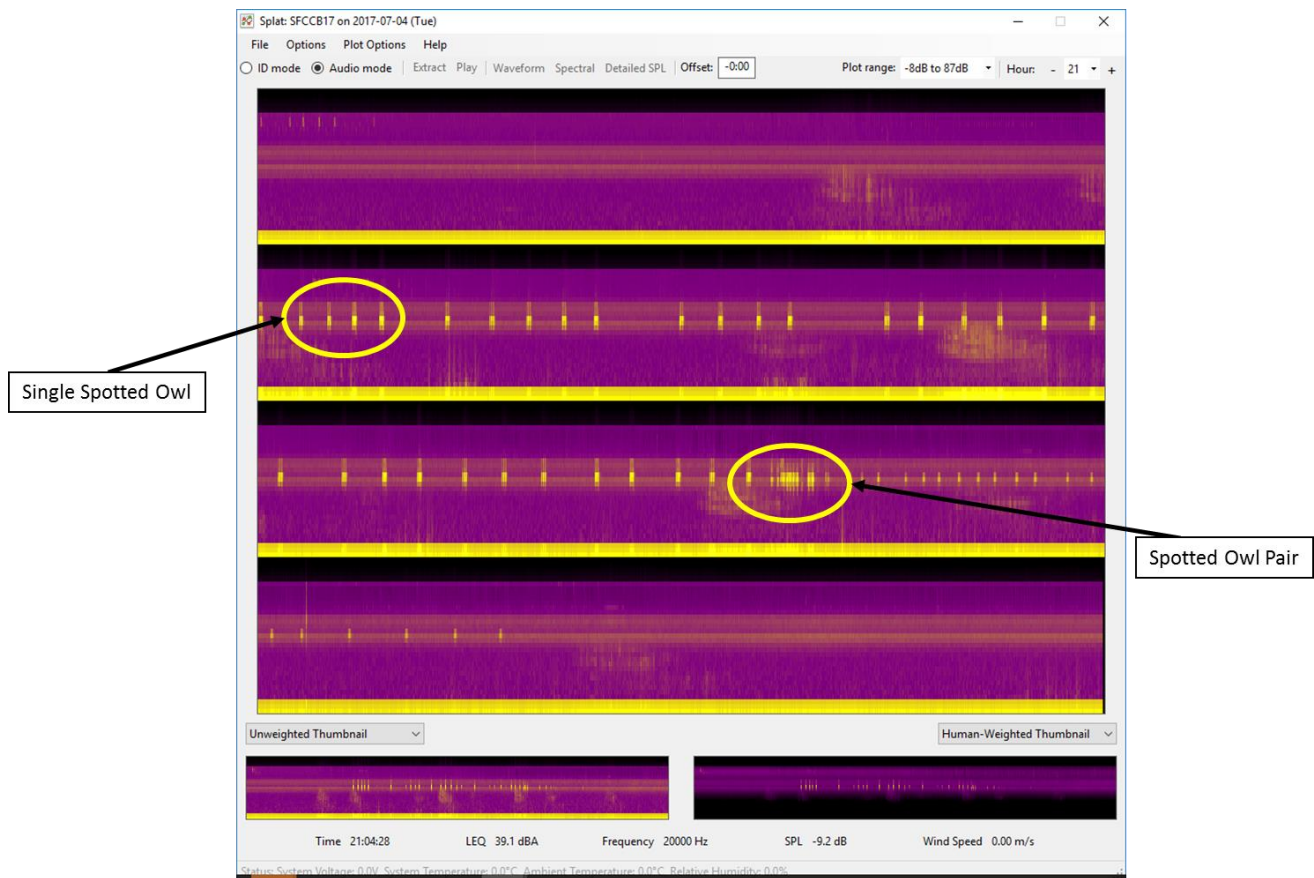




Crater Lake National Park Biological Sound Station Research

2017 Annual Report



ON THE COVER

Spotted owl acoustic signature from the South Fork Crater Creek location

Photograph by Sean Mohren, Terrestrial Ecologist, Crater Lake National Park

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2017 Annual Report

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Abstract

Beginning in 1992 the wildlife team at Crater Lake National Park started implementing the US Fish and Wildlife Service northern spotted owl monitoring protocol to determine distribution, abundance, and reproductive success of northern spotted owls in Crater Lake National Park. As the years progressed, reductions in budgets, shifting priorities and increased awareness of safety has reduced our ability to implement this monitoring protocol, in its entirety, at the Park. In general, the wildlife staff is presently capable of implementing 1-3 noncompliance surveys at each known owl activity center in any given year versus the 6 surveys recommended in the US Fish and Wildlife Service spotted owl monitoring protocol. In addition, there is currently no staff time available to survey areas of the park that contains high quality habitat but is not currently listed as a known owl activity center. In an effort to help improve our ability to determine the occupancy and distribution of northern spotted owl and barred owl, an owl that directly competes with northern spotted owls for habitat and resources, the wildlife team began exploring the use of acoustic stations to help supplement our survey efforts.

