Keeyask Generation Project

Terrestrial Effects Monitoring Plan

Common Nighthawk Habitat Effects Monitoring Report

TEMP-2018-12

KEEYASK

Manitoba Sustainable Development Client File 5550.00
Manitoba Environment Act Licence No. 3107

2017 -2018

KEEYASK GENERATION PROJECT

TERRESTRIAL EFFECTS MONITORING PLAN

REPORT #TEMP-2018-12

COMMON NIGHTHAWK HABITAT EFFECTS MONITORING 2016 & 2017

Prepared for

Manitoba Hydro

By

Wildlife Resource Consulting Services MB Inc.

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SUMMARY

Background

Construction of the Keeyask Generation Project (the Project) at Gull Rapids began in July 2014. The Keeyask Hydropower Limited Partnership (KHLP) was required to prepare a plan to monitor the effects of construction and operation of the generating station on the terrestrial environment. Monitoring results will help the KHLP, government regulators, members of local First Nation communities, and the general public understand how construction and operation of the generating station will affect the environment, and whether or not more needs to be done to reduce harmful effects.

Predicted Project-related effects on common nighthawks are associated with changes in habitat availability and sensory disturbance. While some breeding habitat will be lost, a small, temporary increase in habitat in cleared Project areas is anticipated during construction. Common nighthawks were observed nesting in regenerating forests (burned areas) along the south access road route and foraging in wetlands, inland lakes, inland creeks, and along the Nelson River during studies for the Project's environmental assessment.

The common nighthawk is listed as Threatened under the federal *Species at Risk Act* and as Threatened under *The Endangered Species and Ecosystems Act* of Manitoba. The species is experiencing widespread population declines due in part to loss of breeding habitat. Common nighthawks nest on the ground in a range of open habitats such as forest clearings and edges and on suitable roofs in urban areas, and they forage on flying insects. They blend in with their surroundings and are mainly active at dusk and dawn. As such, they are difficult to detect during traditional daytime surveys. However, breeding activity can be identified by calls and by the booming sound made by territorial males as air rushes through their feathers.

This report describes the results of common nighthawk habitat effects monitoring conducted during the summers of 2016 and 2017, the third and fourth years of Project construction. Monitoring for this study occurred at sites throughout the Gull and Stephens lakes area.

Why is the study being done?

As part of the Terrestrial Effects Monitoring Plan, habitat effects surveys for common nighthawk were initiated in 2016 and continued in 2017, to evaluate Project-related changes in the distribution and abundance of suitable breeding habitat. This study will focus on quantifying the amount of breeding habitat that is lost or altered due to Project activities.

Common Nighthawk Nestlings in the Keeyask Region, July 2017

What was done?

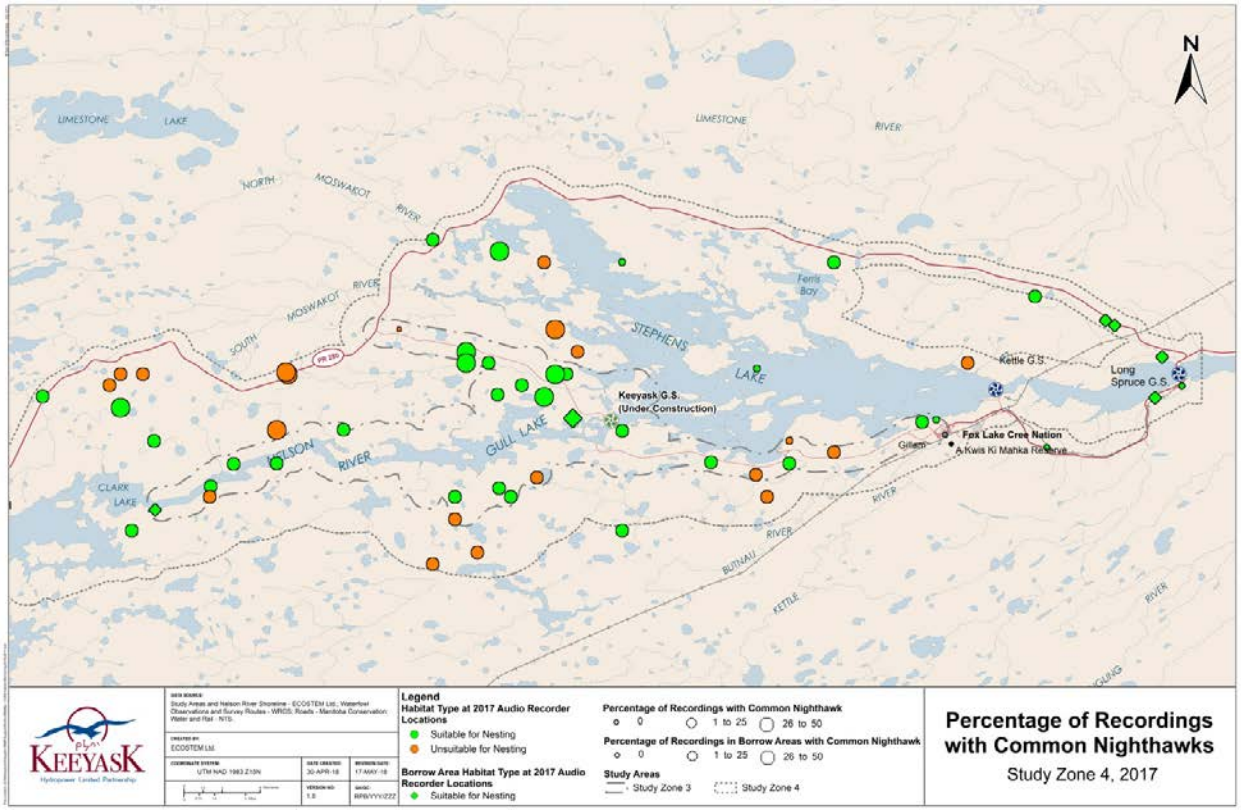
Automated recording units were placed at 50 sites in 2016 and at 61 sites in 2017. Sites were classified by their potential suitability as common nighthawk nesting habitat. Recordings were collected from July 2 to 24, 2016 and from June 30 to July 29, 2017. The recorders were programmed to record for five minutes every 10 minutes from approximately 8:00 p.m. to 1:00 a.m. All recordings were processed and the presence or absence of common nighthawk calls was identified. The accuracy of call identification was also tested.

Custom Designed Automated Recording Unit (ARU) Deployed at Keeyask

What was found?

Common nighthawks were widely distributed in the Gull and Stephens lakes area, and were recorded at most of the sites surveyed in 2016 and 2017, regardless of the expected suitability of the habitat for nesting. Individuals were detected in recently burned habitat on mineral soil and open vegetation habitat on mineral soil. Individuals were also detected at borrow areas, which have been cleared and are possibly subject to disturbance but are thought to be suitable nesting habitat for common nighthawks.

Common nighthawks appeared to be most active until mid-July, roughly coinciding with the breeding season. As expected, most of their calls were recorded between 9:00 p.m. and 11:00 p.m., from dusk until just after sunset, a period when they are typically quite active.



Percentage of Recordings with Common Nighthawks in the Gull and Stephens Lakes Area, 2017

What does it mean?

Common nighthawks were detected at most sites thought to be suitable for nesting, as expected. It is unclear, however, why the species was detected at many of the sites thought to be unsuitable for nesting. Habitat patterns on the landscape likely influenced common nighthawk detections. Common nighthawk home ranges are typically large and several kilometres can separate foraging and nesting habitats. Common nighthawks foraging near

unsuitable nesting habitat may have been recorded by the automated recording units within them, or habitat thought to be unsuitable for breeding may have been suitable for foraging.

What will be done next?

Common nighthawk monitoring will continue in 2018. Power analyses will be performed on the existing data to improve the study design prior to the deployment of the automated recording units in late June 2018. More detailed, multi-year analyses of recordings will then be performed, when construction monitoring for the species concludes.

STUDY TEAM

We would like to thank Sherrie Mason and Rachel Boone of Manitoba Hydro for editorial comments, and Kim Bryson and Megan Anger of Manitoba Hydro, Custom Helicopters, and Ron Bretecher of North/South Consultants Inc., for logistical assistance in the field. We would also like to thank Dr. James Ehnes, ECOSTEM Ltd., for GIS-supported study design and cartography.

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1.0 INTRODUCTION

Construction of the Keeyask Generation Project (the Project), a 695 megawatt hydroelectric generating station (GS) and associated facilities, began in July 2014. The Project is located at Gull Rapids on the lower Nelson River in northern Manitoba where Gull Lake flows into Stephens Lake, 35 km upstream of the existing Kettle GS.

The *Keeyask Generation Project Response to EIS Guidelines* (the EIS), completed in June 2012, provides a summary of predicted effects and planned mitigation for the Project. Technical supporting information for the terrestrial environment, including a description of the environmental setting, effects and mitigation, and a summary of proposed monitoring and follow-up programs is provided in the *Keeyask Generation Project Environmental Impact Statement Terrestrial Supporting Volume* (TE SV). The *Keeyask Generation Project Terrestrial Effects Monitoring Plan* (TEMP) was developed as part of the licensing process for the Project. Monitoring activities for various components of the terrestrial environment were described, including the focus of this report, common nighthawk (*Chordeiles minor*), and the availability of breeding habitat in the Keeyask region during the construction and operation phases.

The common nighthawk is listed as Threatened under *The Endangered Species and Ecosystems Act* of Manitoba and under the federal *Species at Risk Act*. Its status has been recently re-examined by COSEWIC, and it was recommended to be downgraded to a species of Special Concern because its rate of decline has slowed and it is relatively abundant in boreal habitats (Government of Canada 2018). Environment Canada (2016) described the habitats and habits of the common nighthawk. The species is experiencing widespread population declines, due in part to loss of breeding habitat. Common nighthawks nest on the ground in a range of open habitats such as forest clearings and edges and on suitable roofs in urban areas, and they forage on flying insects. They blend in with their surroundings and are mainly active at dusk and dawn. As such, they are difficult to detect during traditional daytime surveys. However, breeding activity can be detected by calls and by the booming sound made by territorial males as air rushes through their feathers (Environment Canada 2016).

