing	SPOW Detected?
3	7	10	25	35	3340	6/24/2011& 10/13/2011	7/22/11	110.39001	31.51095	Yes
19	4	23	25	48	3322	6/24/2011 & 10/5/2011	7/22/11	110.39120	31.51160	Yes
11	8	19	25	44	3657	6/24/2011 & 10/5/2011	7/22/11	110.39177	31.51211	Yes
0	8	8	33	41	3325	6/17/2011 & 10/12/2011	7/20/11	110.35364	31.45895	Yes
0	NA	0	NA	0	3691	6/17/11	-	110.35398	31.46053	Yes
8	NA	8	NA	8	3324	6/22/11		110.37363	31.50315	Yes
9	NA	9	NA	9	3695	6/22/11		110.37222	31.50543	Yes
0	0	0	10	10	3653	9/7/11		110.21963	31.29051	No
NA	0	0	0	0	3695	11/2/11		558644.00000	3482925.00000	Yes
50	**27**	**77**	**118**	**195**						

Site	Recordings begin	Recordings end	February	March	April	May	June	July	August	September
Lower Huachuca 01	14-Feb	11-Sep					11-13, 24-30	1-21	15-17	
Lower Huachuca 02	14-Feb	12-Aug			4-11		3-13, 24-30	1-21		
Lower Huachuca 03	14-Feb	10-Sep					3-13, 24-30	1-21	14-17	
Scheelite 01	14-Feb	24-Sep				17-30	1-19		13-15	4-8
Scheelite 02	15-Feb	17-Jun								
Rock Springs 01	16-Feb	22-Jun				19-26				
Rock Springs 02	16-Feb	21-Jun	25			19-26				
Cave Springs	10-Jun	11-Aug					10-19			
McClure Canyon	20-Jul	7-Aug								

Date of Site Visit	Completed by	Place Name	SM2#	Deployment ID	SPOW Detected
2/20/11	DB	Huachuca Canyon	3340	FTHUA01	N
2/20/11	DB	Huachuca Canyon	3322	FTHUA02	N
2/20/11	DB	Huachuca Canyon	3657	FTHUA03	N
2/24/11	SS	Scheelite	3325	SCHE01	N
2/24/11	SS	Scheelite	3691	SCHE02	N
2/25/11	SS	Rock Spring	3324	ROSP01	N
2/25/11	SS	Rock Spring	3695	ROSP02	N
2/28/11	BMP	Huachuca Canyon	3340	FTHUA01	N
2/28/11	BMP	Huachuca Canyon	3322	FTHUA02	N
2/28/11	BMP	Huachuca Canyon	3657	FTHUA03	N
3/2/11	DB	Scheelite	3325	SCHE01	N
3/2/11	DB	Scheelite	3691	SCHE02	N
3/4/11	SS	Rock Spring	3324	ROSP01	N
3/4/11	SS	Rock Spring	3695	ROSP02	N
3/7/11	BMP	Huachuca Canyon	3340	FTHUA01	N
3/7/11	BMP	Huachuca Canyon	3322	FTHUA02	N
3/7/11	BMP	Huachuca Canyon	3657	FTHUA03	N
3/11/11	DB	Scheelite	3325	SCHE01	**Y**
3/11/11	DB	Scheelite	3691	SCHE02	**Y**
3/14/11	BMP	Huachuca Canyon	3340	FTHUA01	N
3/14/11	BMP	Huachuca Canyon	3322	FTHUA02	N
3/14/11	BMP	Huachuca Canyon	3657	FTHUA03	N
3/14/11	SS	Rock Spring	3324	ROSP01	N
3/14/11	SS	Rock Spring	3695	ROSP02	N
3/21/11	DB	Scheelite	3325	SCHE01	N
3/21/11	DB	Scheelite	3691	SCHE02	N
3/23/11	BMP	Huachuca Canyon	3340	FTHUA01	N
3/23/11	BMP	Huachuca Canyon	3322	FTHUA02	N
3/23/11	BMP	Huachuca Canyon	3657	FTHUA03	N
3/28/11	SS	Rock Spring	3324	ROSP01	N
3/28/11	SS	Rock Spring	3695	ROSP02	N
4/1/11	DB	Scheelite	3325	SCHE01	N
4/1/11	DB	Scheelite	3691	SCHE02	N
4/4/11	BMP	Huachuca Canyon	3340	FTHUA01	N
4/4/11	BMP	Huachuca Canyon	3322	FTHUA02	N
4/4/11	BMP	Huachuca Canyon	3657	FTHUA03	N
4/8/11	SS	Rock Spring	3324	ROSP01	N
4/8/11	SS	Rock Spring	3695	ROSP02	N
4/12/11	DB	Scheelite	3325	SCHE01	N
4/12/11	DB	Scheelite	3691	SCHE02	N
4/12/11	BMP	Huachuca Canyon	3340	FTHUA01	N
4/12/11	BMP	Huachuca Canyon	3322	FTHUA02	N
4/12/11	BMP	Huachuca Canyon	3657	FTHUA03	N
4/25/11	SS	Rock Spring	3324	ROSP01	N
4/25/11	SS	Rock Spring	3695	ROSP02	N
4/29/11	BMP	Huachuca Canyon	3340	FTHUA01	N
4/29/11	BMP	Huachuca Canyon	3322	FTHUA02	N
4/29/11	BMP	Huachuca Canyon	3657	FTHUA03	N
5/2/11	DB	Scheelite	3325	SCHE01	Y
5/2/11	DB	Scheelite	3691	SCHE02	Y
5/18/11	DB	Scheelite	3325	SCHE01	N
5/18/11	DB	Scheelite	3691	SCHE02	N
5/25/11	BMP	Huachuca Canyon	3340	FTHUA01	N
5/25/11	BMP	Huachuca Canyon	3322	FTHUA02	N
5/25/11	BMP	Huachuca Canyon	3657	FTHUA03	N
5/27/11	DB	Rock Spring	3324	ROSP01	N
5/27/11	DB	Rock Spring	3695	ROSP02	N
6/9/11	DB	Scheelite	3325	SCHE01	N
6/9/11	DB	Scheelite	3691	SCHE02	N
6/14/11	DB	Huachuca Canyon	3340	FTHUA01	N
6/14/11	DB	Huachuca Canyon	3322	FTHUA02	N
6/14/11	DB	Huachuca Canyon	3657	FTHUA03	N
6/22/11	DB/SS	Rock Spring	3324	ROSP01	N
6/22/11	DB/SS	Rock Spring	3695	ROSP02	N
6/24/11	BMP	Huachuca Canyon	3340	FTHUA01	N
6/24/11	BMP	Huachuca Canyon	3322	FTHUA 02	N
6/24/11	BMP	Huachuca Canyon	3657	FTHUA03	N
7/22/11	DB	Huachuca Canyon	3340	FTHUA01	N
7/22/11	DB	Huachuca Canyon	3322	FTHUA 02	N
7/22/11	DB	Huachuca Canyon	3657	FTHUA03	N
6/10/21011	DB, BP	Cave Spring	3653	CAVSPR	N
6/17.2011	DB	Cave Spring	3653	CAVSPR	N
6/17/11	DB	Scheelite	3325	SCHE01	N
6/17/11	DB	Scheelite	3691	SCHE02	N
6/24/11	BP	Huachuca Canyon	3340	FTHUA01	N
6/24/11	BP	Huachuca Canyon	3322	FTHUA02	N
6/24/11	BP	Huachuca Canyon	3657	FTHUA03	N
7/20/11	DB	Cave Spring	3653	CAVSPR	N
7/20/11	DB	McClure	3695	MCCL01	Y
7/20/11	DB	Scheelite	3325	SCHE01	N
8/16/11	DB	Scheelite	3325	SCHE01	N
8/18/11	BMP	Huachuca Canyon	3340	FTHUA 01	N
8/18/11	BMP	Huachuca Canyon	3322	FTHUA 02	N
8/18/11	BMP	Huachuca Canyon	3657	FTHUA 03	N
9/7/11	DB	McClure	3695	MCCL01	Y
9/7/11	DB	Cave Spring	3653	CAVSPR	N
10/5/11	SS	Huachuca Canyon	3340	FTHUA 01	N
10/5/11	SS	Huachuca Canyon	3322	FTHUA 02	N
10/5/11	SS	Huachuca Canyon	3657	FTHUA 02	N
10/12/11	DB	Scheelite	3325	SCHE01	N
10/13/11	DB	Huachuca Canyon	3340	FTHUA 01	N
11/2/11	DB	McClure	3695	MCCL01	N