Based on the results of our 2012-2017 sampling efforts, we believe using acoustic stations to supplement traditional northern spotted owl monitoring methods provides us with an efficient and cost effective way to improve our ability to document the presence of northern spotted owls and barred owls at Crater Lake National Park. The 2017 survey effort represents our fourth year of full implementation and the details of this effort are described below. The primary goals for 2017 were to document northern spotted owls and barred owls at 1) known northern spotted owl activity centers and 2) areas of the Park that contain high quality spotted owl habitat.

In the summer of 2017, 21 sound stations were deployed at 6 known northern spotted owl activity centers and 5 locations that were determined to have suitable northern spotted owl nesting habitat. In general, we deployed 2 sound stations at each site for an average of 14.82 days. Northern spotted owls were recorded at two sites that were previously unknown to contain spotted owls. Unfortunately field crews were unable to verify these results due to the close proximity of wildfires in the Park that started shortly after we identified spotted owls using these locations. The acoustic station at the Grayback Ridge known spotted owl activity center recorded a single spotted owl and a unknown *Strix* species was documented at the Thousand Springs known spotted owl activity center but the individual was too far away to be confidently identified to species. Barred owls were documented at 6 of the 21 sites surveyed including 4 known spotted owl activity centers and 2 areas that were sampled because of the presence of spotted owl nesting habitat.

Introduction

Beginning in 1992 the wildlife team at Crater Lake National Park (CRLA or Park) began implementing the US Fish and Wildlife Service (USFWS) northern spotted owl (NSO) (*Strix occidentalis caurina*) monitoring protocol to determine distribution, abundance, and reproductive success of this species at CRLA (USFWS 2011). As the years have progressed, reductions in budgets, shifts in priorities, and increased awareness of safety has reduced our ability to implement this monitoring protocol in its entirety at the Park. Starting in 2012, the wildlife team at CRLA began a pilot study using acoustic stations to aid in the monitoring effort of NSOs and barred owls (*Strix varia*). This was done experimentally to see if using acoustic stations would help a relatively small wildlife team more comprehensively monitor historical NSO territories and to search for new occupied sites. The idea was to use recording stations to document presence information about NSOs and barred owls throughout the park. Once a NSO was recorded, traditional protocol surveys could be completed at those sites to determine nesting locations and reproductive success.

Utilizing acoustic stations to supplement traditional NSO monitoring methods provides us with an efficient and cost effective way to improve our ability to document the presence and distribution of NSOs and barred owls (Mohren 2016, Whyte et al. 2015, Ross and Mohren 2014, Murphy et. al 2013). In the summer of 2017, we had 2 primary goals; the first was to document the presence and distribution of NSOs and barred owls at known spotted owl activity centers; and secondly, to use acoustic stations to survey new areas of the Park that have not been surveyed since the early 90s to determine NSO or barred owl presence and ultimately distribution. In addition to these main goals, we also wanted to track the presence of other Strigidae species such as Great grey owls (*Strix nebulosi*), Northern pygmy owls (*Glaucidium gnoma*), and Flammulated owls (*Psiloscops flammeolus*).

As a survey and monitoring method, acoustic stations have shown to be successful by providing a cost effective, efficient method to survey owls. Sounds stations record on a 24-hour continuous basis and can be left in the field for up to a month if necessary. The data can be reviewed quickly and then used to guide field surveys following the USFWS spotted owl survey methods should a NSO call be recorded. This increases the chance of finding a *Strix* species given the limited number of visits a field crew can typically complete in a short field season. Used in conjunction with the field surveys, the acoustic stations increase what the wildlife team can learn about owl occupancy in the Park. As barred owls expand their range into historically NSO territory, it has been shown that NSOs are less likely to vocalize (Crozier 2006), which could alter the efficacy of a traditional survey. Deploying acoustic stations that survey around the clock for extended periods of time may help improve our chances of documenting a NSO that has reduced its calling time. In addition, acoustic stations may be deployed where it would be impractical to undergo a traditional survey, such as in more remote areas of the Park or areas that are not safe to survey at night.

The acoustic sound systems are not projected to replace the traditional biological surveys of NSO habitat. Nor are they deployed with the intent to substitute one or more of the protocol visits developed by the USFWS (USFWS 2011). While we believe stations can be used as a reliable

survey method to conclude presence/absence, nesting status and reproductive success cannot be accurately determined by acoustic stations. Therefore, traditional survey methods are still needed for compliance surveys and to determine the reproductive status of an owl species.