As part of the TEMP, habitat effects surveys for common nighthawk were initiated in 2016 and continued in 2017, to evaluate Project-related changes in the distribution and abundance of suitable breeding habitat. While it is not expected to be limiting in the post-Project environment, the availability of suitable breeding habitat could have the greatest influence on common nighthawk distribution and abundance in the Keeyask region. The habitat effects study will evaluate how the Project changes the distribution and abundance of common nighthawk breeding habitat. In the future, results will validate the expert information habitat quality model defined in the EIS with data collected in a range of habitats. This validated and possibly refined habitat quality model will ultimately be used to evaluate how the Project changes the distribution and abundance of common nighthawk breeding habitat in the Keeyask region.

2.0 METHODS

Common nighthawks are expected to be found in a higher proportion of their preferred nesting habitat types than in less suitable habitat types. In order to test which of the previously mapped terrestrial habitat and surface water patch types best incorporate environmental attributes that common nighthawks select, automated recording units (ARUs; Photo 1) were placed in a stratified random sample of available habitat types. Potential nesting habitat types were identified as recently burned on mineral soil, open vegetation on mineral soil, or borrow areas, which are considered broad habitat types and are located in a landscape of complex habitat mosaics (TE SV). All other terrestrial areas were considered unsuitable for common nighthawk nesting.

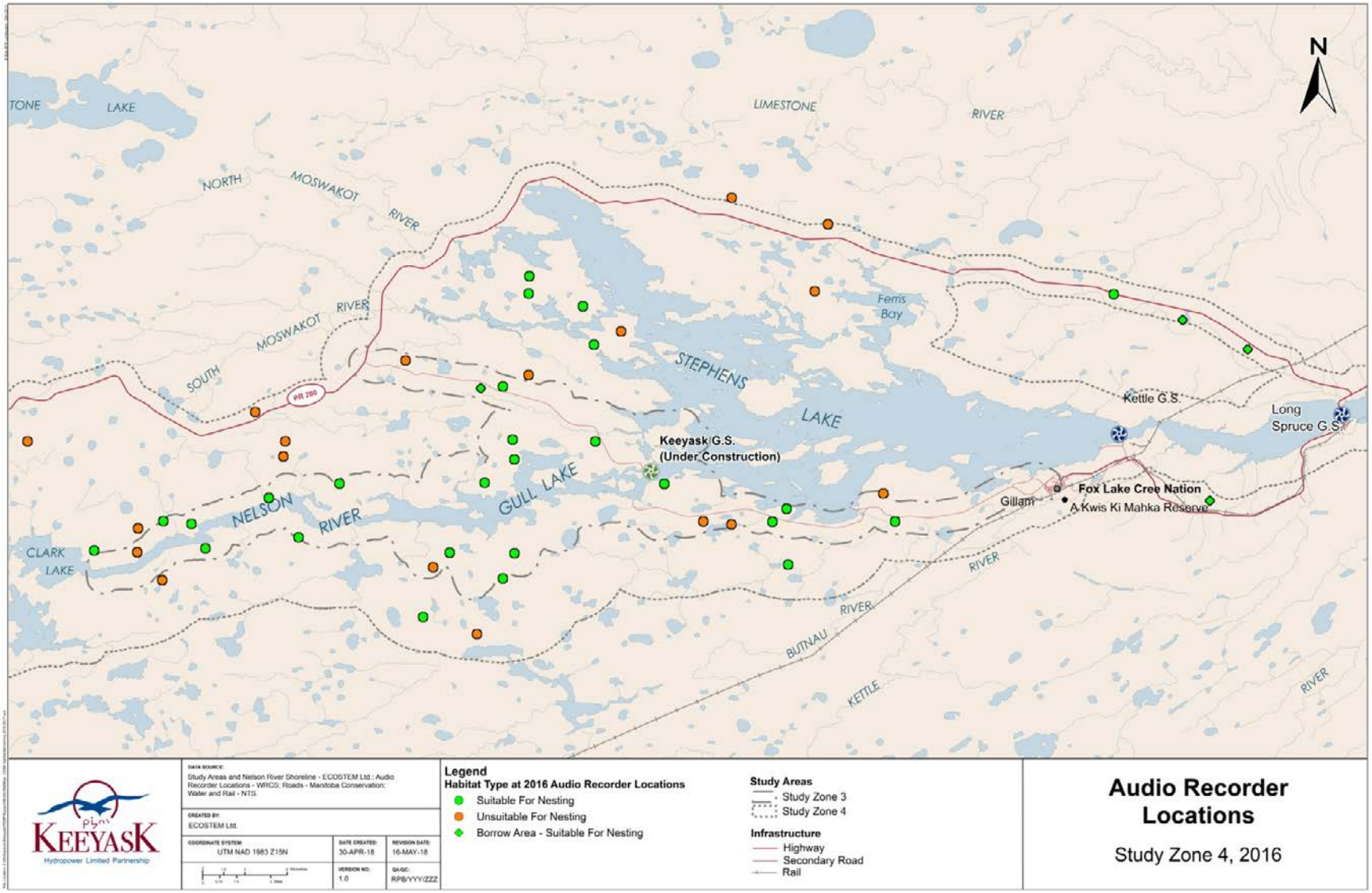
Photo 1: Four-microphone Automated Recording Unit Housed in Protective Case

ARUs were placed at 50 sites in 2016 (Appendix 1, Table A-1; Map 1) and at 61 sites in 2017. Six sites that were randomly selected in 2017 had also been surveyed the previous year (Appendix 1, Table A-2; Map 2). Most sites were within Study Zone 4 and were classified by the potential suitability of nesting habitat as described above and by their position relative to Study Zone 3 (within or beyond; Table 1; see Map 1 and Map 2). Recordings were made from July 2 to 24, 2016 and from June 30 to July 29, 2017. The recorders were programmed to record for five minutes every 10 minutes from approximately 8:00 p.m. to 1:00 a.m. The time when common nighthawks are most active is 30 minutes before sunset (Knight et.al. 2016), which was covered by the recorder program. Analyses of bird vocalizations were performed using the statistical package R and the presence or absence of common nighthawk calls was identified. Analyses of bird vocalizations were performed using the statistical package R, which is one of

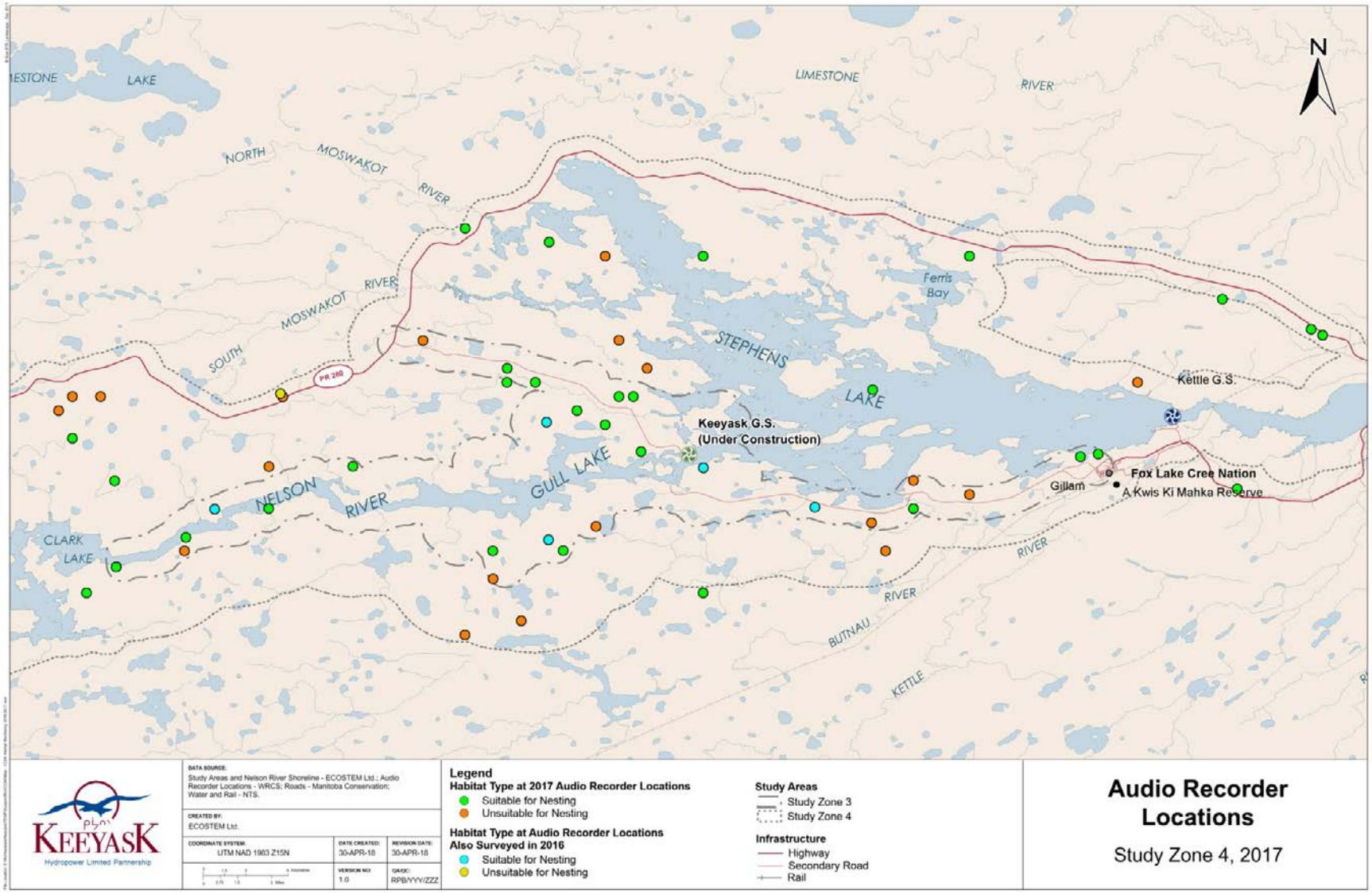
the software programs used by Hafner and Katz (2018) for this type of analysis. A step-wise process was used to analyze bird vocalizations to remove most false positives, where other species were initially identified as common nighthawks. Classification of audio clips involved setting a threshold for target and off-target calls and calculating a difference between the two; classification criteria were adjusted to achieve a false positive rate of less than 5% (see Appendix 2 for detailed analysis methods). All calls identified as common nighthawk were isolated and reviewed for potential false positives not removed during the initial identification process.

