APPENDIX I
AVIFAUNA

Table 1: Spring and Fall Migration Survey Dates and Weather Conditions ***Project # 24-9952***

Survey Round	Date	Temperature (°C)	Wind (Beaufort Scale)	Precipitation	Notes
Spring Migration					
Round 1	12-Apr-22	04-Jan	0-1	0	
	13-Apr-22	04-Jan	0-2	1-2 (light rain, snow/flurries, and fog at start, flurries on and off near end)	Quarry noisy at PC 4
	14-Apr-22	0	0	0	
	19-Apr-22	1	1	0	Ended surveys early this day due to wind picking up above 3
	20-Apr-22	07-Jun	0-1 (gusts of 2)	0-1 (light rain at start)	
	21-Apr-22	06-Jan	0-1 (gusts of 2)	0	
	22-Apr-22	07-Apr	2	0	
Round 2	22-Apr-22	07-Apr	2	0	
	25-Apr-22	08-Mar	0	0 (light mist at start)	
	26-Apr-22	0-9	0-1	0	
	27-Apr-22	4	0	0	
Round 3	04-May-22	11-Feb	0-3	0	
	06-May-22	0-6	0-2	0	
	09-May-22	0-8	02-Jan	0	
Round 4	18-May-22	13-Sep	0-2	0-1 (light rain on and off at start)	Deer observed
	19-May-22	09-Mar	2	0	
	20-May-22	10-Aug	0	0	Quarry noisy at PCs 4 and 8
Round 5	25-May-22	11-Jun	1	0-1 (light rain at start)	
	26-May-22	12-Oct	-2 (gusts of 3 at end	0	
	27-May-22	10-Sep	02-Jan	0	
Fall Migration					
Round 1	15-Aug-22	17-20	3	0	60-100% cloud cover
	16-Aug-22	19-Dec	0-2	0	80-100% cloud cover
Round 2	29-Aug-22	15	0	0	90% cloud cover
	30-Aug-22	16	1	0	10% cloud cover
	03-Sep-22	10.5	0	0	
	04-Sep-22	11	0-3 (3 at end)	0	0-10% cloud cover
Round 3	12-Sep-22	17-22	2-3 (gusts of 4)	0	40-60% cloud cover
	13-Sep-22	10	0-2	0	0-10% cloud cover, light fog at start only
	19-Sep-22	5.5	0	0	50% cloud cover
	28-Sep-22	16.5	0-1	0	90% cloud cover
	29-Sep-22	13	1	0	100% cloud cover
Round 4	10-Oct-22	4.5	2	0	10% cloud cover
	11-Oct-22	0	0	0	0% cloud cover
	12-Oct-22	10-Feb	0-1	0	0% cloud cover
	13-Oct-22	5	0	0	10% cloud cover
	14-Oct-22	9	02-Jan	0	100% cloud cover
Round 5	24-Oct-22	11	0	0	90% cloud cover
	26-Oct-22	15	0	0	90% cloud cover
	28-Oct-22	6.5	03-Feb	0	70% cloud cover
	29-Oct-22	-1	1	0	70% cloud cover
	30-Oct-22	10-May	03-Feb	0	5% cloud cover

Notes: weather conditions represent the entire survey (surveyors recorded weather conditions at the start and end of each survey). Precipitation scale is as follows: 0 = none, 1 = drizzle, and 2 = light/moderate. Wind scale (Beaufort scale) is as follows: 0 = <1 km/hr, 1 = 1-5 km/hr, 2 = 6-11 km/hr, and 3 = 12-19 km/hr. Number of dates vary per round depending on number of surveyors and the time limit each day to complete PCs.