Methods

The general process for implementing acoustic stations includes: 1) selecting a survey area and station locations, 2) setting up the station, 3) retrieving the station, 4) file management, 5) sound file review, and 6) data entry. Each of these sections is discussed briefly below and complete details can be found in the CRLA Acoustic Monitoring Protocol (Murphy and Mohren 2013).

Site Selection

To determine a general area to survey at known NSO activity sites we used ArcGIS to plot all NSO and barred owl locations recorded between 1992 and 2014. We then used a kernel density estimator with a least squares cross validation and a 95% isopleth to develop polygons that were representative of NSO and barred owl use areas. For each site, table 1 shows the size of the modelled area along with the number of NSO and barred owl locations used to create the sample area. To select areas to sample that are not considered NSO activity centers, we used ArcMap to develop polygons around areas of habitat that the Park currently has mapped as NSO nesting habitat and then selected polygons that contained the highest percentage of nesting habitat.

Table 1. Polygon size and number of spotted owl and barred owl locations used to determine where to place acoustic stations at each site.

Site	Area (km2)	# NSO Locations	# Barred Owl Locations
Annie Creek	10.49	9	20
Bear Bluff	0.53	6	2
Boundary Springs	0.05	12	0
Bybee Creek	4.65	10	10
Castle Creek	11.69	12	17
Little Copeland Creek	1.22	13	2
Crater Creek	3.98	21	8
Crater Peak	1.99	5	0
Crescent Ridge	2.15	4	11
Grayback Ridge	8.81	15	2
Maklaks Crater	2.72	7	9
Sand Ridge	3.87	18	14
Lower Sun Creek	8.20	10	20
Thousand Springs	0.16	5	0

Once we determined the areas to sample, we used a geographic information system (GIS) program called System for the Prediction of Acoustic Detectability (SPreAD or SPreAD-GIS) to model how sound will disperse over the landscape at each area to be surveyed (Figure 1). As part of the model, we utilized the following inputs:

- 10 meter DEM
- National Land Cover (NLCD) vegetation data
- PRISM Minimum June Temperature Data
- Park Humidity Data

Using these parameters, we modelled how sound would travel over the landscape for each site. We placed 1 point within each polygon we wanted to survey located in an area that we thought would be the best location for sound collection based on topography and accessibility. We then ran the

SPreAD program and modeled sound based on this point. Once complete, we examined the areas of the survey polygon that were not covered by the modeling of the initial station and added additional stations to cover the remaining area. We then reran the model using both stations to determine total acoustic spread within the sample area with the ultimate goal of having at least 80% of the polygon cover. Once complete, this provided us with a general location to place sound recording devices at each site.

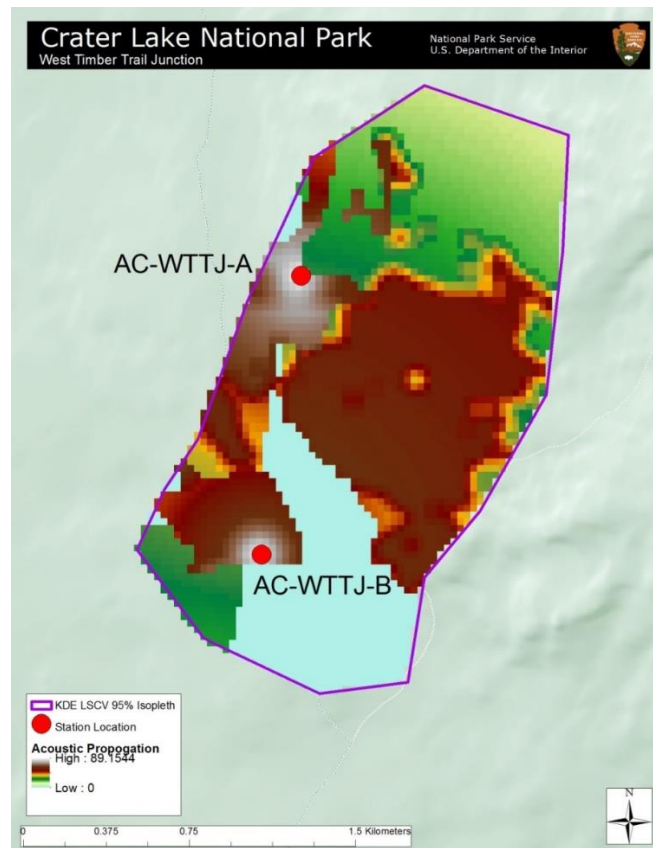


Figure 1. West Timber Trail Junction sample area with acoustic sampling locations, kernel density estimator polygon, and acoustic propagation.