Notes
Card 1A @ 41%. Site & Unit undamaged
Card 2A @ 41%. Site & Unit undamaged
Card 3A @ 41%. Site undamaged; Chip off left lower prong of Slot B when putting card in.
Card 4B @ ?%. Site & Unit undamaged
Card 5A @ ?%. Site & Unit undamaged
Card 6A @ 61%. Site undamaged.
Card 7A @ ?%. Site undamaged. No LED flashes seen.
Card 2C @ 54%. Site and Unit undamaged. Ravens seen and heard
Card 3C @ 54%. Site and unit undamaged
Card 1C @ 54%. Site and unit undamaged. Ravens seen and heard. Two white-tailed deer seem.
Card 4A @ 47%. Site & Unit undamaged. Single card left in unit.
Card 5C @ 40%. Site & Unit undamaged. Single card left in unit.
Card 6B @ 46%. Site undamaged. No LED flashes seen.
Card 7B @ 40%. Site undamaged. No LED flashes seen.
Card 1B @ 46%. Site and unit undamaged. Very windy
Card 2B @ 46%. Site and unit undamaged.
Card 3B @ 46%. Site and unit undamaged.
Lone MSO roosting below lower unit. Card 4C @ 59% replaced with Card 8B. Site & Unit undamaged. Single card left in unit.
Lone MSO. Card 5B @ 59% replaced with Card 8A . Site & Unit undamaged. Single card left in unit.
Card 1D @ 45%. Site and unit undamaged.
Card 2D @ 45%. Site and unit undamaged.
Card 3D @ 45%. Site and unit undamaged.
Card 6C @ 65%. Unit undisturbed.
Card 7C @ 65%. Unit undisturbed.
Card AHFinal @ 64%; replaced with card 8 (?). Bad batteries retrieved from office; and put in this unit. Should re-visit sooner than normal. Plan to re-visit next Monday. Unit undisturbed. (*Appears to be a mistake in my card identification on*
Card 8A @ 64%; replaced with Card 8C. Unit undisturbed.
Card (no identifying code) @ 57%; relpaced with Card 5A. Unit in good condition.
Card (no identifying code) @ 57%; relpaced with Card 6A. Unit in good condition.
Card B @ 57%; replaced with card 7A. Unit in good condition.
Card 6D @ 88%. Replaced with card 3A in slot A & card 3B in slot B. Unit undisturbed.
Card 7D @ 88%. Replaced with card 4A in slot A & card 4B in slot B. Unit undisturbed.
Card AHFinal @ 68%; replaced with card 4C & 1D. Batteries still functioning. Unit undisturbed.
Batteries dead upon arrival (strange because VERY old batteries in other unit were still working). Card 8C @ 68%; replaced with Cards2D and 5B. Unit undisturbed.
I did not go to this unit as the batteries that I took into the field were dead so I left the old batteries in. Batteries have already been deployed for 12 days.
Batteries that I took into the field were dead so I tried to put the old batteries back into unit but those also would not work. I spent 45 minutes trying to figure out what was wrong with the unit. Batteries have already been deployed for 12 days.
Batteries that I took into the field were dead so I left the old batteries in. Batteries have already been deployed for 12 days. Card 7A @ 74% and changed out. Unit is good condition. Saw 3 White-tailed deer.
Card 3A @ 67%. Replaced with card 6C in slot A & card 3B in slot B. Unit undisturbed.
Card 4A @ 67%. Replaced with card 4B in slot A & card in slot B. Unit undisturbed.
Card 4C @ 66%; replaced with card 2C. Unit undisturbed. Card 1D 0% used, replaced in slot B.
Card 2D @ 66%; replaced with Card 1C. Unit undisturbed. Card 5B 0% used, replaced in slot B. Single ***Chipmunk*** spotted and observed on way up to unit.
Card 5A from slot A @ 98% used, card 5C from slot B @ 23% used, replaced card in slot A with card 6B. Batteries ran for 21 days. DOWNLOADED 6/1
ARU has been off since 3 March 2011 due to dead batteries. Therefore card 2A was left in slot A @ 0% used.
Card 1B in slot A @ 48% used, replaced with card 7B.
Card 6C @ 94% & card 3B @ 5%. Moved 3B to slot A. Card 3A placed in slot B. Unit undisturbed.
Card 4B @ 94% & card 7C @ 5%. Moved 7C to slot A. Card 7C-1 placed in slot B. Unit undisturbed.
Card 6b @ 99% used. Put card 1A in slot A and card 5A in slot B. DOWNLOADED 6/2
Card 2A @ 99% used. Put card 2B in slot A and card 4D in slot B. DOWNLOADED 6/2
Card 7B @ 99% used. Put card 3C in slot A and card 3D in slot B. DOWNLOADED 6/2
Card 2C @ 99%; replaced with card in slot B (1D). Card 1D @ 17%, replaced with Card 7B in slot B. Unit undisturbed.
Card 1C @ 99%; replaced with Card in slot B (5B). Card 5B @ 17% , replaced with card 2A in slot B. MSO located at WPT #36 @ big Pine site below SM. Unit undisturbed.
Card 1D @ 94%; replaced with card in slot B (7B). Card 7B @ 10%, replaced with Card 8B in slot B. Unit undisturbed. DOWNLOADED 5/31
Card 5B @ 94%; replaced with Card in slot B (2A). Card 2A @ 10% , replaced with card 7A in slot B. Unit undisturbed.
Card 1A from slot A @ 94% used and card 5A from slot B @ 43% used. Put card with no identification label in slot A. Batteries were dead upon my arrival (25 day deployment too long).
Card 2B from slot A @ 94% used and card 4D from slot B @ 43% used. I had to leave card 4D in ARU as the cards I took to the field already had info on them. Batteries were dead upon my arrival (25 day deployment too long).
Card 3C from slot A @ 94% used and card 3D from slot B @ 43% used. I had to leave card 3D in ARU as the cards I took to the field already had info on them. Batteries were dead upon my arrival (25 day deployment too long). Sponge on
Card 3B @ 96% & card 3A @ 43%. Moved 3A to slot A. Card 6C placed in slot B. Unit undisturbed. Batteries were dead. DOWNLOADED 6/1
Card 7C @ 96% & card 7C @ 43%. Moved 7C to slot A. Card 5C placed in slot B. Unit undisturbed. Batteries were dead. DOWNLOADED 6/1
Card 7B @ 96%; replaced with card in slot B (8B). Card 8B @ 31%. Card 4B in slot B. Unit undisturbed. DOWNLOADED 5/31
Card 2A @ 96%; replaced with Card in slot B (7D). Card 7D @ 31% . Card 8A in slot B. Unit undisturbed.
Card 3C from slot A @ 95% used. No card in slot B. Card 6D left in slot A; Card 5B in slot B.
Card 4D from slot A @ 96% used. No card in slot B. Card 4B left in slot A; Card 5D in slot B.
Card 3D from slot A @ 96% used. No card in slot B. Card 3A left in slot A; Card 6A in slot B.
Unit Removed from field due to wildfire threat (Monument fire). MSO feather and sign detected in canyon.
Unit Removed from field due to wildfire threat (Monument fire). MSO feather and sign detected in canyon.
Removed card 6D from slot A @ 52 % used. Unit removed from field due to wildfire potential damage
Removed card 4B from slot A @ 52 % used. Unit removed from field due to wildfire potential damage
Removed card 3A from slot A @ 52 % used. Unit removed from field due to wildfire potential damage
Unit redeployed (wildfire threat). Card 8C @ 10% in slot A; Card 1A @ 0% in slot B.
Unit redeployed (wildfire threat). Card 2D @ 10% in slot A; Card 5C @ 0%in slot B.
Unit redeployed (wildfire threat). Card 5A @ 10% in slot A; Card B7 @ 0% in slot B.
Unit deployed.
Batteries and cards changed in expectation of Monument fire crossing to Fort lands. Card 4A @ 36%. Card 4A replaced with card 7A.
Unit removed from the field in expectation of Monument fire reaching Fort lands.
Unit removed from the field in expectation of Monument fire reaching Fort lands.
Unit Removed from field due to wildfire threat (Monument fire).
Unit Removed from field due to wildfire threat (Monument fire).
Unit Removed from field due to wildfire threat (Monument fire).
Batteries dead. Card 7A @ 96%; Card 9A @ 26%. Card 9A in slot A; Card 8A in slot B.
Unit deployed. Card 1E in slot A; Card 5B in slot B. Adult MSO flew in on descent from installation of ARU.
Unit re-deployed after threat of Monumen fire. Card 5D in slot A; Card 4B in slot B. The second unit was not deployed; to be used in other canyons.
Batteries dead. Card 5D @ 99%. Card 4B at 33%. Card 4B in slot A; Card 6B in slot B.
Changed batteries at 1045hrs; retrieved card from slot A @ 98%; retrieved card 1A from slot B @ 44%; put card 1A in slot A and card 3B in slot B; ARU approximately 20-25 meters off orginal mark
Changed batteries at 1025 hrs; retrieved card 2D from slot A @ 98% and card 5C from slot B @ 22%; put card 2C in slot A and card 7C in slot B; unit had condensation on inside of it- wiped unit out
Changed batteries at 1019 hrs; retrieved card 5A from slot A @ 98% and card 37 from slot B @ 39%; put card in slot A and card in slot B; unit in good condition
Batteries dead. Card 1E @ 99%; Card 5B @ 45%. Card 5B in Slot A; Card 3A in slot B. Adult male and female MSO detected @ WPT #118. Female flew in; unsure if male flew in or already there.
Unit removed. Microphone on ground and padded end missing. ARU hanging by one bungee with hooked ends stretched. No microphone backup so had to remove. Card 9A @ 97%; Card 8A @ 50%
Not found
Batteries dead & microphone missing. Retrieved ARU. Removed card 2C from slot A & card 7C from slot B. Water inside case & condensation on batteries & some other surfaces.
Batteries dead. Retrieved ARU. Removed card 5A from slot A & card 5B from slot B.
Removed unit from field. Batteries dead. Moisture on batteries and a little water in box. Card 6B in slot A; Card 1B in slot B
Removed unit from field. Batteries dead. Card 1A in slot A; Card 3B in slot B.
Batteries dead. Card 5B @ 99%; Card 3A @ 45%. ARU removed from the field. Noted one area with abundant sign of MSO, but no MSO observed in area.