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Common Name	Scientific Name	Code	Group	*SARA*	*ESA*	NS S-Rank	Number Observed	Age	Sex	Point Count Observations
Canada warbler	***Cardellina canadensis***	**CAWA**	**6**	**T**	**E**	**S3B**	**4**	**A**	**2 M**	**1, 12, 17**
Evening grosbeak	***Coccothraustes vespertinus***	**EVGR**	**6**	**SC**	**V**	**S3B, S3N, S3M**	**5**	**A**	**-**	**5, 31**
Peregrine falcon	***Falco peregrinus***	**PEFA**	**4**	**-**	**V**	**S1B, SUM**	**2**	**A**	**-**	**11, 36**
Boreal chickadee	***Poecile hudsonica***	**BOCH**	**6**	**-**	**-**	**S3**	**61**	**A**	**-**	**1, 5, 11, 12, 15, 18, 19, 20, 21, 22, 23, 24, 25, 32, 33, 35, 38, 40, 41**
Canada jay	***Perisoreus canadensis***	**CAJA**	**6**	**-**	**-**	**S3**	**9**	**A**	**-**	**1, 24, 28**
Cape May warbler	***Setophaga tigrina***	**CMWA**	**6**	**-**	**-**	**S3B, SUM**	**3**	**A**	**-**	**7, 13, 26**
Pine siskin	***Spinus pinus***	**PISI**	**6**	**-**	**-**	**S3**	**44**	**A**	**-**	**1, 2, 3, 4, 5, 8, 9, 10, 11, 14, 17, 18, 23, 27, 30, 31, 33, 34, 36, 37, 38, 40**
Rose-breasted grosbeak	***Pheucticus ludovicianus***	**RBGR**	**6**	**-**	**-**	**S3B**	**1**	**A**	**-**	**39**
Alder flycatcher	*Empidonax alnorum*	ALFL	6	-	-	S5B	3	A	-	1, 8
American black duck	*Anas rubripes*	ABDU	1	-	-	S5B, S5N	15	A, 9 J	1 F	9, 11, 14
American crow	*Corvus brachyrhynchos*	AMCR	6	-	-	S5	27	A	-	1, 2, 4, 8, 9, 10, 12, 13, 18, 19, 21, 23, 28, 29, 31, 33, 36, 37, 41
American goldfinch	*Carduelis tristis*	AMGO	6	-	-	S5	196	A	-	1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27 29, 31, 32, 34, 35, 36, 37, 39, 40, 41
American redstart	*Setophaga ruticilla*	AMRE	6	-	-	S5B	5	A	-	1, 3, 4, 13, 21
American robin	*Turdus migratorius*	AMRO	6	-	-	S5B, S3N	228	A	-	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26 27, 28, 29, 30, 31, 32, 33, 34, 35, 37, 38, 39, 40, 41
American tree sparrow	*Spizelloides arborea*	ATSP	6	-	-	S5N	1	A	-	25
Bald eagle	*Haliaeetus leucocephalus*	BAEA	4	-	-	S5	2	A	-	3
Barred owl	*Strix varia*	BDOW	5	-	-	S5	3	A	-	15, 39, 40
Bay-breasted warbler	*Setophaga castanea*	BBWA	6	-	-	S3S4B, S4S5M	4	A	-	24, 28, 41
Blackburnian warbler	*Setophaga fusca*	BLBW	6	-	-	S4B, S5M	4	A	-	23, 33, 41
Blackpoll warbler	*Setophaga striata*	BLPW	6	-	-	S3B, S5M	1	A	-	23
Black-and-white warbler	*Mniotilta varia*	BAWW	6	-	-	S5B	61	A	1 M, 1 F	1, 2, 3, 4, 5, 7, 8, 10, 11, 12, 13, 14, 17, 18, 20, 21, 23, 24, 27, 28, 30, 31, 32, 33, 34, 35 36, 37, 38, 39, 40, 41