Table 1: Number of Audio Recorder Sites in Study Zone 4, 2016 and 2017

	2016			2017		
Habitat Type	**In Study Zone 3**	**Outside Study Zone 3**	**Total**	**In Study Zone 3**	**Outside Study Zone 3**	**Total**
Nesting	19	12	31	21	19	40
Unsuitable	6	13	19	7	14	21



Map 1: Common Nighthawk Audio Recorder Locations in Study Zone 4, 2016



Map 2: Common Nighthawk Audio Recorder Locations in Study Zone 4, 2017

3.0 RESULTS

Common nighthawks were widely distributed in Study Zone 4 in 2016 and 2017. Ten ARUs failed in 2016 and one failed in 2017. Calls were identified at 95% (n = 38) of the remaining 40 sites surveyed in 2016 and at 87% (n = 52) of the remaining 60 sites surveyed in 2017 (Table 2). There was little difference in the percentage of sites at which the species was detected in habitat considered suitable for nesting and in unsuitable habitat. Common nighthawks were identified at a greater percentage of sites inside Study Zone 3 than outside in both years (Map 3, Map 4).

Table 2: Sites where Common Nighthawk was Detected, 2016 and 2017

		2016		2017	
Habitat Type	**Position**	**Number**	**Percentage**	**Number**	**Percentage**
Nesting	Inside Study Zone 3	17	100	19	90
	Outside Study Zone 3	6	86	15	79
	Total	23	96	34	85
Unsuitable	Inside Study Zone 3	5	100	5	83
	Outside Study Zone 3	10	91	13	93
	Total	15	94	18	90
All	Inside Study Zone 3	22	100	24	89
	Outside Study Zone 3	16	89	28	85
	Total	*38*	*95*	*52*	*87*

Common nighthawks (Photo 2) were detected at 38 of the 40 sites surveyed in 2016 (Appendix 1, Table A-3). At the 23 of 24 sites in habitat suitable for nesting where common nighthawk calls were identified, calls were detected on an average of 12% of recordings (range 0.2% – 39.1%) and on an average of 58% of survey nights (range 5.0% – 100%). At the 15 of 16 sites in unsuitable habitat where common nighthawk calls were identified, they were detected on an average of 13% of recordings (range 0.2% – 37.3%) and on an average of 54% of survey nights (range 5.3% to 100%). There was little difference in the frequency of common nighthawk detections in habitat that was suitable for nesting and in unsuitable habitat.

Common nighthawk calls were identified at 52 of the 60 sites surveyed in 2017 (Appendix 1, Table A-4). They were detected at 34 of 40 sites in habitat suitable for nesting, on an average of 13% of recordings (range 0.3% – 41.8%) and an average of 57% of survey nights (range 4.8% – 100%). Common nighthawks were recorded at 18 of 20 sites in unsuitable habitat, on an average of 14% of recordings (range 0.2% – 44.7%) and an average of 62% of survey nights (range 4.0% – 100%). As in 2016, the difference in the frequency of common nighthawk detections in habitat suitable for nesting and in unsuitable habitat was small.

Photo 2: Common Nighthawk in the Keeyask Region, June 2016

Borrow areas were considered potentially suitable nesting habitat. Common nighthawk calls were recorded at one of the two borrow areas surveyed in 2016, on a small percentage of recordings (5.8%; see Appendix 1, Table A-3). In 2017, common nighthawks were detected at six of the eight borrow areas surveyed. They were detected on fewer than 2% of recordings at five of the sites in borrow areas; however, calls were identified on 28% of recordings at the sixth, the only site in an active borrow area (see Appendix 1, Table A-4). Calls were recorded during six of the 11 nights (54.5%) the site was surveyed. In both survey years, at borrow areas where the percentage of recordings with calls was less than five, common nighthawks were recorded on fewer than half of the survey nights (range 8.0% – 40.0%).

At all sites in 2016, the number of recordings on which common nighthawks were identified from July 3 to 20 was greatest the night of July 11 (n = 245; Figure 1), then began to decrease. Relatively few common nighthawk recordings were made the nights of July 12 and 13, in the middle of the survey period.

At all sites in 2017, the number of recordings on which common nighthawks were detected between July 5 and 27 was greatest the night of July 6 (n = 367; Figure 2). As in 2016, relatively few recordings were made in the middle of the survey period; there were 13 recordings with common nighthawk calls on July 16, the fewest of the survey period. The number of common nighthawk recordings gradually declined after July 14.

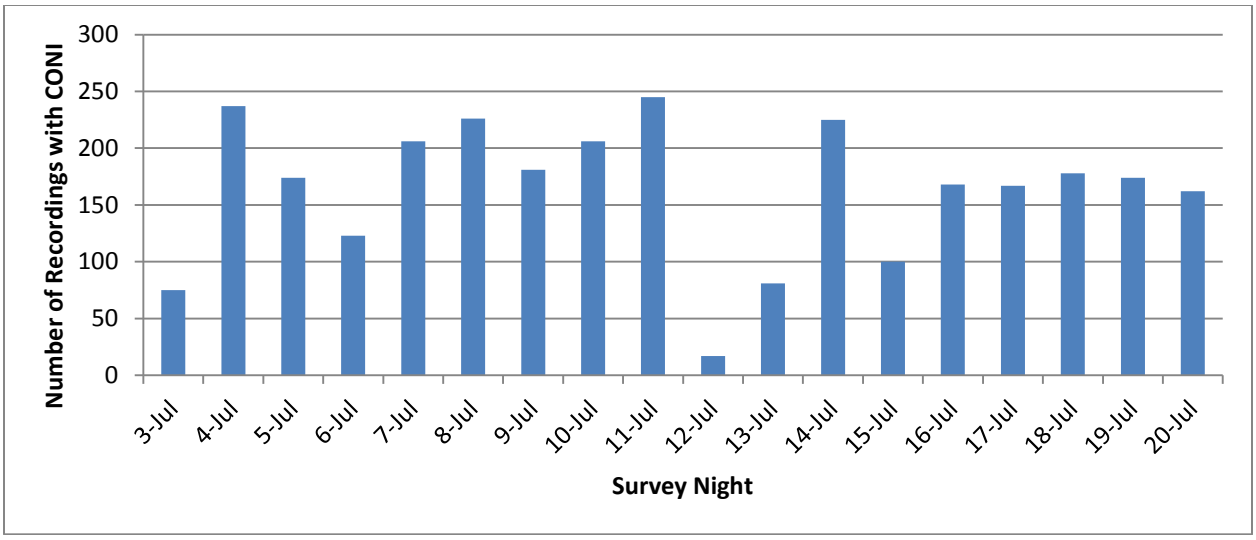


Figure 1: Number of Recordings with Common Nighthawk (CONI) per Survey Night, Across All Sites Surveyed in 2016

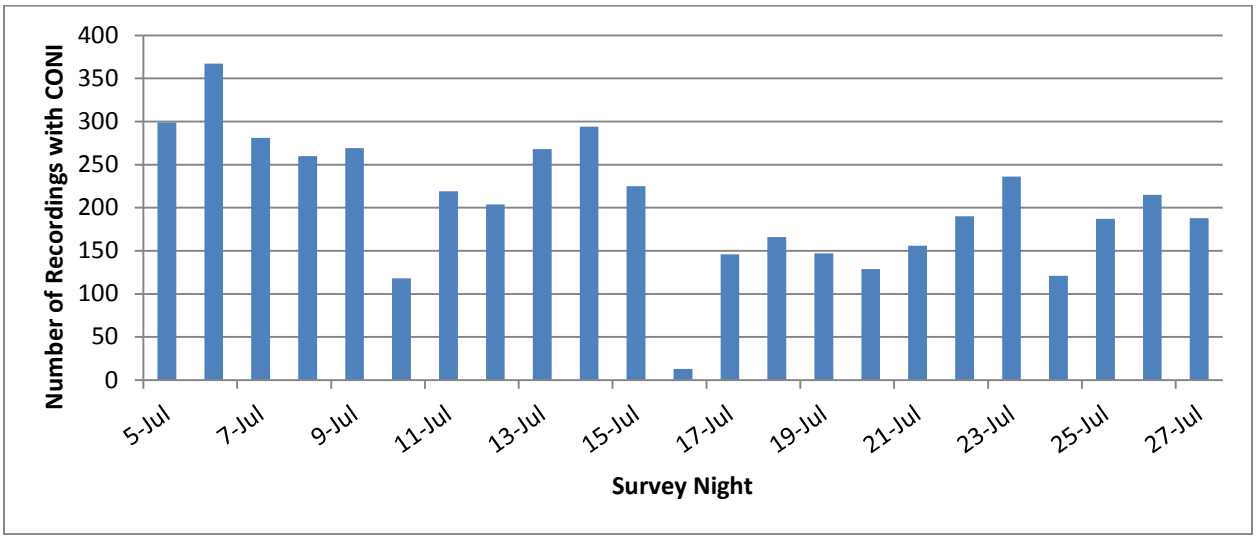


Figure 2: Number of Recordings with Common Nighthawk (CONI) per Survey Night, Across All Sites Surveyed in 2017

Common nighthawks appeared to be most active between 9:00 p.m. and 11:00 p.m. in 2016 and 2017 (Figure 3, Figure 4), at dusk and just after sunset. Relatively few recordings were made from 8:00 p.m. to 9:00 p.m. and from 11:00 p.m. to midnight each year.