HourBin	AllStations	FTHUA01	FTHUA02	FTHUA03	SCHEE01	SCHEE02	ROSPR01	ROSPR02	MCCLU01	CAVSP01
0	7911	3782	845	824	1076	1077	0	11	296	0
1	2500	931	273	301	573	416	0	0	6	0
2	852	230	151	154	155	160	0	0	2	0
3	1118	280	138	205	139	256	0	0	100	0
4	1129	221	181	207	193	251	3	0	73	0
5	1697	563	153	184	209	583	0	0	5	0
6	1549	727	181	154	304	174	0	0	9	0
7	1481	606	129	137	264	220	0	0	125	0
8	1319	447	85	96	333	316	4	0	38	0
9	6242	3777	628	418	761	326	1	0	331	0
10	2235	818	196	230	403	407	0	0	181	0
11	2963	1449	449	327	263	474	0	1	0	0
12	230	177	44	9	0	0	0	0	0	0
Totals	31226	14008	3453	3246	4673	4660	8	12	1166	0

HourBin	ACC	ALC	BS	CC	CHI	COO	FLC	JBC	NC	SLC	SPOW	Territory	Bonding
	Territory	Territory	Territory	Bonding	Bonding	Bonding	Territory	Bonding	Bonding	Territory			
0	40	235	570	1728	2	23	2591	182	1265	1043	232	4479	3200
1	117	169	133	613	1	5	1133	14	130	129	56	1681	763
2	1	26	18	80	0	1	542	2	88	59	35	646	171
3	4	74	19	129	0	0	622	0	159	40	71	759	288
4	9	42	1	174	0	0	669	7	161	20	46	741	342
5	20	130	38	345	0	9	633	3	223	238	58	1059	580
6	34	105	76	417	0	17	640	136	36	52	36	907	606
7	15	132	43	460	0	12	540	47	18	175	39	905	537
8	5	101	3	348	0	17	680	24	65	53	23	842	454
9	83	329	190	2774	0	40	1468	365	376	420	197	2490	3555
10	14	290	21	381	1	15	847	0	352	211	103	1383	749
11	12	336	26	1010	4	16	693	0	573	57	236	1124	1603
12	0	0	10	66	1	0	22	0	98	0	33	32	165
Totals	354	1969	1148	8525	9	155	11080	780	3544	2497	1165	17048	13013