Once the general location of the sound station was selected, it was up to the field crew to determine an appropriate microsite location to setup the recording device. Some things considered when placing the stations included:

- Avoiding areas with high winds (e.g. avoid unprotected ridgelines).
- Avoiding deploying near large reflective surfaces, such as rock walls.
- Shunning areas close to constant noise sources such as streams, roads, nesting birds, areas of heavy woodpecker use, and squirrel caches.

- Preventing equipment / animal conflicts by avoiding game trails and other areas where non-target animals were likely to congregate.
- Selecting areas where microphones could be effectively mounted.

Setting up and Removing the Sites

Each biological sound station consists of a Roland R-05 MP3 recorder, Olympus ME51S microphone, 2 Urbanti 100mm funnels, a 40Ah 3.2V LiFePO4 battery, and a modified Pelican case (Figure 2). The wildlife team, as much as possible, standardizes our equipment to make certain results are comparable from site-to-site and year-to-year.

Microphones were incased in a PVC tube which then attaches to two funnels. This structure was securely lashed to a tree using parachute cord at approximately 60-70 inches above the ground in a way that prevents movement from wind. The selected tree was large enough so that it would not move with wind, but small enough that the microphones extend beyond the trunk. An audio cord was attached to the microphone on one end and to the Pelican case on the other end, with extra cord being wrapped around the tree to prevent noise or snagging on passing wildlife (Figure 3).



Figure 2. Components of a biological sound station



Figure 3. Photograph of a sound station deployed at Bybee Creek

Once the setup was in place, settings on the Roland recorder were checked to make certain they followed the settings described in the CRLA Acoustic Survey Protocol (Murphy and Mohren 2013). Once the settings were checked, the station was activated and the device was checked to make sure it was working by having the surveyor record their name, site location, date, and time into the device. Once complete, the Pelican case was sealed, chained to the tree, and covered with woody debris (Figure 4). The surveyor completed the datasheet which included: site ID, general location, date set, time set, surveyor, UTM coordinates, GPS accuracy, elevation, habitat, ground porosity, potential noise, sound station assigned number, microphone orientation, and any general deployment notes. In addition, photographs were taken of the setup and of the habitat in each cardinal direction.

In general, sound stations are deployed for a two week period. Upon arriving at the microphone, the surveyor opened the Pelican case and stated their name, location, site ID, date, and time into the microphone to determine if the site is still working. The recorder was then turned off and the surveyor documented the recovery date and time, if the unit was functioning, and any general recovery notes on the datasheet.



Figure 4. Photograph of a sound station deployed at the Lower Sun Creek Site. The Pelican box is covered with woody debris to prevent being tampered with by wildlife.

File Management, Data Review, and Data Entry

Once back in the office sound files were transferred from the Roland R-05 recorder to a supplemental storage device. Sound files are very large and therefore not stored on the NPS server. Instead they are stored on 2 external hard drives. One drive is called “Acoustic Raw Data” and one drive is called “Acoustic Working”. The raw audio drive is used to store unmanipulated data and acts as a backup, the files on the “Acoustic Working” hard drive are used to analyze the sound data.

Once transferred to the “working” hard drive a toolbox called “Acoustic Monitoring Toolbox” (AMT) developed by the NPS sounds program is used to rename and convert the MP3 files into a useable format. Within the toolbox, a program called “Audio Renamer” is used to rename the MP3 files to include the site ID and sample year. After renaming the MP3 files, they are converted into a text format using a program called AUDIO2NV SPL. Once files are in the text format, SPLAT, a program in AMT, is used to create and review spectrographs of the recordings. Spectrographs are reviewed to determine if any NSOs or barred owls called at the site (Figure 5). If a spectrograph appears to be an owl, the audio is listened to, and any owl species recorded are documented on the datasheet. In addition to owl species, predatory birds such as goshawks (*Accipiter gentilis*) are documented since they may have an effect on the distribution of spotted or barred owls. Along with the raptor calls, a plethora of other species and sounds (e.g. other owls, coyotes, elk bugle, thunder, trees falling, etc.) are periodically documented. Once the sound files are reviewed, the results are entered into a Microsoft Access database that contains automated summaries that are incorporated into this annual report.