Black-capped chickadee	*Poecile atricapilla*	BCCH	6	-	-	S5	114	A	-	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 17, 18, 20, 21, 23, 24, 25, 26, 29, 30, 31, 32 33, 34, 35, 36, 37, 39, 40, 41
Black-throated blue warbler	*Setophaga caerulescens*	BTBW	6	-	-	S5B	2	A	-	33, 37
Black-throated green warbler	*Dendroica virens*	BTNW	6	-	-	S5B	82	A	-	1, 2, 3, 4, 5, 6, 7, 8, 10, 12, 13, 14, 16, 18, 20, 22, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33 34, 37, 38, 39, 40, 41
Blue jay	*Cyanocitta cristata*	BLJA	6	-	-	S5	63	A	1 M, 1 F	1, 2, 4, 5, 6, 9, 10, 13, 14, 15, 16, 17, 18, 19, 20, 22, 23, 24, 29, 30, 31, 32, 34, 35, 36 39, 40
Blue-headed vireo	*Vireo solitarius*	BHVI	6	-	-	S5B	38	A	-	1, 2, 4, 5, 6, 8, 10, 11, 14, 16, 18, 19, 20, 22, 23, 24, 26, 27, 28, 29, 32, 33, 37
Broad-winged hawk	*Buteo platypterus*	BWHA	4	-	-	S5B	2	A	-	32, 37
Brown creeper	*Certhia americana*	BRCR	6	-	-	S5	4	A	-	10, 20
Chestnut-sided warbler	*Setophaga pensylvanica*	CSWA	6	-	-	S5B	1	A	-	1
Chipping sparrow	*Spizella passerina*	CHSP	6			S4B, S5M	2	A	-	14, 23
Common grackle	*Quiscalus quiscula*	COGR	6	-	-	S5B	15	A	-	1, 2, 14, 23, 24, 36, 40
Common raven	*Corvus corax*	CORA	6	-	-	S5	16	A	-	2, 4, 5, 8, 11, 13, 24, 31
Common yellowthroat	*Geothlypis trichas*	COYE	6	-	-	S5B	39	A	-	1, 4, 5, 8, 9, 11, 12, 14, 17, 22, 23, 24, 32, 38, 39, 40
Dark-eyed junco	*Junco hyemalis*	DEJU	6	-	-	S4S5	114	A	-	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28 29, 30, 31, 32, 34, 37, 38, 39, 40, 41
Downy woodpecker	*Dryobates pubescens*	DOWO	7	-	-	S5	17	A	-	1, 2, 3, 6, 7, 8, 10, 14, 16, 21, 24, 32, 38
Golden-crowned kinglet	*Regulus satrapa*	GCKI	6	-	-	S5	45	A	-	3, 5, 6, 8, 9, 12, 13, 15, 16, 18, 20, 21, 22, 23, 27, 28, 30, 31, 33, 34, 35, 36, 37, 38, 40
Green-winged teal	*Anas crecca*	GWTE	1	-	-	S4S5B, S5M	2	A	-	24
Hairy woodpecker	*Picoides villosus*	HAWO	7	-	-	S5	15	A	-	2, 12, 17, 19, 20, 23, 25, 26, 29, 30, 31, 37
Hermit thrush	*Catharus guttatus*	HETH	6	-	-	S5B	140	A	-	1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27 29, 30, 31, 32, 34, 35, 36, 37, 38, 39, 40
Least flycatcher	*Empidonax minimus*	LEFL	6	-	-	S4S5B, S5M	3	A	-	18, 21, 23
Lincoln's sparrow	*Melospiza lincolnii*	LISP	6	-	-	S4B, S5M	6	A	-	14, 24, 38
Magnolia warbler	*Dendroica magnolia*	MAWA	6	-	-	S5B	50	A	-	1, 2, 3, 5, 7, 8, 9, 10, 11, 12, 13, 14, 17, 18, 19, 21, 22, 23, 24, 25, 26, 27, 31, 32, 33, 34 38, 39, 40, 41
Mallard	*Anas platyrhynchos*	MALL	1	-	-	S5B, S5N	4	A	1 F	11, 24
Mourning dove	*Zenaida macroura*	MODO	7	-	-	S5	1	A	-	11