Location	FTHUA01	FTHUA012	FTHUA013	FTHUA014	FTHUA015	FTHUA016	FTHUA017	FTHUA018	FTHUA019	FTHUA0110	FTHUA0111	FTHUA02	FTHUA0212	FTHUA0213
HourBin	Territory	Territory	Territory	Bonding	Bonding	Bonding	Territory	Bonding	Bonding	Territory		Territory	Territory	Territory
CallType	ACC	ALC	BS	CC	CHI	COO	FLC	JBC	NC	SLC	SPOW	ACC	ALC	BS
0	40	102	220	1399	2	23	424	181	976	377	38	0	27	153
1	105	63	55	399	1	0	154	14	125	5	10	0	18	33
2	1	8	9	69	0	1	76	2	46	13	5	0	2	7
3	4	30	19	86	0	0	84	0	47	3	7	0	22	0
4	9	13	0	105	0	0	61	7	18	2	6	0	5	0
5	20	49	35	314	0	6	68	3	53	14	1	0	35	1
6	25	38	26	368	0	17	83	136	13	21	0	9	29	25
7	4	45	3	391	0	12	70	47	10	20	4	0	27	20
8	5	29	1	290	0	8	56	24	20	8	6	0	9	0
9	83	143	74	2564	0	33	228	365	117	109	61	0	62	93
10	14	117	16	335	0	10	142	0	162	12	10	0	42	1
11	1	147	3	545	0	9	183	0	520	14	27	0	84	13
12	0	0	0	66	0	0	12	0	98	0	1	0	0	10
Total	311	784	461	6931	3	119	1641	779	2205	598	176	9	362	356

FTHUA0214	FTHUA0215	FTHUA0216	FTHUA0217	FTHUA0218	FTHUA0219	FTHUA0220	FTHUA0221	FTHUA03	FTHUA0322	FTHUA0323	FTHUA0324	FTHUA0325	FTHUA0326	FTHUA0327
Bonding	Bonding	Bonding	Territory	Bonding	Bonding	Territory		Territory	Territory	Territory	Bonding	Bonding	Bonding	Territory
CC	CHI	COO	FLC	JBC	NC	SLC	SPOW	ACC	ALC	BS	CC	CHI	COO	FLC
47	0	0	313	1	1	245	58	0	32	117	22	0	0	307
49	0	0	153	0	0	9	11	0	37	25	28	0	0	180
1	0	0	118	0	0	14	9	0	3	0	0	0	0	127
5	0	0	97	0	0	3	11	0	10	0	1	0	0	164
7	0	0	145	0	0	11	13	0	7	0	2	0	0	172
5	0	0	88	0	0	8	16	0	28	0	0	0	0	132
16	0	0	64	0	0	22	16	0	32	25	3	0	0	73
4	0	0	51	0	0	15	12	0	38	20	0	0	0	52
7	0	0	48	0	0	17	4	0	18	1	5	0	0	53
95	0	0	172	0	3	150	53	0	72	17	14	0	0	175
20	0	0	91	0	0	22	20	0	77	0	5	0	0	87
7	2	0	166	0	0	34	143	0	94	9	6	0	0	152
0	1	0	5	0	0	0	28	0	0	0	0	0	0	5
263	3	0	1511	1	4	550	394	0	448	214	86	0	0	1679

FTHUA0328	FTHUA0329	FTHUA0330	FTHUA0331	SCHEE01	SCHEE0132	SCHEE0133	SCHEE0134	SCHEE0135	SCHEE0136	SCHEE0137	SCHEE0138	SCHEE0139	SCHEE0140	SCHEE0141
Bonding	Bonding	Territory		Territory	Territory	Territory	Bonding	Bonding	Bonding	Territory	Bonding	Bonding	Territory	
JBC	NC	SLC	SPOW	ACC	ALC	BS	CC	CHI	COO	FLC	JBC	NC	SLC	SPOW
0	8	251	87	0	20	49	116	0	0	707	0	24	120	40
0	0	5	26	0	8	17	68	0	0	369	0	0	109	2
0	2	13	9	0	0	0	0	0	0	128	0	0	18	9
0	0	3	27	0	0	0	0	0	0	118	0	1	0	20
0	4	3	19	0	2	0	5	0	0	169	0	9	0	8
0	0	7	17	0	3	0	0	0	0	185	0	0	3	18
0	0	9	12	0	4	0	6	0	0	277	0	9	0	8
0	0	18	9	11	0	0	35	0	0	210	0	0	0	8
0	0	14	5	0	4	0	0	0	0	324	0	1	0	4
0	3	88	49	0	5	2	96	0	0	566	0	6	65	21
0	2	15	44	0	8	4	6	0	0	248	0	14	107	16
0	12	9	45	11	4	0	86	0	0	116	0	35	0	11
0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
0	31	435	353	22	58	72	418	0	0	3417	0	99	422	165

SCHEE02	SCHEE0242	SCHEE0243	SCHEE0244	SCHEE0245	SCHEE0246	SCHEE0247	SCHEE0248	SCHEE0249	SCHEE0250	SCHEE0251	ROSPR01	ROSPR0152	ROSPR0153	ROSPR0154
Territory	Territory	Territory	Bonding	Bonding	Bonding	Territory	Bonding	Bonding	Territory		Territory	Territory	Territory	Bonding
ACC	ALC	BS	CC	CHI	COO	FLC	JBC	NC	SLC	SPOW	ACC	ALC	BS	CC
0	54	31	144	0	0	674	0	131	34	9	0	0	0	0
12	43	3	69	0	5	271	0	5	1	7	0	0	0	0
0	13	2	10	0	0	91	0	40	1	3	0	0	0	0
0	12	0	37	0	0	148	0	31	25	3	0	0	0	0
0	15	1	55	0	0	112	0	68	0	0	0	0	0	0
0	15	2	26	0	3	155	0	170	206	6	0	0	0	0
0	2	0	24	0	0	134	0	14	0	0	0	0	0	0
0	22	0	30	0	0	145	0	8	9	6	0	0	0	0
0	41	1	46	0	9	170	0	44	1	4	0	0	0	0
0	47	4	5	0	7	215	0	28	8	12	0	0	0	0
0	46	0	15	1	5	249	0	49	29	13	0	0	0	0
0	7	1	366	2	7	75	0	6	0	10	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	317	45	827	3	36	2439	0	594	314	73	0	0	0	0

ROSPR0155	ROSPR0156	ROSPR0157	ROSPR0158	ROSPR0159	ROSPR0160	ROSPR0161	ROSPR02	ROSPR0262	ROSPR0263	ROSPR0264	ROSPR0265	ROSPR0266	ROSPR0267	ROSPR0268
Bonding	Bonding	Territory	Bonding	Bonding	Territory		Territory	Territory	Territory	Bonding	Bonding	Bonding	Territory	Bonding
CHI	COO	FLC	JBC	NC	SLC	SPOW	ACC	ALC	BS	CC	CHI	COO	FLC	JBC
0	0	0	0	0	0	0	0	0	0	0	0	0	11	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	8	0	0	0	0	0	0	0	0	0	0	12	0