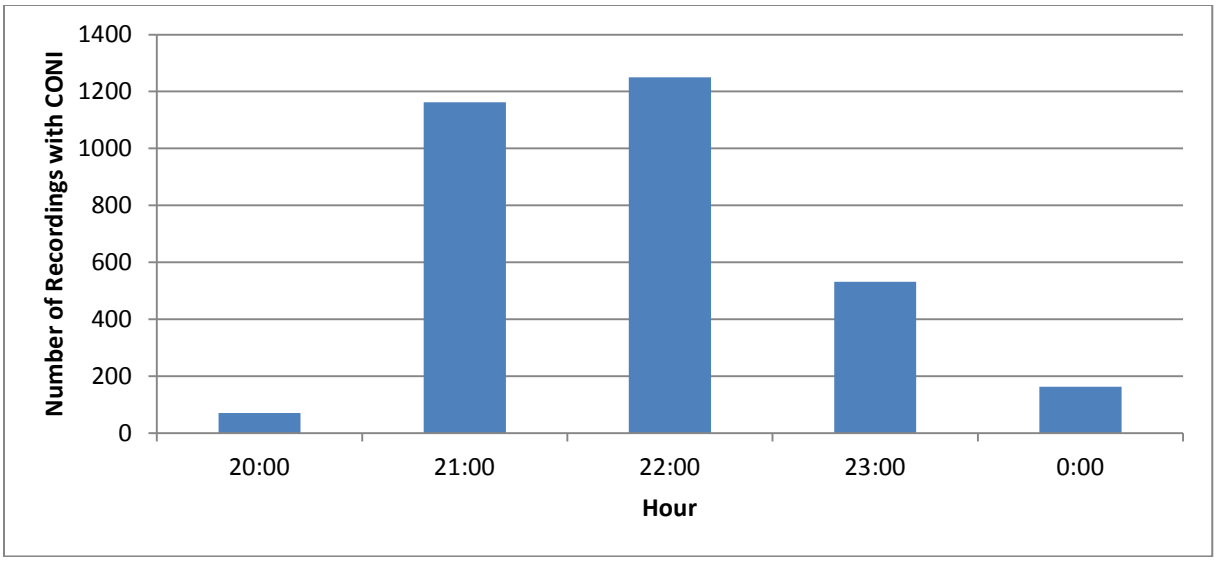


Figure 3: Number of Recordings with Common Nighthawk (CONI) per Hour, Across All Sites Surveyed in 2016

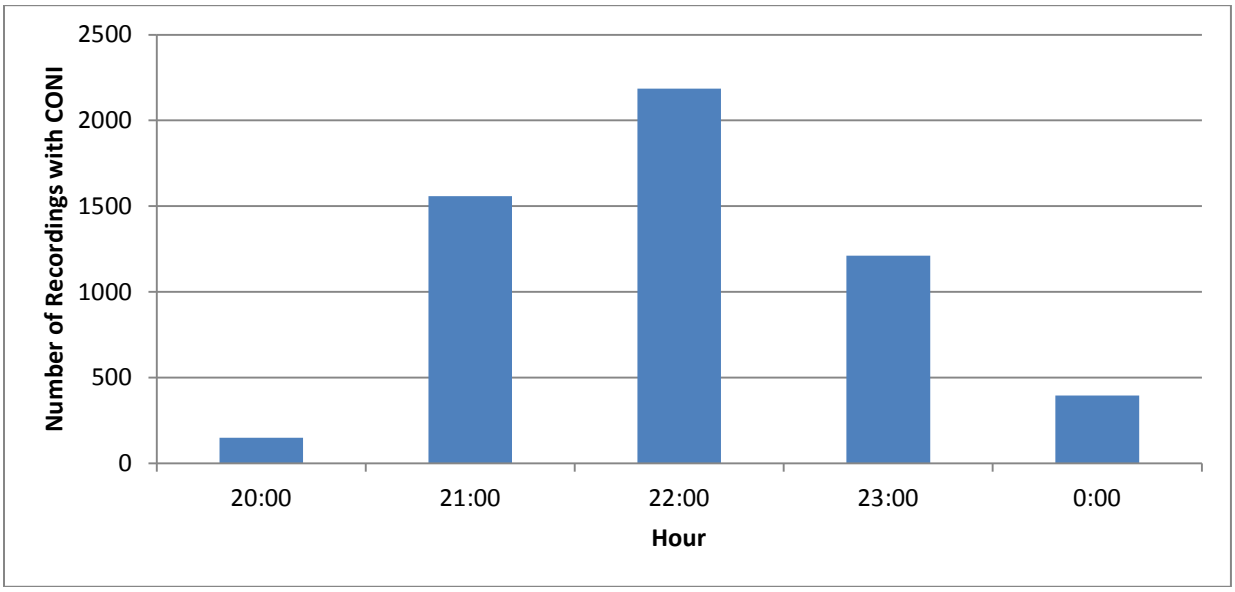
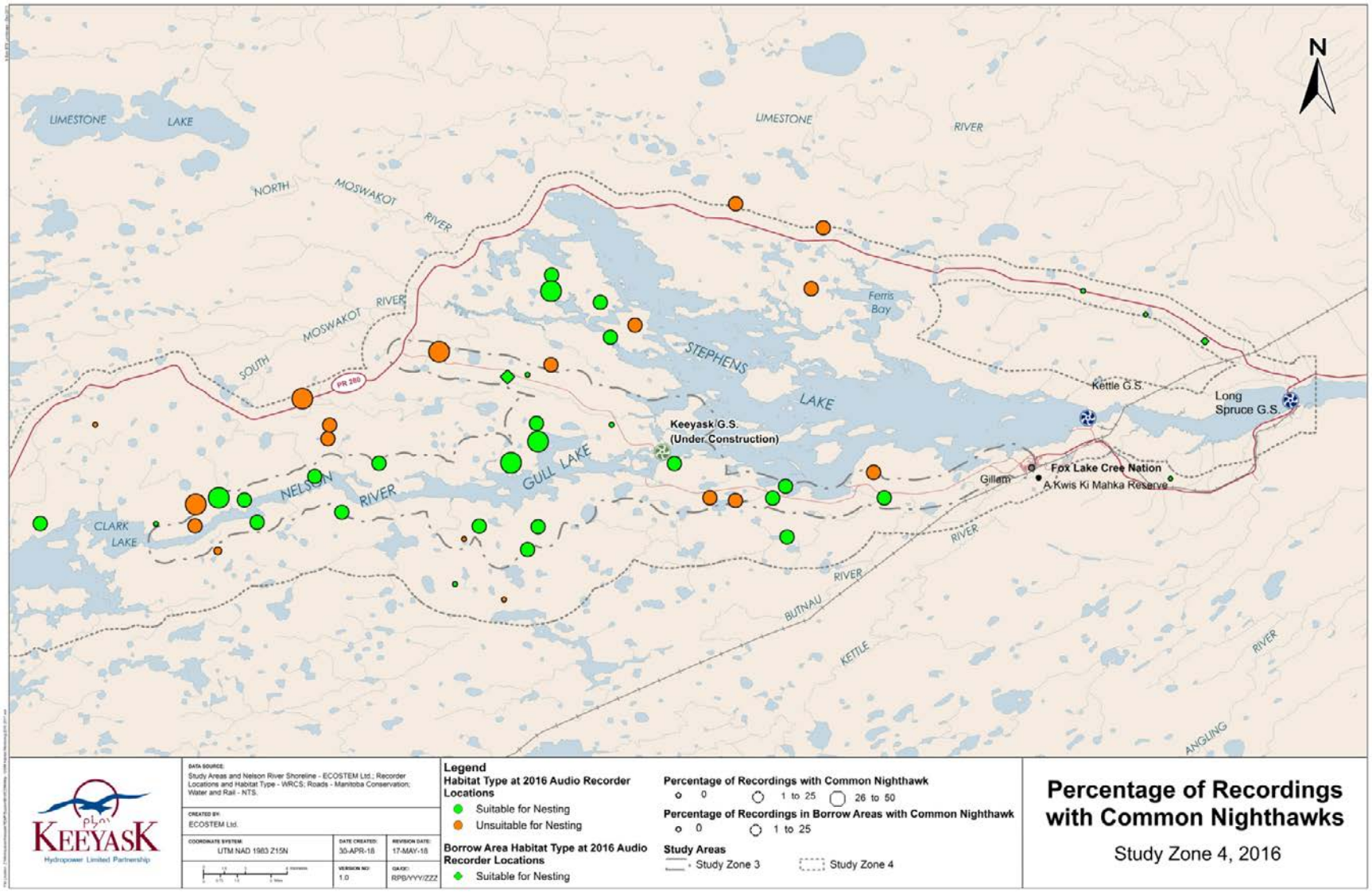


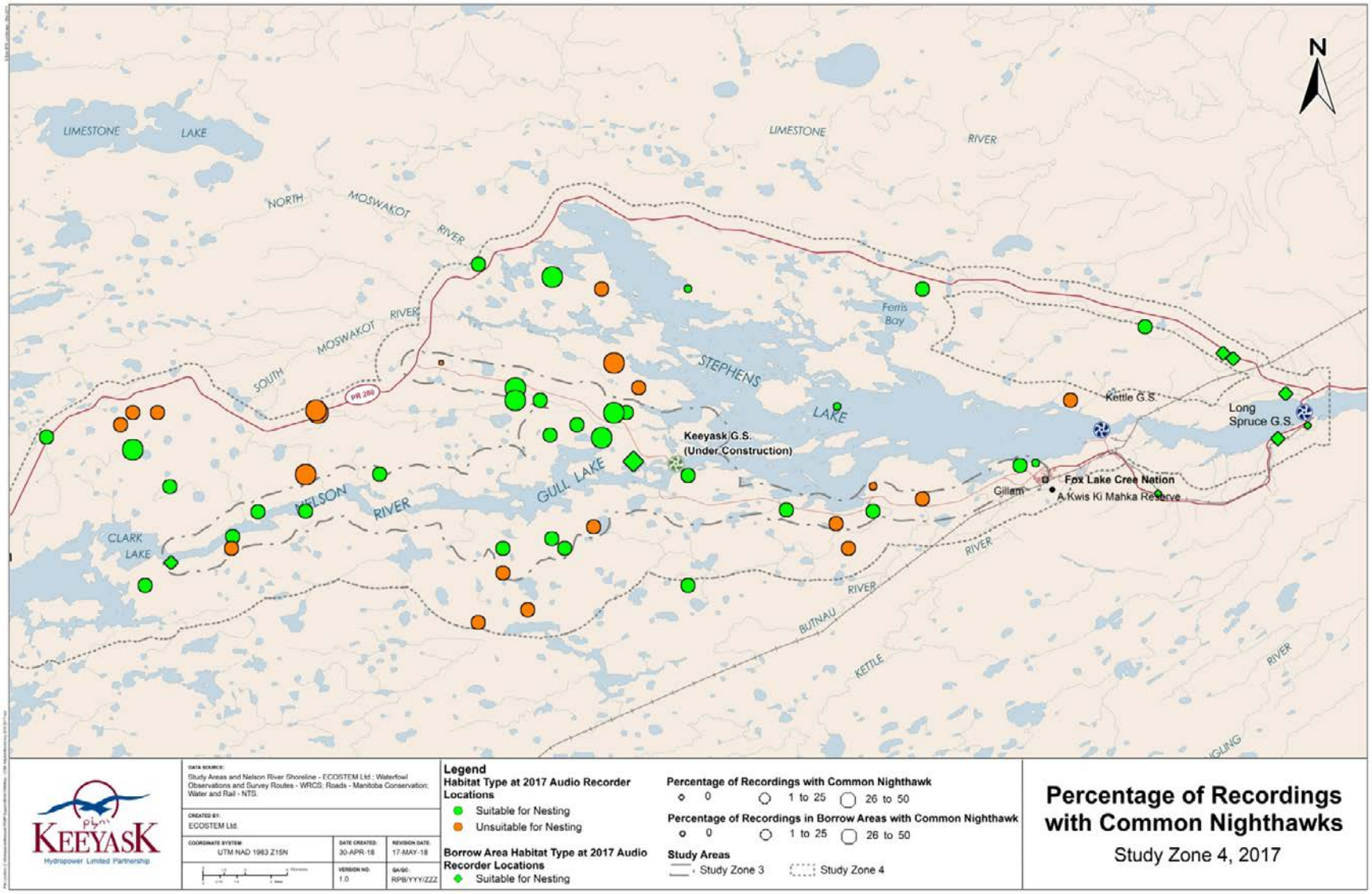
Figure 4: Number of Recordings with Common Nighthawk (CONI) per Hour, Across All Sites Surveyed in 2017