Common Name	Scientific Name	Code	Group	*SARA*	*ESA*	NS S-Rank	Number Observed	Age	Sex	Point Count Observations
Mourning warbler	*Geothlypis philadelphia*	MOWA	6	-	-	S4B, S5M	5	A	2 M	1, 8, 15, 39
Nashville warbler	*Vermivora ruficapilla*	NAWA	6	-	-	S4B, S5M	8	A	-	1, 8, 14, 15, 21, 38, 40
Northern cardinal	*Cardinalis cardinalis*	NOCA	6	-	-	S4	2	A	-	6, 16
Northern flicker	*Colaptes auratus*	NOFL	7	-	-	S5B	64	A	-	1, 2, 3, 4, 5, 6, 7, 8, 9, 14, 16, 17, 18, 19, 20, 22, 23, 24, 25, 26, 29, 30, 31, 32, 34, 35 36, 37, 39, 40
Northern harrier	*Circus hudsonius*	NOHA	4	-	-	S4B, S4S5M	2	A	-	35, 38
Northern parula	*Parula americana*	NOPA	6	-	-	S5B	12	A	-	2, 3, 7, 8, 14, 20, 22, 23, 39, 41
Northern waterthrush	*Parkesia noveboracensis*	NOWA	6	-	-	S4B, S5M	1	A	-	40
Ovenbird	*Seiurus aurocapilla*	OVEN	6	-	-	S5B	106	A	-	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 23, 24, 25, 26, 27, 29 30, 33, 34, 35, 37, 38, 39, 40, 41
Palm warbler	*Dendroica palmarum*	PAWA	6	-	-	S5B	24	A	-	1, 2, 8, 11, 14, 16, 20, 22, 23, 24, 32, 36, 38, 40
Pileated woodpecker	*Dryocopus pileatus*	PIWO	7	-	-	S5	10	A	-	1, 2, 7, 14, 17, 37
Pine grosbeak	*Pinicola enucleator*	PIGR	6	-	-	S3B, S5N, S5M	4	A	-	2, 8, 25, 28
Purple finch	*Carpodacus purpureus*	PUFI	6	-	-	4S5B, S3S4N, S5	81	A	-	1, 2, 5, 6, 7, 8, 10, 11, 13, 14, 15, 17, 18, 20, 21, 22, 23, 24, 25, 26, 29, 30, 32, 34, 37 38, 39, 40, 41
Red-breasted nuthatch	*Sitta canadensis*	RBNU	6	-	-	S4S5	9	A	-	1, 8, 15, 18, 20, 23, 26, 41
Red-eyed vireo	*Vireo olivaceus*	REVI	6	-	-	S5B	15	A	-	1, 2, 3, 4, 6, 7, 8, 9, 13, 20, 26, 29
Red-tailed hawk	*Buteo jamaicensis*	RTHA	4	-	-	S5	6	A	-	13, 36, 37, 39
Red-winged blackbird	*Agelaius phoeniceus*	RWBL	6	-	-	S4B	1	A	-	14
Ring-necked duck	*Aythya collaris*	RNDU	1	-	-	S5B	12	A	2 M, 1F	9, 11
Ring-necked pheasant	*Phasianus colchicus*	RIPH	7	-	-	SNA	5	A	-	3, 6, 7, 37, 38
Ruby-crowned kinglet	*Regulus calendula*	RCKI	6	-	-	S4B, S5M	82	A	-	5, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25, 26, 29, 30, 31, 32, 34 35, 36, 38, 40
Ruffed grouse	*Bonasa umbellus*	RUGR	7	-	-	S5	25	A	-	2, 5, 7, 12, 19, 20, 25, 30, 31, 33, 35, 37, 39, 40
Savannah sparrow	*Passerculus sandwichensis*	SAVS	6	-	-	S4S5B, S5M	6	A	-	12, 14, 23, 24, 38
Sharp-shinned hawk	*Accipiter striatus*	SSHA	4	-	-	S5	1	A	-	24
Song sparrow	*Melospiza melodia*	SOSP	6	-	-	S5B	14	A	-	2, 8, 11, 14, 32, 38
Spotted sandpiper	*Actitis macularius*	SPSA	2	-	-	S3S4B, S5M	6	A	-	4, 11
Spruce grouse	*Canachites canadensis*	SPGR	7	-	-	S4	1	A	-	16