ROSPR0269	ROSPR0270	ROSPR0271	MCCLU01	MCCLU0172	MCCLU0173	MCCLU0174	MCCLU0175	MCCLU0176	MCCLU0177	MCCLU0178	MCCLU0179	MCCLU0180	MCCLU0181	CAVSP01
Bonding	Territory		Territory	Territory	Territory	Bonding	Bonding	Bonding	Territory	Bonding	Bonding	Territory		Territory
NC	SLC	SPOW	ACC	ALC	BS	CC	CHI	COO	FLC	JBC	NC	SLC	SPOW	ACC
	0	0	0	0	0	0	0	0	0	155	0	125	16	0
	0	0	0	0	0	0	0	0	0	6	0	0	0	0
	0	0	0	0	0	0	0	0	0	2	0	0	0	0
	0	0	0	0	0	0	0	0	0	11	0	80	6	3
	0	0	0	0	0	0	0	0	0	7	0	62	4	0
	0	0	0	0	0	0	0	0	0	5	0	0	0	0
	0	0	0	0	0	0	0	0	0	9	0	0	0	0
	0	0	0	0	0	0	0	0	0	12	0	0	113	0
	0	0	0	0	0	0	0	0	0	25	0	0	13	0
	0	0	0	0	0	0	0	0	0	111	0	219	0	1
	0	0	0	0	0	0	0	0	0	30	0	125	26	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	373	0	611	178	4

CAVSP0182	CAVSP0183	CAVSP0184	CAVSP0185	CAVSP0186	CAVSP0187	CAVSP0188	CAVSP0189	CAVSP0190	CAVSP0191
Territory	Territory	Bonding	Bonding	Bonding	Territory	Bonding	Bonding	Territory	
ALC	BS	CC	CHI	COO	FLC	JBC	NC	SLC	SPOW
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0

Call Type and Location	Total
ACC-CAVSP01	0
ACC-FTHUA01	311
ACC-FTHUA02	9
ACC-FTHUA03	0
ACC-MCCLU01	0
ACC-ROSPR01	0
ACC-ROSPR02	0
ACC-SCHEE01	22
ACC-SCHEE02	12
ALC-CAVSP01	0
ALC-FTHUA01	784
ALC-FTHUA02	362
ALC-FTHUA03	448
ALC-MCCLU01	0
ALC-ROSPR01	0
ALC-ROSPR02	0
ALC-SCHEE01	58
ALC-SCHEE02	317
BS-CAVSP01	0
BS-FTHUA01	461
BS-FTHUA02	356
BS-FTHUA03	214
BS-MCCLU01	0
BS-ROSPR01	0
BS-ROSPR02	0
BS-SCHEE01	72
BS-SCHEE02	45
CC-CAVSP01	0
CC-FTHUA01	6931
CC-FTHUA02	263
CC-FTHUA03	86
CC-MCCLU01	0
CC-ROSPR01	0
CC-ROSPR02	0
CC-SCHEE01	418
CC-SCHEE02	827
CHI-CAVSP01	0
CHI-FTHUA01	3
CHI-FTHUA02	3
CHI-FTHUA03	0
CHI-MCCLU01	0
CHI-ROSPR01	0
CHI-ROSPR02	0
CHI-SCHEE01	0
CHI-SCHEE02	3
COO-CAVSP01	0
COO-FTHUA01	119
COO-FTHUA02	0
COO-FTHUA03	0
COO-MCCLU01	0
COO-ROSPR01	0
COO-ROSPR02	0
COO-SCHEE01	0
COO-SCHEE02	36
FLC-CAVSP01	0
FLC-FTHUA01	1641
FLC-FTHUA02	1511
FLC-FTHUA03	1679
FLC-MCCLU01	373
FLC-ROSPR01	8
FLC-ROSPR02	12
FLC-SCHEE01	3417
FLC-SCHEE02	2439
JBC-CAVSP01	0
JBC-FTHUA01	779
JBC-FTHUA02	1
JBC-FTHUA03	0
JBC-MCCLU01	0
JBC-ROSPR01	0
JBC-ROSPR02	0
JBC-SCHEE01	0
JBC-SCHEE02	0
NC-CAVSP01	0
NC-FTHUA01	2205
NC-FTHUA02	4
NC-FTHUA03	31
NC-MCCLU01	611
NC-ROSPR01	0
NC-ROSPR02	0
NC-SCHEE01	99
NC-SCHEE02	594
SLC-CAVSP01	0
SLC-FTHUA01	598
SLC-FTHUA02	550
SLC-FTHUA03	435
SLC-MCCLU01	178
SLC-ROSPR01	0
SLC-ROSPR02	0
SLC-SCHEE01	422
SLC-SCHEE02	314
SPOW-CAVSP01	0
SPOW-FTHUA01	176
SPOW-FTHUA02	394
SPOW-FTHUA03	353
SPOW-MCCLU01	4
SPOW-ROSPR01	0
SPOW-ROSPR02	0
SPOW-SCHEE01	165
SPOW-SCHEE02	73