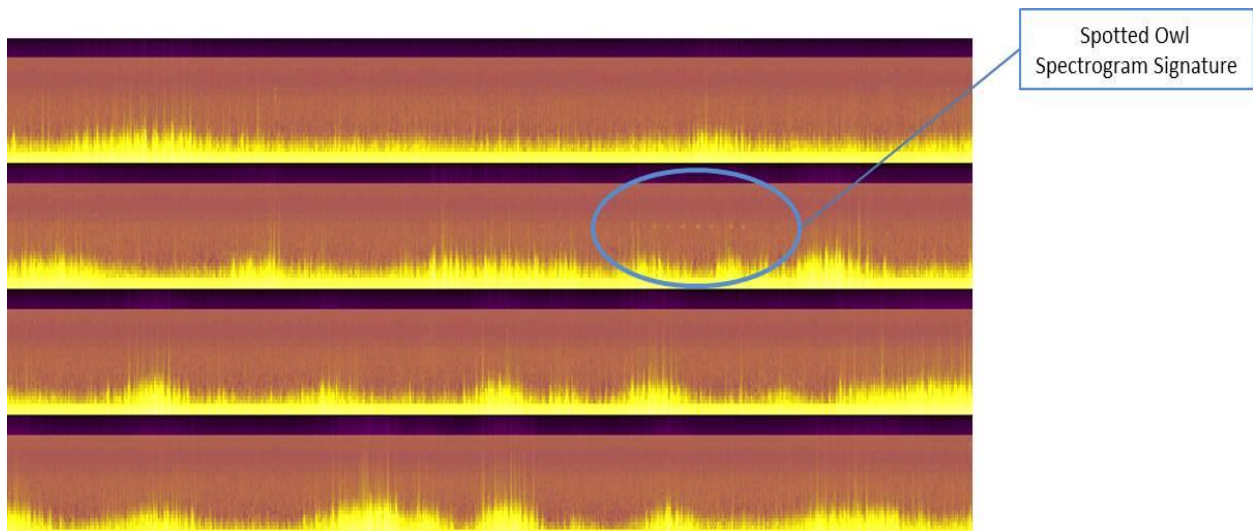


Figure 5. Northern spotted owl spectrogram in the SPLAT tool of the NPS AMT Toolbox.

Results

Results from the 2017 field season

This year heavy snowfall amounts persisted late into the spring that severely impacted our ability to survey sites. In many cases, sites that are generally accessible in June could not be accessed until middle to late July. In addition, the Park had 2 prominent wildfires that limited our access to many of the known spotted owl activity centers as well as much of the potential spotted owl habitat we intended to survey. The Blanket Creek fire started on USFS lands just outside the southwest corner of Crater Lake National Park on 7/26/2017 and grew to approximately 31,632 acres, spilling over onto NPS managed lands. The Spruce Lake fire began on 7/29/2017 and grew to approximately 15,825 acres in the west central portion of the Park, and burning over portions of the Little Copeland Creek known spotted owl activity center.

Even with these limitations, a total of 21 sound stations were deployed at 6 known owl activity centers and 5 areas containing spotted owl nesting habitat between June 1, 2017 and August 17, 2017. We used 2 stations at each site with one exceptions, only one station was deployed at the Grayback Ridge site because years of previous acoustic and field crew surveys have shown the northern end of this site to be the most used by spotted owls. We collected 7,467 hours of data with an average of 14.82 days surveyed per station (range 0-22 days). We documented spotted owls at three sites during the 2017 field season, and barred owls were recorded on 9 stations at 6 sites in 2017 (Table 2). This makes for a detection of an owl species of interest at 73% of the sites surveyed and 52% of the deployed stations.

Table 2. Number of days deployed and species observed at sound stations used to sample at Crater Lake National Park in 2017
Known spotted owl activity centers

Site	Location	Days Surveyed	Owl Species	Other Predators
Annie Creek	AC-ANCR-A-17	15	Barred Owl	
	AC-ANCR-B-17	15	Barred Owl	
Bear Bluff	AC-BEBL-A-17	22	Flammulated Owl	Northern Goshawk
	AC-BEBL-B-17	22	Barred Owl, Flammulated Owl, Great Horned Owl	
Castle Point Trail	AC-CAPO-A-17	0	None	
	AC-CAPO-B-17	4	Barred Owl, Spotted Owl	
Cavern Creek Boundary	AC-CACB-A-17	14	Flammulated Owl	
	AC-CACB-B-17	21	None	
Copeland Creek Forks	AC-COCF-A-17	19	Barred Owl	
	AC-COCF-B-17	19	Barred Owl, Flammulated Owl, Great Horned Owl	
Crater Creek	AC-CACR-A-17	15	Barred Owl	
	AC-CACR-B-17	18	Barred Owl	
Crescent Ridge	AC-CRRI-A-17	22	None	
	AC-CRRI-B-17	22	Flammulated Owl	
Grayback Ridge	AC-GRRI-A-17	17	Spotted Owl	
North East Corner	AC-NECO-A-17	14	None	
	AC-NECO-B-17	4	None	
South Fork Crater Creek	AC-SFCC-A-17	0	None	
	AC-SFCC-B-17	18	Spotted Owl	
Thousand Springs	AC-THSP-A-17	17	Barred Owl	Northern Goshawk
	AC-THSP-B-17	15	None	

The goal was to have each station record for a total of 14 days, however 4 stations at 3 sites did not meet our target survey time. Of these 4 cases, 1 station was destroyed by a bears (Castle Point Trail B) and three stations had mechanical issues (Castle Point Trail A, North East Corner B, South fork Crater Creek). The site that was destroyed by bears recorded for 3.68 days and still managed to record a northern spotted owl and a barred owl. Two additional stations, both at the Crater Creek site were destroyed by bears but this did not occur until after the 14 day sampling goal was met.