A total of 49,753 audio clips from 2016 were reviewed to ensure that all calls attributed to common nighthawk were correctly identified. Ninety-seven percent of common nighthawk calls were accurately identified (n = 48,041). There were 1,712 false positive identifications. A total of 56,993 audio clips from 2017 were reviewed. Ninety-seven percent of common nighthawk calls were accurately identified (n = 55,148). There were 1,845 false positive identifications.

Three common nighthawk nests and one potential nest were incidentally reported between 2015 and 2017 in Project sites (Appendix 3).



Map 3: Percentage of Recordings with Common Nighthawks in Study Zone 4, 2016



Map 4: Percentage of Recordings with Common Nighthawks in Study Zone 4, 2017

4.0 DISCUSSION

Common nighthawk calls were identified at sites throughout Study Zone 4 in 2016 and 2017, in habitat that is likely suitable for nesting and also in less suitable habitat. It is unclear why the species was detected at most of the sites thought to be unsuitable for nesting. More distant birds could have been detected on the recorders in unsuitable habitat, or individuals passing through could have been recorded. As there was little difference in the frequency of detection in each habitat category (i.e., common nighthawks were recorded on similar percentages of recordings and survey nights in each), the latter seems unlikely. However, common nighthawk home ranges are typically large and several kilometres can separate foraging and nesting habitats (Environment Canada 2016). Common nighthawks foraging near unsuitable nesting habitat may have been recorded, or habitat thought to be unsuitable for breeding may have been adequate for foraging.

The EIS predicted that land clearing would result in a temporary gain of breeding habitat, but construction noise was expected to deter nesting in areas near Project activities. Ten sites were surveyed in borrow areas over two years, one of which was active. Common nighthawks were detected at seven of these sites, including the active borrow area. However, the species was detected on few recordings at most sites in borrow areas and on a small proportion of the nights surveyed. These borrow areas may be on the periphery of the birds' territories, or individuals may have been passing through. At the active borrow area that was surveyed in 2017, 28% of recordings included common nighthawk calls and the species was detected on 55% of survey nights, suggesting that at least one individual frequented the area over a longer period and that habitat effectiveness at the site may not have been substantially reduced by construction disturbance. Anecdotal information collected on common nighthawk nests that were located in borrow areas and along dykes, substantiates EIS predictions regarding the use of disturbed habitats. From the 2015 to 2017 construction period, buffers were placed at all known common nighthawk nest sites to minimize disturbance while nesting and raising young.

Common nighthawks appeared to be most active until mid-July, roughly coinciding with their breeding season (Manitoba Breeding Bird Atlas 2018). As expected, the majority of their calls were recorded between 9:00 and 11:00 p.m., at dusk and just after sunset, a period when they are typically most active (Environment Canada 2016). Relatively few common nighthawk recordings were made the nights of July 12 and 13, 2016 and July 16, 2017, in the middle of the respective survey periods. A review of the recordings on these dates indicated that windy conditions influenced detections.

5.0 SUMMARY AND CONCLUSIONS

Common nighthawks were widely distributed in Study Zone 4, and were recorded at most of the sites surveyed in 2016 and 2017, regardless of the expected suitability of the habitat for nesting. Individuals were detected at borrow areas, which have been cleared and may be subject to disturbance. Additional reviews of recordings will be conducted to ensure that no common nighthawk calls were missed during the analysis. Common nighthawk monitoring will continue in 2018. Power analyses will be performed on the existing data to improve the study design prior to the deployment of the automated recording units in late June 2018. More detailed, multi-year analyses of recordings will then be performed, when construction monitoring for the species concludes.

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APPENDIX 1:
TABLES

Table A-1: Recorder Locations for Common Nighthawk, 2016

Site	UTM Coordinate	Site	UTM Coordinate
AA34	15 V 331678 6241650	BI29	15 V 365506 6246407
AE24	15 V 335344 6251702	BL32	15 V 368378 6243636
AF30	15 V 336353 6245370	BN32	15 V 370454 6243416
AG26	15 V 337559 6249535	BN8	15 V 370471 6267483
AG27	15 V 337422 6248426	Bor_05	15 V 351980 6253445
AH33	15 V 338544 6242466	Bor_09	15 V 405715 6245155
AK29	15 V 341558 6246430	Bor_18	15 V 408513 6256314
AP20	15 V 346429 6255498	Bor_19	15 V 403707 6258471
AQ39	15 V 347723 6236596	BQ32	15 V 373469 6243613
AR35	15 V 348458 6240260	BR31	15 V 374512 6244569
AS34	15 V 349685 6241337	BR35	15 V 374633 6240457
AU40	15 V 351693 6235347	BT15	15 V 376592 6260592
AV29	15 V 352259 6246495	BU10	15 V 377570 6265530
AW36	15 V 353603 6239433	BY30	15 V 381650 6245697
AW22	15 V 353603 6253586	BZ32	15 V 382512 6243634
AX26	15 V 354322 6249670	CP15	15 V 398633 6260381
AX27	15 V 354446 6248212	D33	14 V 679696 6241707
AX34	15 V 354458 6241285	J34	14 V 685510 6241537
AY14	15 V 355555 6261697	N26	15 V 318563 6249528
AY15	15 V 355502 6260421	S34	15 V 323479 6241489
AY21	15 V 355498 6254422	V32	15 V 326709 6243132
BC16	15 V 359503 6259491	V34	15 V 326647 6241366
BD19	15 V 360314 6256655	X32	15 V 328572 6243662
BD26	15 V 360416 6249525	X36	15 V 328493 6239311
BF18	15 V 362312 6257640	Z32	15 V 330646 6243454

Table A-2: Recorder Locations for Common Nighthawk, 2017

Site	UTM Coordinate	No. Years Surveyed	Site	UTM Coordinate	No. Years Surveyed
AD29	15 V 334506 6246498	1	Bor_12	15 V 323605 6239338	1
AD32	15 V 334503 6243504	1	Bor_13	15 V 415732 6250429	1
AE24	15 V 335494 6251505	2	Bor_20	15 V 408871 6256292	1
AJ29	15 V 340502 6246508	1	Bor_22	15 V 409698 6255858	1
AO20	15 V 345494 6255498	1	Bor_23	15 V 413316 6249378	1
AR12	15 V 348512 6263502	1	BQ32	15 V 373501 6243496	2
AR41	15 V 348495 6234496	1	BU24	15 V 377588 6251961	1
AT35	15 V 350493 6240497	1	BU33	15 V 377504 6242492	1
AT37	15 V 350503 6238498	1	BV35	15 V 378502 6240499	1
AU22	15 V 351508 6253506	1	BX30	15 V 380502 6245505	1
AU23	15 V 351497 6252509	1	BX32	15 V 380501 6243500	1
AV40	15 V 352507 6235516	1	C36	14 V 678889 6239217	1
AW23	15 V 353515 6252494	1	CB14	15 V 384502 6261500	1
AX13	15 V 354498 6262500	1	CB31	15 V 384500 6244500	1
AX26	15 V 354505 6249495	2	CJ28	15 V 392415 6247210	1
AX34	15 V 354496 6241496	2	CK28	15 V 393678 6247393	1
AY35	15 V 355503 6240501	1	CN23	15 V 396499 6252500	1
AZ25	15 V 356498 6250503	1	CT17	15 V 402545 6258443	1
BB14	15 V 358495 6261498	1	I26	14 V 684220 6249404	1
BB26	15 V 358497 6249484	1	O25	15 V 319508 6250504	1
BB33	15 V 357849 6242239	1	P24	15 V 320498 6251499	1
BC20	15 V 359495 6255524	1	P27	15 V 320489 6248523	1
BC24	15 V 359493 6251496	1	P35	15 V 335509 6251489	1
BD24	15 V 360506 6251500	1	Q38	15 V 321497 6237499	1
BE22	15 V 361501 6253508	1	R24	15 V 322499 6251496	1
BI14	15 V 365493 6261499	1	S30	15 V 323502 6245499	1
BI29	15 V 365499 6246493	2	S36	15 V 323622 6239355	1
BI38	15 V 365501 6237501	1	X34	15 V 328592 6241447	1
Bor_07	15 V 361074 6247556	1	X35	15 V 328497 6240500	1
Bor_08	15 V 413948 6253028	1	Z32	15 V 330646 6243454	2
Bor_10	15 V 403605 6244918	1			