Sound Name	Sound Duration (hh:mm:ss)	Number of Events
FtDrum_Retrieval1_0505-2505		
FTDRT1ST4	194:07:00	272,965
FTDRT1ST5	194:07:00	265,647
FTDRT1ST6	194:07:00	350,436
FTDRT2ST3	194:07:00	179,520
FTDRT2ST4	194:07:00	130,942
FTDRT2ST6	194:07:00	178,653
FtDrum_Retrieval2_2605-1406		
FTDRT1ST4	173:29:00	255,963
FTDRT1ST5	173:29:00	298,518
FTDRT1ST6	173:29:00	305,081
FTDRT1ST7	173:29:00	390,409
FTDRT2ST3	96:08:00	84,981
FTDRT2ST4	173:29:00	112,133
FTDRT2ST6	173:29:00	174,377
FTDRT2ST8	173:29:00	307,742
FtDrum_Retrieval3_1506-0707		
FTDRT1ST4	196:35:00	236,594
FTDRT1ST5	187:55:00	146,158
FTDRT1ST6	196:35:00	263,690
FTDRT1ST7	187:55:00	372,237
FTDRT2ST3	196:35:00	71,757
FTDRT2ST4	196:35:00	105,277
FTDRT2ST6	196:35:00	152,541
FTDRT2ST8	196:35:00	186,412
FtDrum_Retrieval4_0807-2607		
FTDRT1ST4	169:18:00	119,321
FTDRT1ST5	169:18:00	79,867
FTDRT1ST6	169:18:00	152,167
FTDRT1ST7	141:51:00	254,746
FTDRT2ST3	169:18:00	101,914
FTDRT2ST4	169:18:00	75,961
FTDRT2ST6	169:18:00	110,073
FTDRT2ST8	169:18:00	186,412
FtDrum_Retrieval5_2707-1408		
FTDRT1ST4	181:51:00	94,217
FTDRT1ST5	181:51:00	62,267
FTDRT1ST6	181:51:00	126,044
FTDRT1ST7	171:54:00	209,633
FTDRT2ST3	181:51:00	88,221
FTDRT2ST4	181:51:00	96,550
FTDRT2ST6	181:51:00	163,186
FTDRT2ST8	181:51:00	142,286
FtDrum_Retrieval6_1508-3108		
FTDRT1ST4	176:08:00	129,388
FTDRT1ST5	176:08:00	37,810
FTDRT1ST6	176:08:00	84,616
FTDRT1ST7	176:08:00	237,295
FTDRT2ST3	154:42:00	154,390
FTDRT2ST4	176:08:00	203,935
FTDRT2ST6	176:08:00	159,957
FTDRT2ST8	176:08:00	133,282
FtDrum_Retrieval7_0109-1709		
FTDRT1ST4	178:33:00	119,321
FTDRT1ST5	155:32:00	79,867
FTDRT1ST6	178:33:00	152,167
FTDRT1ST7	178:33:00	254,746
FTDRT2ST3	110:06:00	101,914
FTDRT2ST4	178:33:00	75,961
FTDRT2ST6	178:33:00	110,073
FTDRT2ST8	178:33:00	186,412
FtDrum2011_Retrieval8_1809-0210		
FTDRT1ST4	179:45:00	80,797
FTDRT1ST5	155:07:00	47,916
FTDRT1ST6	179:45:00	109,309
FTDRT1ST7	179:45:00	210,345
FTDRT2ST3	46:49:00	34,404
FTDRT2ST4	179:45:00	181,483
FTDRT2ST6	82:28:00	81,122
FTDRT2ST8	179:45:00	169,906
min	**46:49:00**	**34,404**
max	**196:35:00**	**390,409**
mean	**172:44:35**	**161,957**
SUM	**10710:04:09**	**10,041,314**

Detection Threshold	Filter Time Periods***	Recording Duration at Twlight Level	True Positive Rate (TPR)*	FP/hr****	FP/hr w/o EWPW *****	Positive Predictive Value (PPV)**	FPR
		Route 1, all four stops					
0.10	Exclude Civil Twilight	4,878	0.667	96.04	114.02	0.903	0.0161
0.15	Exclude Civil Twilight	4,878	0.519	25.59	30.37	0.964	0.0043
0.20	Exclude Civil Twilight	4,298	0.411	8.60	10.21	0.986	0.0013
0.25	Exclude Civil Twilight	4,878	0.330	2.36	2.80	0.994	0.0004
0.10	Exclude Civil and Nautical Twilight	4,091	0.651	88.47	100.82	0.884	0.0143
0.15	Exclude Civil and Nautical Twilight	4,091	0.489	19.13	21.79	0.963	0.0031
0.20	Exclude Civil and Nautical Twilight	4,091	0.378	4.22	4.81	0.989	0.0007
0.25	Exclude Civil and Nautical Twilight	4,091	0.299	0.94	1.07	0.996	0.0002
0.10	Exclude Civil, Nautical and Astronomical Twilight	3,175	0.651	85.42	96.15	0.879	0.0136
0.25	Exclude Civil, Nautical and Astronomical Twilight	3,175	0.300	1.21	1.36	0.995	0.0000
0.10	Include only Nautical Twilight	788	0.696	134.62	204.90	0.936	0.0293
0.15	Include only Nautical Twilight	788	0.575	59.09	89.93	0.965	0.0129
0.20	Include only Nautical Twilight	788	0.474	24.97	38.01	0.982	0.0054
0.25	Include only Nautical Twilight	788	0.388	9.75	14.83	0.991	0.0021
0.10	Include Only Astronomical Twilight	916	0.651	99.04	117.93	0.898	0.0168
0.25	Include Only Astronomical Twilight	916	0.295	0.00	0.00	1.000	0.0000
		Route 1, Stop 4 - FTDRT1ST4					
0.10	Exclude Civil Twilight	1,285	0.656	87.41	102.96	0.904	0.0143
0.15	Exclude Civil Twilight	1,285	0.471	25.77	30.36	0.956	0.0042
0.20	Exclude Civil Twilight	1,285	0.343	8.96	10.56	0.979	0.0015
0.25	Exclude Civil Twilight	1,285	0.236	2.99	3.52	0.988	0.0005
0.10	Exclude Civil and Nautical Twilight	1,078	0.621	73.95	83.43	0.887	0.0116
0.15	Exclude Civil and Nautical Twilight	1,078	0.417	15.15	17.09	0.960	0.0024
0.20	Exclude Civil and Nautical Twilight	1,078	0.290	3.56	4.02	0.987	0.0006
0.25	Exclude Civil and Nautical Twilight	1,078	0.190	0.00	0.00	1.000	0.0000
0.10	Exclude Civil, Nautical and Astronomical Twilight	836	0.608	70.05	78.31	0.885	0.0109