In addition to spotted and barred owl recordings, predatory species such as Northern goshawks were documented on 2 station (18%) and Great Horned Owls were documented at 4 stations (36%) (Table 2). Flammulated owls were also documented at 5 stations (23.8%) on 4 sites (33.3%).

We surveyed 7 sites using both acoustic survey methods and the USFWS traditional field crew survey methods. The total number of field crew visits to a site ranged from 1-3 and was depending on time available to complete a survey (Table 3). We compared the diversity of owls observed at each site when using acoustic station versus the traditional field crew survey methods (Table 3). Field crews documented NSOs at the Grayback Ridge and Thousand Springs sites. Using the acoustic survey methods, we were able to document a spotted owl at the Grayback Ridge site, however we could only determine that either a spotted owl or barred owl was present at the Thousand Springs site. The type of call (single note) recorded at the Thousand Springs site would not provide us with the opportunity to determine which species was present. We document a pair of spotted owls calling at the South Fork Crater Creek site using the acoustic sampling techniques. Field crews conducted 3 follow up day surveys at this site but did not document any owls. Unfortunately, field crews were unable to continue surveys of this area due to the presence of the Spruce Lake wildfire that was within close proximity to this site. Barred owls were found by the field crews at 3 of the sites where both sampling methods were used, while acoustic stations recorded barred owls at 4 of the sites. In addition, field crews did not document any additional owl species but we did record flammulated owl and great horned owls at several sites (Table 3).

Table 3. Comparison of owl species of interest observed using traditional USFWS protocol methods versus using acoustic stations.

Overlapping Locations	# Traditional Surveys*	Owl Species Observed with Traditional method	# Days Acoustic Surveyed**	Owl Species Observed with Acoustic Methods
Annie Creek	2	Barred Owl	15	Barred Owl
Bear Bluff	2	Barred Owl	22	Barred Owl, Flammulated Owl, Great Horned Owl
Crater Creek	1	None	18	Barred Owl
Crescent Ridge	2	None	22	Flammulated Owl
Grayback Ridge	1	Spotted Owl	17	Spotted Owl
South Fork Crater Creek	3	None	18	Spotted Owl
Thousand Springs	2	Spotted Owl, Barred Owl	17	Barred Owl

*includes initial survey and follow up surveys, **number of days at least one sound station was in operation

Site Specific Results

The following section provides a description of the survey results of each site sampled during the 2017 field season.

1. Annie Creek – The Annie Creek stations recorded for 15 days. ANCR-A recorded a barred owl. ANCR-B recorded barred owl family group (male, female and young), along with several unknown Strix calls.
2. Bear Bluff – The Bear Bluff stations recorded for 22 days. BEBL-A recorded a flammulated owl and BEBL-B recorded a barred owl. Access to this site was delayed due to late snow melt and was further limited due to the proximity of the Blanket Creek fire and associated fire suppression activities.
3. Crater Creek - The Crater Creek Boundary stations recorded for 15 days for CACR-A and 18 days for CACR-B. CACR-A recorded an unknown Strix and a barred owl. CACR-B recorded a barred owl.
4. Crescent Ridge – The Crescent Ridge stations recorded for 22 days. No owls were documented.
5. Grayback Ridge – The Grayback Ridge station recorded for 17 days. Due to the late snow melt, this site was not accessible until July 31. GRRI-A recorded a spotted owl and an unknown Strix. Only 1 station was placed at this site because historically spotted owls have only been documented in the northern portion of this site.
6. Thousand Springs – The Thousand Springs stations recorded for 17 days on THSP-A and 15 days on THSP-B. THSP-A recorded a northern goshawk, a barred owl and an unknown Strix. THSP-B had no detectable species recorded. Traditional survey methods documented a spotted owl at this location.
7. Castle Point Trail – The Castle Point Trail stations recorded for 0 days for CAPO-A and 3.7 days for CAPO-B. CAPO-A had a mechanical malfunction and did not record. CAPO-B recorded a northern spotted owl, a barred owl and an unknown Strix, the stations microphone was then destroyed by a bear and stopped recording. A late snow melt delayed access to this site and follow up visits after the recording had been analyzed were not possible because of the proximity of this site to the Blanket fire.
8. Cavern Creek Boundary – The Cavern Creek Boundary stations recorded 14 days for CACB-A and 20 days for CACB-B. CACB-A had no species detected. CACB-B had an unknown Strix recorded.
9. Copeland Creek Forks – The Copeland Creek Forks stations recorded for 19 days. A barred owl and unknown Strix were recorded on both stations at this site.
10. North East Corner – The NECO stations recorded for 14 days on NECO-A and 4 days on NECO-B. The NECO-B site appeared to have mechanical issues which prevented it from recording for the desired 14 days. No species were recorded on either station.
11. South Fork Crater Creek – The SFCC-A had a mechanical issue with the connection of the microphone to the recording unit and therefore did not record. The SFCC-B station recorded