Table A-3: Audio Recordings for Common Nighthawk (CONI), 2016

Habitat Type	Site	Recordings			Survey Nights		
		Number	Number with CONI	Percentage with CONI	Number	Number with CONI	Percentage with CONI
Nesting	AA34	404	2	0.5	20	2	10
	AF30	480	53	11.0	20	14	70
	AH33	456	4	0.9	19	4	21
	AK29	456	99	21.7	19	16	84
	AS34	456	54	11.8	19	15	79
	AV29	432	113	26.2	18	15	83
	AW36	455	87	19.1	19	18	95
	AX26	432	75	17.4	18	16	89
	AX27	432	115	26.6	19	15	79
	AX34	456	15	3.3	19	8	42
	AY14	456	97	21.3	19	16	84
	AY15	456	172	37.7	19	18	95
	BC16	456	35	7.7	19	12	63
	BD19	456	11	2.4	19	9	47
	BI29	456	1	0.2	19	1	5
	BOR_05	432	25	5.8	18	10	56
	BOR_18	480	0	0	20	0	0
	BQ32	480	24	5.0	20	12	60
	BR31	480	1	0.2	20	1	5
	BR35	456	2	0.4	19	2	11
	BZ32	456	18	3.9	19	11	58
	J34	348	12	3.4	19	7	37
	X32	432	169	39.1	18	18	100
	Z32	432	26	6.0	18	11	61
Unsuitable	AE24	480	176	36.7	20	20	100

Habitat Type	Site	Recordings			Survey Nights		
		Number	Number with CONI	Percentage with CONI	Number	Number with CONI	Percentage with CONI
	AG26	456	85	18.6	19	16	84
	AG27	480	27	5.6	20	14	70
	AP20	432	134	31.0	18	17	94
	AY21	480	69	14.4	20	16	80
	BF18	456	87	19.1	19	15	79
	BL32	480	11	2.3	20	5	25
	BN32	456	5	1.1	19	4	21
	BN8	364	1	0.3	17	1	6
	BT15	480	2	0.4	20	2	10
	BU10	480	3	0.6	20	3	15
	BY30	456	1	0.2	19	1	5
	D33	456	19	4.2	19	7	37
	V32	456	170	37.3	19	18	95
	V34	432	73	16.9	18	17	94
	X36	397	0	0	19	0	0

Table A-4: Audio Recordings for Common Nighthawk (CONI), 2017

Habitat Type	Site	Recordings			Survey Nights		
		Number	Number with CONI	Percentage with CONI	Number	Number with CONI	Percentage with CONI
Nesting	AD32	648	4	0.6	27	2	7
	AJ29	648	128	19.8	27	24	89
	AR12	672	3	0.4	28	3	11
	AT35	600	116	19.3	25	21	84
	AU22	624	223	35.7	26	25	96
	AU23	624	253	40.5	26	25	96
	AW23	625	71	11.4	26	21	81
	AX13	648	216	33.3	27	26	96
	AX26	625	80	12.8	26	20	77
	AX34	600	64	10.7	25	21	84
	AY35	600	66	11.0	25	20	80
	AZ25	625	25	4.0	26	13	50
	BB26	624	211	33.8	26	24	92
	BC24	624	261	41.8	26	26	100
	BD24	624	150	24.0	26	22	85
	BI14	649	0	0	27	0	0
	BI29	504	2	0.4	21	1	5
	BI38	625	58	9.3	26	23	88
	Bor_07[1]	264	74	28.0	11	6	55
	Bor_08	601	11	1.8	25	10	40
	Bor_10	368	0	0	16	0	0
	Bor_12	600	7	1.2	25	5	20
	Bor_13	625	0	0	26	0	0
	Bor_20	600	5	0.8	25	4	16
	Bor_22	600	2	0.3	25	2	8

Habitat Type	Site	Recordings			Survey Nights		
		Number	Number with CONI	Percentage with CONI	Number	Number with CONI	Percentage with CONI
Nesting	Bor_23	600	3	0.5	25	3	12
	BQ32	625	61	9.8	26	19	73
	BU24	600	0	0	25	0	0
	BX32	601	24	4.0	25	14	56
	CB14	552	42	7.6	23	15	65
	CJ28	600	6	1.0	25	6	24
	CK28	600	0	0	25	0	0
	CT17	600	5	0.8	25	5	20
	I26	720	49	6.8	30	19	63
	P27	696	283	40.7	29	22	76
	Q38	720	11	1.5	30	6	20
	S30	696	84	12.1	29	22	76
	S36	600	0	0	25	0	0
	X34	696	5	0.7	29	5	17
	Z32	648	69	10.6	26	19	73
Unsuitable	AD29	648	175	27.0	27	26	96
	AE24	649	290	44.7	27	26	96
	AR41	601	74	12.3	25	24	96
	AT37	601	65	10.8	25	20	80
	AV40	600	15	2.5	25	12	48
	BB14	648	86	13.3	27	23	85
	BB33	601	18	3.0	25	11	44
	BC20	624	259	41.5	26	26	100
	BE22	624	69	11.1	26	23	88
	BU33	624	6	1.0	26	6	23
	BV35	318	5	1.6	14	4	29

Habitat Type	Site	Recordings			Survey Nights		
		Number	Number with CONI	Percentage with CONI	Number	Number with CONI	Percentage with CONI
	BX30	600	0	0	25	0	0
Unsuitable	C36	600	0	0	25	0	0
	CB31	530	120	22.6	25	17	68
	CN23	600	1	0.2	25	1	4
	O25	720	99	13.8	30	22	73
	P24	696	38	5.5	29	16	55
	P35	672	297	44.2	28	28	100
	R24	696	10	1.4	29	8	28
	X35	697	2	0.3	29	2	7

1. Active borrow area.

APPENDIX 2:
ANALYSIS METHODS

AUTOMATED RECORDING UNITS (ARUS)

Although there is extensive precedent for using automated recording units (ARUs) for avian studies (Shonfield and Bayne 2017)[1], we had difficulty finding an ARU to meet our needs. In some of the species at risk studies proposed for the *Terrestrial Effects Monitoring Plan* (TEMP), for example, it was necessary to estimate distance and direction to the vocalizing birds. This required more than two channels of audio recording. Study design also demanded a large number of recorders to meet sample size requirements. After surveying the available technology, no recorders were found that could record four channels at a reasonable cost. Wildlife Resource Consulting Services MB Inc. commissioned Myrica Systems Inc. to design custom ARUs and a local contract assembler was hired to build them.

There were a number of criteria to be met in the ARU design:

- **Time accuracy**: ARUs contained a temperature-compensated quartz clock with an accuracy of +/- 2 minutes per year over a range of -40°C to 85°C.
- **Flexible time scheduling**: Timing parameters included start times, recording duration, interval, and number repetitions. Recordings can be corrected for sunrise and sunset over the season; units were loaded with daily sunrise and sunset times determined from National Oceanic and Atmospheric Administration (NOAA) calculations given the year, latitude, and longitude.
- **Lengthy unattended run time**: The design was optimized for minimal power consumption. ARUs could be powered from AA, D and 6V lantern batteries as required to meet recording time requirements.
- **Audio sensitivity**: Microphones were mounted in a separate case containing low-noise pre-amplifiers. Gain was set to match the sensitivity of human observers trained to identify bird calls.
- **Noise insensitivity**: Filtering was designed to remove frequencies above and below the range of interest for the bird species being recorded. This reduces, for example, wind noise. Microphones were also fitted with open-cell foam “windsocks.”
- **Environmental tolerance**: ARUs were designed and components chosen to operate in the full range of temperatures expected in the field. Microphone cables were sheathed in metal braid to resist chewing by rodents. Electronics were protected in weatherproof cases.

[1] Shonfield, J. and Bayne. E.M. 2017. Autonomous recording units in avian ecological research: current use and future applications. Avian Conservation and Ecology 12(1):14. https://doi.org/10.5751/ACE-00974-120114.

- **Directionality**: Each of four microphones was mounted in a recessed hole on each face of a square enclosure. This provided a degree of audio isolation of each from its neighbours. The 'north' microphone was labelled on enclosures to permit alignment in the field.
- **Data storage**: ARUs were fitted with secure digital (SD) cards (8 gigabyte [GB] or 32GB) as appropriate. The audio sampling rate was also varied to match study, storage, and analysis requirements (16.0 kilohertz [kHz] or 44.1 kHz). Files were compressed in Ogg Vorbis format (OGG) using a patent-and-royalty-free algorithm, which provided no noticeable signal degradation. Each field recording consisted of two stereo recordings on the SD card (A and B). An audible time marker (click) was used to verify synchronization of the two stereo recordings.
- **Data identification**: Each ARU had a serial number label and was programmed with the same number in software. Recording file names contained the day of the year (DOY), hour (HH) and minute (MM) that the recording started. For example, two stereo recordings would be labelled 1832110A.ogg and 1832110B.ogg. As a back-up, data were embedded within the audio file that included time, date, and serial number.

PRE-PROCESSING DATA

For each survey year, field recordings from each recorder were copied from SD cards into a directory structure on a hard drive matching the respective year, study, and site. Each recording was 300 seconds in length. Data from each year comprised several terabytes despite data being in compressed format. Data were kept in separate working and backup repositories.

Analysis of bird vocalizations was performed using the statistical package R[1]. In order for data to be analyzed in R, OGG files had to be converted to wave (WAV) format using either SOX[2] or LameXP[3]. It was determined that an audio bandwidth of 5.5 kHz was sufficient to recognize the species of interest in recordings. For this reason, OGG files were converted to WAV format with a sampling rate of 11.025 kHz; this reduced the storage volume of uncompressed data and speeded file reading during analysis.

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[1] R (www.r-project.org), a free statistical analysis software environment. The Package 'monitoR' (https://CRAN.R-project.org/package=monitoR) was used. monitoR is described briefly in "A short introduction to acoustic template matching with monitoR." Sasha D. Hafner and Jonathan Katz. February 14, 2018 (available from www.r-project.org) and in more detail in: "monitoR: Automation Tools For Landscape-scale Acoustic Monitoring - PhD Dissertation. Jonathan Katz. The University of Vermont. May, 2015.

[2] SOX (http://sox.sourceforge.net) is a free command line application for converting formats of and processing data in audio files.

[3] LameXP (http://lamexp.sourceforge.net) is a free audio file format converter with a windows front end.