0.25	Exclude Civil, Nautical and Astronomical Twilight	836	0.199	0.00	0.00	1.000	0.0000
0.10	Include only Nautical Twilight	208	0.713	156.92	238.64	0.928	0.0328
0.15	Include only Nautical Twilight	208	0.562	80.77	122.83	0.951	0.0169
0.20	Include only Nautical Twilight	208	0.432	36.92	56.15	0.970	0.0077
0.25	Include only Nautical Twilight	208	0.314	18.46	28.08	0.977	0.0039
0.10	Include Only Astronomical Twilight	241	0.656	87.63	102.05	0.894	0.0141
0.25	Include Only Astronomical Twilight	241	0.167	0.00	0.00	1.000	0.0000
		Route 1, Stop 5 - FTDRT1ST5					
0.10	Exclude Civil Twilight	1,234	0.546	68.86	84.58	0.928	0.0117
0.15	Exclude Civil Twilight	1,234	0.408	17.51	21.50	0.974	0.0030
0.20	Exclude Civil Twilight	1,032	0.283	6.97	8.57	0.987	0.0010
0.25	Exclude Civil Twilight	1,234	0.191	1.56	1.91	0.995	0.0003
0.10	Exclude Civil and Nautical Twilight	1,032	0.571	61.38	73.94	0.933	0.0102
0.15	Exclude Civil and Nautical Twilight	1,032	0.438	13.02	15.68	0.980	0.0022
0.20	Exclude Civil and Nautical Twilight	1,032	0.310	3.25	3.92	0.992	0.0005
0.25	Exclude Civil and Nautical Twilight	1,032	0.211	0.46	0.56	0.999	0.0001
0.10	Exclude Civil, Nautical and Astronomical Twilight	798	0.580	53.53	63.56	0.938	0.0088
0.25	Exclude Civil, Nautical and Astronomical Twilight	798	0.217	0.60	0.71	0.998	0.0000
0.10	Include only Nautical Twilight	201	0.466	105.07	143.94	0.909	0.0204
0.15	Include only Nautical Twilight	201	0.309	40.60	55.61	0.944	0.0079
0.20	Include only Nautical Twilight	201	0.195	19.10	26.17	0.960	0.0037
0.25	Include only Nautical Twilight	201	0.125	7.16	9.81	0.977	0.0014
0.10	Include Only Astronomical Twilight	235	0.547	87.83	111.22	0.921	0.0151
0.25	Include Only Astronomical Twilight	235	0.196	0.00	0.00	1.000	0.0000
		Route 1, Stop 6 - FTDRT1ST6					
0.10	Exclude Civil Twilight	1,285	0.736	107.58	127.69	0.903	0.0177
0.15	Exclude Civil Twilight	1,285	0.603	31.00	36.80	0.964	0.0051
0.20	Exclude Civil Twilight	1,078	0.523	11.14	13.22	0.987	0.0015
0.25	Exclude Civil Twilight	1,285	0.480	3.74	4.43	0.994	0.0006
0.10	Exclude Civil and Nautical Twilight	1,078	0.727	97.56	110.14	0.881	0.0152
0.15	Exclude Civil and Nautical Twilight	1,078	0.570	22.27	25.15	0.963	0.0035
0.20	Exclude Civil and Nautical Twilight	1,078	0.490	5.35	6.04	0.988	0.0008
0.25	Exclude Civil and Nautical Twilight	1,078	0.462	2.23	2.51	0.994	0.0003
0.10	Exclude Civil, Nautical and Astronomical Twilight	836	0.730	98.18	109.41	0.869	0.0151
0.25	Exclude Civil, Nautical and Astronomical Twilight	836	0.469	2.87	3.20	0.991	0.0000
0.10	Include only Nautical Twilight	208	0.749	159.23	261.12	0.941	0.0374
0.15	Include only Nautical Twilight	208	0.655	76.15	124.89	0.967	0.0179
0.20	Include only Nautical Twilight	208	0.574	30.00	49.20	0.985	0.0070
0.25	Include only Nautical Twilight	208	0.508	11.54	18.92	0.993	0.0027
0.10	Include Only Astronomical Twilight	241	0.720	95.60	113.02	0.911	0.0154
0.25	Include Only Astronomical Twilight	241	0.446	0.00	0.00	1.000	0.0000
		Route 1, Stop 7 - FTDRT1ST7					
0.10	Exclude Civil Twilight	1,074	0.793	123.80	142.43	0.872	0.0218
0.15	Exclude Civil Twilight	1,074	0.661	28.16	32.39	0.961	0.0050
0.20	Exclude Civil Twilight	903	0.570	6.91	7.95	0.991	0.0010
0.25	Exclude Civil Twilight	1,074	0.485	0.89	1.03	0.998	0.0002
0.10	Exclude Civil and Nautical Twilight	903	0.775	125.94	137.55	0.807	0.0211
0.15	Exclude Civil and Nautical Twilight	903	0.604	27.10	29.60	0.939	0.0045
0.20	Exclude Civil and Nautical Twilight	903	0.507	4.78	5.22	0.986	0.0008
0.25	Exclude Civil and Nautical Twilight	903	0.424	1.06	1.16	0.996	0.0002
0.10	Exclude Civil, Nautical and Astronomical Twilight	705	0.774	124.60	134.64	0.793	0.0202
0.25	Exclude Civil, Nautical and Astronomical Twilight	705	0.402	1.36	1.47	0.995	0.0000
0.10	Include only Nautical Twilight	171	0.814	112.28	179.70	0.956	0.0275
0.15	Include only Nautical Twilight	171	0.727	33.68	53.91	0.984	0.0083
0.20	Include only Nautical Twilight	171	0.646	11.23	17.97	0.994	0.0028
0.25	Include only Nautical Twilight	171	0.557	0.00	0.00	1.000	0.0000
0.10	Include Only Astronomical Twilight	199	0.777	130.25	148.63	0.843	0.0250
0.25	Include Only Astronomical Twilight	199	0.475	0.00	0.00	1.000	0.0000