for 18 days and recorded a pair of northern spotted owls. The crew completed 3 days of daytime follow up surveys but did not document any owls. During the first night survey, a lightning storm forced us to end the survey before it even began. From this storm, the Spruce Lake fire started and burned up the boundary of this area and prevented any additional surveys in 2017.

Results from the project to date

Beginning in 2012 the wildlife team at Crater Lake National Park began a 2 year pilot study to determine the feasibility of utilizing acoustic stations to help supplement field crew surveys. It was determined that acoustic sampling is an efficient and effective method to determine NSO and barred owl presence along with the presence of multiple other owl species. Based on the results of the pilot study, full implementation of the project began in 2014. Table 4 provides a breakdown of the number of sites, station, and sampling effort that has been accomplished to date.

Table 4. Number of hours sampled each year along with the average number of hours sampled at each station

Project Status	Year	# of Sites Sampled	# Stations Sampled	Total # Hours Sampled	Average # Days Sampled Per Station
Pilot	2012	5	5	2001	16.67
Pilot	2013	4	6	2187	15.19
Full Implementation	2014	7	14	5863	17.45
Full Implementation	2015	16	32	11,293	14.70
Full Implementation	2016	15	29	10,064	14.46
Full Implementation	2017	11	21	7,467	14.82
Total		58	107	38,875	15.55

Since 2014, we have simultaneously sampled 21 sites utilizing both the acoustic survey method and surveys conducted by field crews implementing a limited number of surveys following the USFWS spotted owl survey protocol. When comparing acoustic survey techniques versus traditional field crew surveys documentation of spotted owls and goshawks appears to be similar, however great horned owls and barred owls are more numerous documented using the acoustic sampling methods (Figure 6).

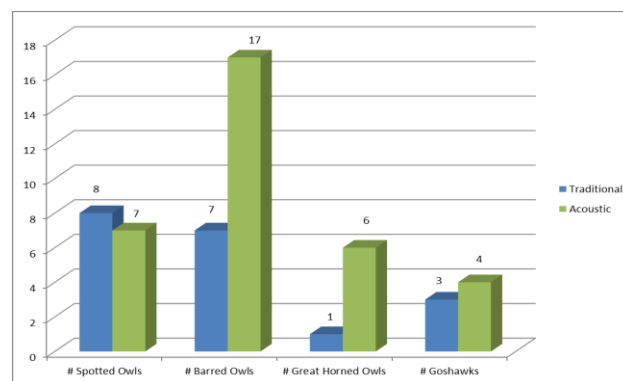


Figure 6. Number of sites where spotted, barred, and great horned owls along with goshawks were documented between 2014 and 2017 using USFWS spotted owl protocol surveys and the CRLA acoustic protocol surveys.

Discussion

This year at the South Fork Crater Creek site, the acoustics stations recorded a pair of northern spotted owls. South Fork Crater Creek is an example of one of the sites that offers good NSO habitat but was not previously surveyed due to limited time and personnel. The findings at this site provide an example of some of the potential benefits acoustic monitoring can offer. Upon finding acoustic evidence of NSO at the site, the field crew conducted several daytime follow up survey to further determine presence but failed to document any owls. A nighttime follow up survey was scheduled for the site but weather and a nearby wildfire closed the site for the remainder of the season before the night surveys could occur. It is recommended that this site be surveyed in the 2018 season following the established acoustic and USFWS protocols.

In addition to South Fork Crater Creek, the Castle Point Trail site is another site that contains NSO habitat but has not been surveyed, a single spotted owl was recorded at this site. The acoustic monitor at this site ran for 3.67 days before it was destroyed by a bear, but during that time it detected a barred owl and a spotted owl. Follow up surveys by the field crew was not possible because of the close proximity of this site to the Blanket Creek fire. It is recommended that the site be surveyed in the 2018 season following established USFWS spotted owl protocols and CRLA acoustic protocols.