SPECIES DETECTION

Templates were created from exemplars of species vocalizations (calls) of interest. MonitoR uses a method called template matching to identify species by their sounds. The method can be thought of as taking a low-resolution spectrogram and measuring its correlation against the spectrogram of a whole recording. In fact, templates can be plotted as spectrograms (**Error! Reference source not found.**).

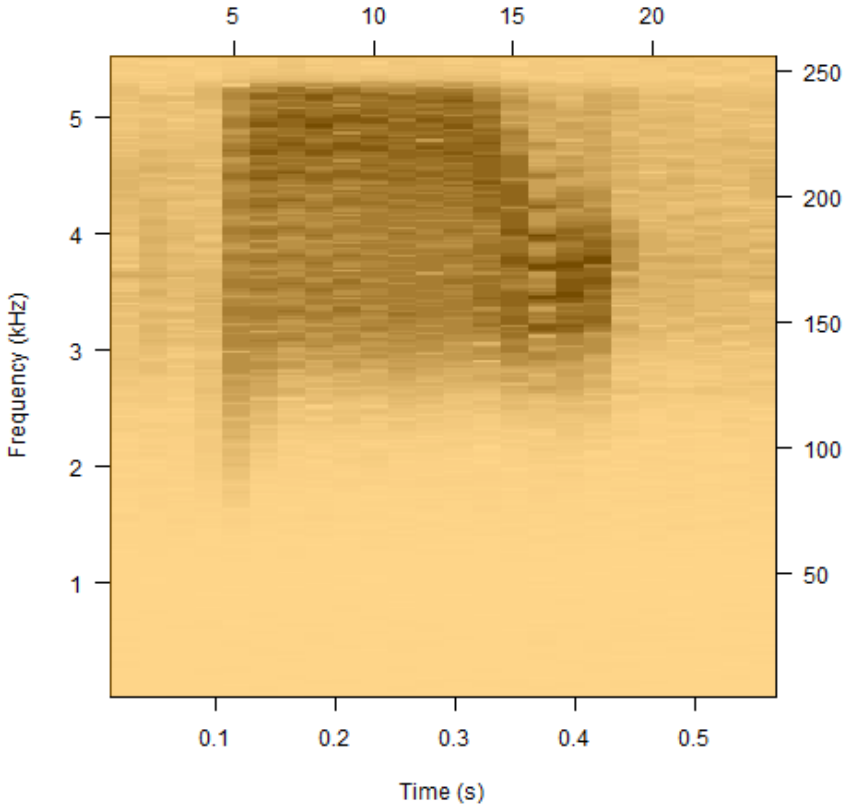


Figure B-1: Example Spectrogram of a Common Nighthawk Clip Extracted from a Recording

It was necessary to use multiple exemplars for a given species to cover the range in variation of calls. It was also necessary to measure correlation against other non-target sounds (calls and environmental sound) that also had a high correlation with the same species.

Due to the very large collection of recordings for analysis, a balance needed to be struck between the detail of templates used and the speed of analysis; recording analysis with detailed templates would take much longer. Attention was also paid to the duration and frequency bandwidth chosen for each template. To reduce analysis time to a practical order of magnitude, a two-step process of analysis was required.

In the first step, a limited number of low-resolution templates were used to discover candidate calls of the target species, recognizing that there would be many false positives. These candidate calls were extracted as two-second sound clips with each clip starting one second prior to the centre of the call detection and running to one second after the centre of the call. Datasets were also created at this step that included clip file name and statistics about the candidate clip. A clip spectrogram (Figure B-2) was created for each clip that was useful for validation. By the second step, the volume of data had been greatly reduced and only clips were processed. These could then be analyzed at high resolution to remove most false positives.

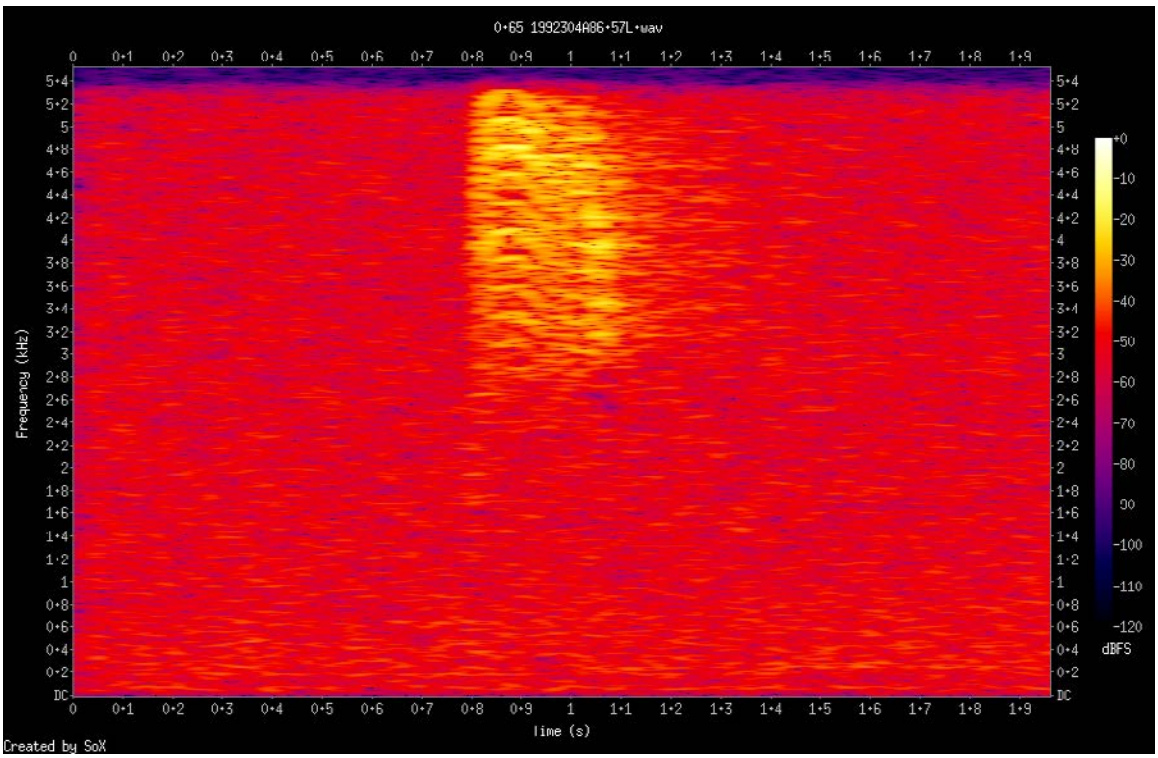
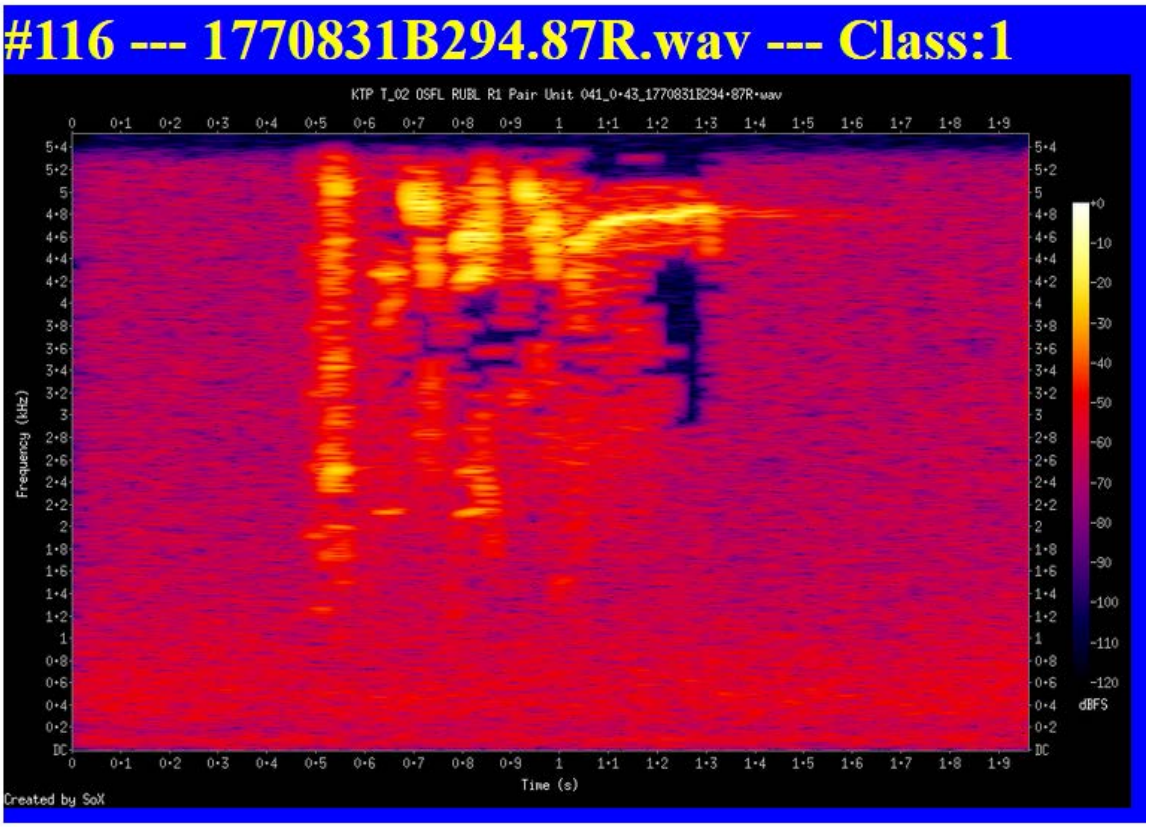


Figure B-2: Example Spectrogram of a Common Nighthawk Clip Extracted from a Recording

Classification of clips involved setting a threshold for target and off-target calls and calculating a difference between the two; classification criteria were adjusted to achieve a false positive rate of less than 5%. A viewing system for validation was developed to allow experts to view each call (clip) as a spectrogram along with its classification and to listen to it by simply clicking on the spectrogram. The graphic user interface is an HTML web page with an example shown in Figure B-3. Summary statistics were created for all detections to aid in validation. Examples are given in Figure B-4 and Figure B-5.



Clip #116 from the Recording made on Day 177 at 0831hr, 294.87sec into Recording B Observed on the Left (L) Channel. "Class:1" Indicates this is a Positive Result.