* TPR - Estimated proportion of hand browsed events in given time range found by detector at given threshold

* PPV - Estimated proportion of detection events that are sounds made by EWPW

*** Civil Twilight - apparent position of the center of the sun is 0° to 6° below the horizon
Nautical Twilight - apparent position of the center of the sun is 6° to 12° below the horizon

**** FP/hr estimate as 480 * FP / hours of recording in twilight range
Note: Multiply by 480 since random sample of 1/480th of the time base was hand browsed and rated as TP, FP, FN, or TN

***** FP per hour without EWPW
EWPW sounds are so prevalent in these sound streams that FP/hr is significantly lowered because EWPW is masking potential FP
This measurement attempts to characterize the FP/hr at times when EWPW are not singing, and can't mask potential FP.

Number of Detections	Positive Truth Matches	Positive Truth Misses	Positive Truth Total	Negative Truth Matches	Negative Truth Misses	Negative Truth Total	Positive + Negative Truth Total	Truth Total	Test Matches Positive Truth
	TP	FN		FP	TN				TP (test)
Route 1, all four stops									
1,748,532	7,546	3,767	11,313	976	59,462	60,438	71,751	71,751	9,339
1,284,016	5,875	5,438	11,313	260	60,178	60,438	71,751	71,751	7,273
997,675	4,655	6,658	11,313	77	60,361	60,438	71,751	71,751	5,787
798,482	3,731	7,582	11,313	24	60,414	60,438	71,751	71,751	4,649
1,117,494	4,808	2,573	7,381	754	52,152	52,906	60,287	60,287	5,919
773,023	3,612	3,769	7,381	163	52,743	52,906	60,287	60,287	4,453
580,134	2,790	4,591	7,381	36	52,870	52,906	60,287	60,287	3,463
456,867	2,206	5,175	7,381	8	52,898	52,906	60,287	60,287	2,745
794,368	3,411	1,825	5,236	565	41,093	41,658	46,894	46,894	4,201
320,151	1,573	3,663	5,236	8	41,650	41,658	46,894	46,894	1,958
631,038	2,737	1,195	3,932	221	7,311	7,532	11,464	11,464	3,419
510,993	2,262	1,670	3,932	97	7,435	7,532	11,464	11,464	2,819
417,541	1864	2068	3932	41	7491	7532	11464	11464	2323
341,615	1,525	2,407	3,932	16	7,516	7,532	11,464	11,464	1,904
1,914	1,397	748	2,145	189	11,059	11,248	13,393	13,393	1,718
136,716	633	1,512	2,145	0	11,248	11,248	13,393	13,393	787
Route 1, Stop 4 - FTDRT1ST4									
398,980	1,910	1,003	2,913	234	16,141	16,375	19,288	19,288	2,308
269,588	1,373	1,540	2,913	69	16,306	16,375	19,288	19,288	1,651
186,572	999	1,914	2,913	24	16,351	16,375	19,288	19,288	1,210
130,316	687	2,226	2,913	8	16,367	16,375	19,288	19,288	838
239,531	1,139	694	1,833	166	14,135	14,301	16,134	16,134	1,346
148,831	765	1,068	1,833	34	14,267	14,301	16,134	16,134	894
97,532	531	1,302	1,833	8	14,293	14,301	16,134	16,134	627
65,237	348	1,485	1,833	0	14,301	14,301	16,134	16,134	419
171,948	802	517	1,319	122	11,054	11,176	12,495	12,495	960
47,774	262	1,057	1,319	0	11,176	11,176	12,495	12,495	316
159,449	770	310	1,080	68	2,006	2,074	3,154	3,154	961
120,757	607	473	1,080	35	2,039	2,074	3,154	3,154	756
89,040	467	613	1,080	16	2,058	2,074	3,154	3,154	582
65,079	339	741	1,080	8	2,066	2,074	3,154	3,154	419
432	337	177	514	44	3,081	3,125	3,639	3,639	386
17,463	86	428	514	0	3,125	3,125	3,639	3,639	103
Route 1, Stop 5 - FTDRT1ST5									
397,517	1,885	1,565	3,450	177	14,934	15,111	18,561	18,561	2,334
281,313	1,408	2,042	3,450	45	15,066	15,111	18,561	18,561	1,728
192,955	978	2,472	3,450	15	15,096	15,111	18,561	18,561	1,206
127,730	659	2,791	3,450	4	15,107	15,111	18,561	18,561	814
314,369	1,513	1,138	2,651	132	12,819	12,951	15,602	15,602	1,876
226,249	1,161	1,490	2,651	28	12,923	12,951	15,602	15,602	1,425
157,097	822	1,829	2,651	7	12,944	12,951	15,602	15,602	1,015
105,148	559	2,092	2,651	1	12,950	12,951	15,602	15,602	686
224,026	1,098	794	1,892	89	10,012	10,101	11,993	11,993	1,354
75,153	410	1,482	1,892	1	10,100	10,101	11,993	11,993	498
83,148	372	427	799	44	2,116	2,160	2,959	2,959	458
55,064	247	552	799	17	2,143	2,160	2,959	2,959	303
35,858	156	643	799	8	2,152	2,160	2,959	2,959	191
22,582	100	699	799	3	2,157	2,160	2,959	2,959	128
567	415	344	759	43	2,807	2,850	3,609	3,609	522
29,995	149	610	759	0	2,850	2,850	3,609	3,609	188
Route 1, Stop 6 - FTDRT1ST6									
514,148	2,237	804	3,041	288	15,980	16,268	19,309	19,309	2,790
404,397	1,833	1,208	3,041	83	16,185	16,268	19,309	19,309	2,306
345,998	1,589	1,452	3,041	25	16,243	16,268	19,309	19,309	2,011
313,617	1,460	1,581	3,041	10	16,258	16,268	19,309	19,309	1,855
315,945	1,353	508	1,861	219	14,205	14,424	16,285	16,285	1,696
233,514	1,060	801	1,861	50	14,374	14,424	16,285	16,285	1,348
197,489	912	949	1,861	12	14,412	14,424	16,285	16,285	1,170
184,293	860	1,001	1,861	5	14,419	14,424	16,285	16,285	1,107
227,790	945	349	1,294	171	11,141	11,312	12,606	12,606	1,177
133,219	607	687	1,294	5	11,307	11,312	12,606	12,606	780
198,203	884	296	1,180	69	1,775	1,844	3,024	3,024	1,094
170,883	773	407	1,180	33	1,811	1,844	3,024	3,024	958
148,509	677	503	1,180	13	1,831	1,844	3,024	3,024	841
129,324	600	580	1,180	5	1,839	1,844	3,024	3,024	748
570	408	159	567	48	3,064	3,112	3,679	3,679	519
51,074	253	314	567	0	3,112	3,112	3,679	3,679	327
Route 1, Stop 7 - FTDRT1ST7									
437,887	1,514	395	1,909	277	12,407	12,684	14,593	14,593	1,907
328,718	1,261	648	1,909	63	12,621	12,684	14,593	14,593	1,588
272,150	1,089	820	1,909	13	12,671	12,684	14,593	14,593	1,360
226,819	925	984	1,909	2	12,682	12,684	14,593	14,593	1,142
247,649	803	233	1,036	237	10,993	11,230	12,266	12,266	1,001
164,429	626	410	1,036	51	11,179	11,230	12,266	12,266	786
128,016	525	511	1,036	9	11,221	11,230	12,266	12,266	651
102,189	439	597	1,036	2	11,228	11,230	12,266	12,266	533
170,604	566	165	731	183	8,886	9,069	9,800	9,800	710
64,005	294	437	731	2	9,067	9,069	9,800	9,800	364
190,238	711	162	873	40	1,414	1,454	2,327	2,327	906
164,289	635	238	873	12	1,442	1,454	2,327	2,327	802
144,134	564	309	873	4	1,450	1,454	2,327	2,327	709
124,630	486	387	873	0	1,454	1,454	2,327	2,327	609
345	237	68	305	54	2,107	2,161	2,466	2,466	291
38,184	145	160	305	0	2,161	2,161	2,466	2,466	169

Test Matches Negative Truth FP (test)	Test Matches Positive or Negative Truth	Test Total
1,007	10,346	1,748,532
272	7,545	1,284,016
82	5,869	997,675
28	4,677	798,482
774	6,693	1,117,494
169	4,622	773,023
39	3,502	580,134
10	2,755	456,867
578	4,779	794,368
10	1,968	320,151
232	3,651	631,038
103	2,922	510,993
43	2366	417541
18	1,922	341,615
196	1,914	323,126
0	787	136,716
246	2,554	398,980
76	1,727	269,588
26	1,236	186,572
10	848	130,316
171	1,517	239,531
37	931	148,831
8	635	97,532
0	419	65,237
125	1,085	171,948
0	316	47,774
75	1,036	159,449
39	795	120,757
18	600	89,040
10	429	65,079
46	432	67,583
0	103	17,463
182	2,516	397,517
47	1,775	281,313
16	1,222	192,955
4	818	127,730
135	2,011	314,369
29	1,454	226,249
8	1,023	157,097
1	687	105,148
90	1,444	224,026
1	499	75,153
46	504	83,148
18	321	55,064
8	199	35,858
3	131	22,582
45	567	90,343
0	188	29,995
298	3,088	514,148
85	2,391	404,397
27	2,038	345,998
12	1,867	313,617
229	1,925	315,945
52	1,400	233,514
14	1,184	197,489
7	1,114	184,293
178	1,355	227,790
7	787	133,219
69	1,163	198,203
33	991	170,883
13	854	148,509
5	753	129,324
51	570	88,155
0	327	51,074
281	2,188	437,887
64	1,652	328,718
13	1,373	272,150
2	1,144	226,819
239	1,240	247,649
51	837	164,429
9	660	128,016
2	535	102,189
185	895	170,604
2	366	64,005
42	948	190,238
13	815	164,289
4	713	144,134
0	609	124,630
54	345	77,045
0	169	38,184