Field crews were able to detect spotted owls at 2 sites this year (Thousand Springs and Grayback Ridge). In the case of the Thousand Springs stations, a *Strix* species was recorded using the acoustic station but the call was too quiet to determine if the species was a spotted or barred owl. The spotted owl located by the field crew was at the very southern end of this site and was determined to be using USFS lands for nesting which may be the reason this species could not be documented using the acoustic methods. Both Barred owls and goshawks have occupied the northern portion of this site for many years, it may be the spotted owls are more focused on the southern end of the site to avoid these other species. An expansion of the site is recommended to ensure we are covering the total area being utilized by spotted owls. In the case of the Grayback Ridge site, this site became accessible very late in the season due to excessive snow falls causing late snow melt (station deployed on 7/31/17), because of this, field crew time constraints, and a history of the spotted owls only being located in the northern portion of the site only the closer of the 2 acoustic stations was placed, thus drastically limiting the acoustic detection probability. Even with this being the case, we were able to document spotted owls using the acoustic sampling methods at this site.

These examples demonstrate how the acoustic stations can be an effective supplement to the traditional survey methodology; however, their main utility is to determine presence and absence. Surveys utilizing the USFWS spotted owl protocol are still necessary to determine nesting locations and reproductive status. Similar to wildlife programs at other Parks and agencies, funding to implement NSO surveys is limited at Crater Lake National Park and is often focused on compliance work to ensure disturbance activities are not having a negative effect on spotted owls. Acoustic stations continue to be an effective and cost efficient method to help better understand the distribution of spotted owls and their competitors throughout the entire park.

Wildland fire continues to have a significant influence on spotted owls at Crater Lake National Park. This year the Spruce Lake and Blanket Creek fires consumed approximately 47,239 acres of land of which 19,832 acres was within Crater Lake National Park. Eight of the 45 areas previously select for sampling as part of this project were directly affected by these two fires. In addition to these 2 fires, several large fires have occurred at Crater Lake National Park over the last decade (Bybee Creek, Crescent Ridge, Lonesome, Oasis, Red Cone, and Trail). Taking these fires into account, 16 of the 45 areas of high quality spotted owl habitat selected to sample as part of this project have been impacted in some degree by wildfire and are likely no longer able to support nesting spotted owls. An evaluation of these sites are needed to determine if they should still be classified as spotted owl habitat for the foreseeable future.

As part of this study we have been able to demonstrate that our acoustic survey protocol is just as effective at documenting spotted owls as the limited number of surveys being conducted by the field crew. However, what is unclear is how sampling using the acoustic survey protocol compares to sampling using the complete USFWS protocol which includes 6 visits (including day and night surveys) spaced approximately 1 week apart. The wildlife team at Crater Lake National Park has secured a limited amount of funding to help answer this question in 2019. We will look for some additional funding to help expand this effort beyond the Park boundary into the surrounding USFS lands where northern spotted owls are likely more abundant and can be sampled earlier in the season due to better weather and accessibility.

We continue to look for ways to make improvements on our sampling methods and equipment. Sometime in 2018 we are expecting a new vegetation map which is being developed by the Klamath Inventory and Monitoring Network. It is our hope that we can use this more detailed vegetation map along with stand structure data calculated using Light Detection and Ranging (LiDAR) data to help better define spotted owl habitat which will help focus some of our sampling efforts.

Literature Cited

- Crozier, M.L., M.E. Seamans, R.J. Gutierrez, P.J. Loschl, R.B. Horn, S.G. Sovern, E.D. Forsman. 2006. Does the presence of Barred owls suppress the calling behavior of spotted owls? *The Condor* 108:760-769
- Gutiérrez, R. J., M. Cody, S. Courtney, and Alan B. Franklin. 2006. The Invasions of Barred Owls and Its Potential Effect on the Spotted Owl: A Conservation Conundrum. *Biological Invasions* 9.2 pp181-196
- Mohren, S. 2016. Crater Lake National Park biological sound station protocol, 2016 annual report. Crater Lake National Park. Crater Lake, OR.
- Murphy, J. Hansen, K.H., and S. Mohren. 2013. Sound station pilot project: 2013 annual report. Crater Lake National Park. Crater Lake, OR.
- Murphy, J. and S. Mohren. 2013. Crater Lake National Park biological sound station protocol. Crater Lake National Park. Crater Lake, OR.
- Ross, C.E. and S.R. Mohren. 2014. Crater Lake National Park biological sound station research: 2014 annual report. Crater Lake National Park. Crater Lake, OR.
- U.S. Fish and Wildlife Service. 2011a. Protocol for surveying proposed management activities that may impact spotted owls. USDI Fish and Wildlife Service, Portland, OR. 38pp.
- Whyte, K.H., Ross, C.E., and S.R. Mohren. 2015. Crater Lake National Park biological sound station research: 2015 annual report. Crater Lake National Park. Crater Lake, OR.