Figure B-3: Example of HTML Display of Classified Rusty Blackbird Clip

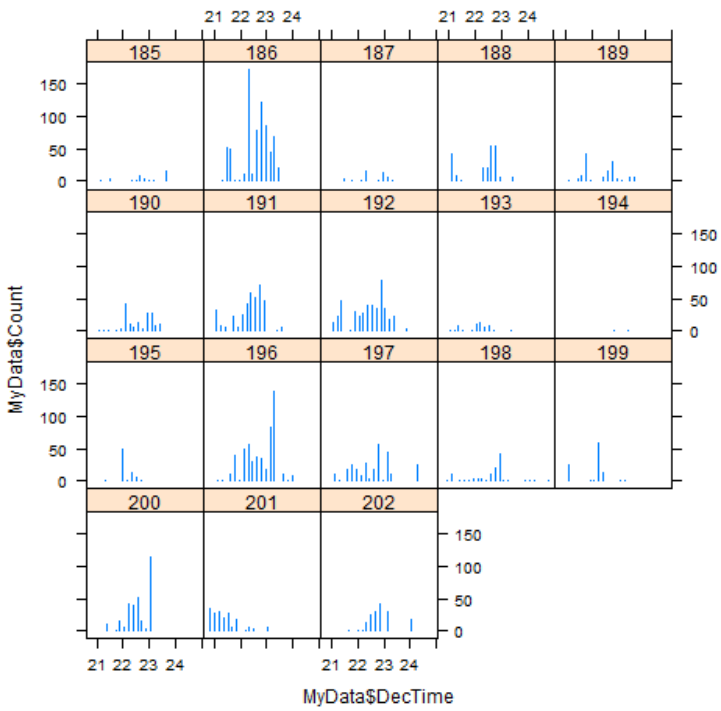
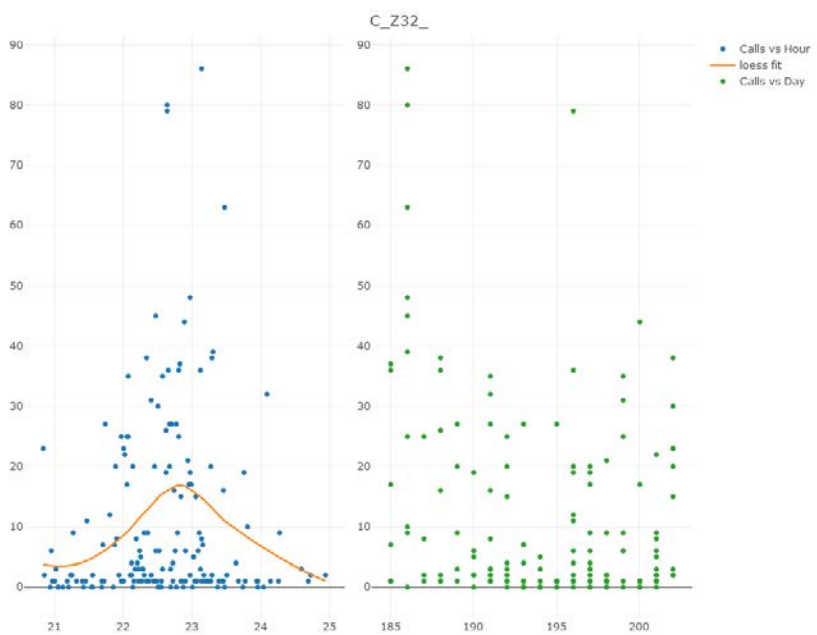


Figure B-4: Summary of Total Calls Detected for a Species within a Site and Year, Summarized by Day of Year and Hour of Day



Note the Peak in Calling at about 2300h as Expected for this Species.

Figure B-5: Summary of Calls Detected for Common Nighthawk within a Site and Year, vs. Hour of Day and vs. Day of Year

DISTANCE AND DIRECTION ESTIMATION

Sound pressure level in decibels (SPL), which humans perceive as 'sound volume', has been shown to provide a good estimate of distance to a calling bird (Yip et al. 2017)[1]. Direction can be estimated using the equivalent of Interaural Level Difference (ILD); from a human perspective this would be equivalent to using sound volume as a cue about direction (Nelson and Suthers 2004)[2]. Although many automated direction estimation algorithms use Interaural Time Difference (ITD), humans do not use this for frequencies high frequencies (Roman et al. 2003)[3]. There were several reasons why there was concern that ITD might be unreliable in the studies. Some include: low signal to noise ratios (SNR), reverberation, environmental noise like wind, etc. In addition, the recording hardware was expected to have small differences that would be more pronounced at the high frequencies of bird calls. Microphones and circuits were identical by design, but tolerances in components were not and phase errors were expected. Exact synchronization of the two stereo recordings was problematic, even with the synchronization click that was used. It was concluded that ILD was the best choice.

An algorithm was devised to find the peak root mean square (RMS) amplitude within each clip and convert it to a decibel value with an accurate time stamp. The four peak values were then used to triangulate the direction of the call (Figure B-6); it was assumed that the calling bird was in the horizontal plane of the microphone array. For common nighthawk, directionality was not achievable or valid since this species calls in flight and could be anywhere within a hemisphere surrounding the microphone array.

In the final data set, distance of the calling bird was estimated using decibel-distance curves created with field calibration recordings. Using the sound clips, distances were estimated by choosing the largest decibel value measured by the four microphones. For common nighthawks, distance estimation was problematic since they fly erratically while calling. Estimates were obtained from other researchers of the maximum recording distance expected for common nighthawk detected with the recorders (Figure B-7).

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[1] Yip, D.A., Leston, L., Bayne, E.M., Sólymos, P., and Grover, A. 2017. Experimentally derived detection distances from audio recordings and human observers enable integrated analysis of point count data. Avian Conservation and Ecology 12(1):11. https://doi.org/10.5751/ACE-00997-120111.

[2] Nelson, B.S. and Suthers, R.A. 2004. Sound localization in a small passerine bird: discrimination of azimuth as a function of head orientation and sound frequency. The Journal of Experimental Biology 207: 4121–4133.

[3] Roman, N., Wang, D., and Brown, G. 2003. Speech segregation based on sound localization. The Journal of the Acoustical Society of America 114: 2236–2252. https://doi.org /10.1121/1.1610463.

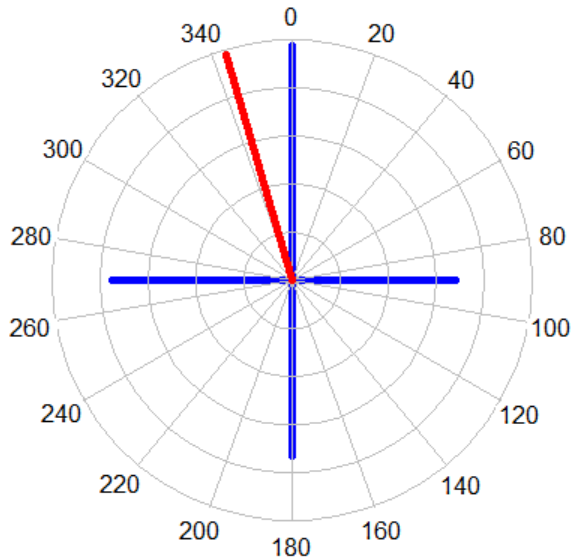

Figure B-6: Example of Direction Calculated from the Peak RMS Amplitude of a Clip from All Four Microphones

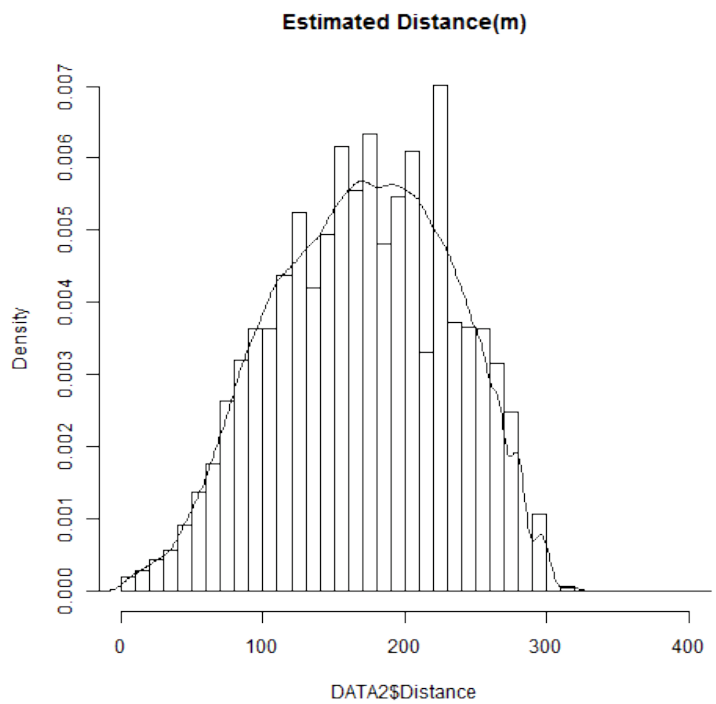

Figure B-7: Example of Distribution of Distance Estimates for Common Nighthawk in One Dataset

APPENDIX 3:
INCIDENTAL OBSERVATIONS

Table C-1: Locations of Common Nighthawks and Nests at Project Sites, 2015 and 2017

Location	Date	Additional Details
15 V 358180 6251710	July 2015	Nest observed in the Km 15 borrow area; buffer established restricting construction activity (Photo C-1)
15 U 365894 6250105	July 2017	Nest observed in a borrow area; buffer established restricting construction activity (Photo C-2)
15 V 355174 6242506	July 2017	Nest observed in a clearing along the south dyke (Photo C-3)
15 V 357704 6243754	July 2017	Two individuals observed in a clearing along the south dyke (Photo C-4). Potential nest or roosting

Photo C-1: Common Nighthawk Nest with Two Eggs at Km 15 Borrow Area, July 2015

Photo C-2: Borrow Area Flagged Off to Protect Common Nighthawk Nest, July 2017

Photo C-3 Common Nighthawk Nest with Two Eggs in a Clearing along the South Dyke, July 2017

Photo C-4: Common Nighthawk in a Clearing along the South Dyke, July 2017