Swainson's thrush	*Catharus ustulatus*	SWTH	6	-	-	S4B, S5M	10	A	-	1, 3, 5, 20, 25, 28, 29, 36
Swamp sparrow	*Melospiza georgiana*	SWSP	6	-	-	S5B	22	A	-	1, 9, 11, 12, 14, 23, 24
Tree swallow	*Tachycineta bicolor*	TRES	6	-	-	S4B	1	A	-	5
White-breasted nuthatch	*Sitta carolinensis*	WBNU	6	-	-	S4	1	A	-	12
White-throated sparrow	*Zonotrichia albicollis*	WTSP	6	-	-	S4S5B, S5M	134	A	-	1, 2, 3, 4, 8, 11, 12, 14, 17, 19, 20, 22, 23, 24, 25, 27, 31, 32, 33, 34, 35, 37, 38, 39, 40 41
White-winged crossbill	*Loxia leucoptera*	WWCR	6	-	-	S4S5	205	A	1 F	1, 8, 10, 12, 14, 18, 20, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 36, 40, 41
Wilson's snipe	*Gallinago delicata*	WISN	2	-	-	S3B, S5M	5	A	-	9, 15, 24, 39, 41
Winter wren	*Troglodytes troglodytes*	WIWR	6	-	-	S5B	1	A	-	3
Yellow-bellied flycatcher	*Empidonax flaviventris*	YBFL	6	-	-	S4B, S5M	2	A	-	10, 33
Yellow-bellied sapsucker	*Sphyrapicus varius*	YBSA	7	-	-	S5B	1	A	-	7
Yellow warbler	*Dendroica petechia*	YWAR	6	-	-	S5B	7	A	-	1, 8, 9, 11, 12, 31
Yellow-rumped warbler	*Dendroica coronata*	YRWA	6	-	-	S5B	83	A	2 M	1, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 21, 22, 23, 24, 26, 27, 28, 29, 30, 31 32, 34, 35, 36, 37, 38, 39, 40, 41
Unknown buteo	*n/a*	*n/a*	4	-	-	*n/a*	1	A	-	23
Unknown cormorant	*n/a*	*n/a*	2	-	-	*n/a*	8	A	-	6
Unknown finch (American goldfinch or purple finch)	*n/a*	*n/a*	6	-	-	*n/a*	1	A	-	16
Unknown flycatcher (least or yellow-bellied flycatcher)	*n/a*	*n/a*	6	-	-	*n/a*	2	A	-	1, 5
Unknown passerine	*n/a*	*n/a*	6	-	-	*n/a*	27	A	-	3, 6, 7, 8, 11, 12, 13, 17, 19, 21, 24, 29, 32, 33, 37
Unknown raptor (diurnal)	*n/a*	*n/a*	4	-	-	*n/a*	4	A	-	1, 5, 18, 31
Unknown sparrow	*n/a*	*n/a*	6	-	-	*n/a*	8	A	-	1, 5, 14, 19, 38
Unknown thrush	*n/a*	*n/a*	6	-	-	*n/a*	1	A	-	17

Common Name	Scientific Name	Code	Group	*SARA*	*ESA*	NS S-Rank	Number Observed	Age	Sex	Point Count Observations
Unknown warbler	*n/a*	*n/a*	6	-	-	*n/a*	5	A	-	2, 4, 10, 17, 18
Unknown woodpecker (hairy or downy woodpecker)	*n/a*	*n/a*	7	-	-	*n/a*	4	A	-	6, 12, 14
Unknown woodpecker	*n/a*	*n/a*	7	-	-	*n/a*	12	A	-	5, 8, 9, 12, 13, 16, 20, 21, 22, 37, 38, 40

Total Number of Species (does not include unknowns)	81
Total Number of Individuals	2501

Notes: incidental observations not included (those observed outside of point count locations). A=Adult; J=Juvenile. Bird group is coded as: 1 = waterfowl; 2 = shorebirds; 3 = other waterbirds (i.e., that are not waterfowl or shorebirds); 4 = diurnal raptors; 5 = nocturnal raptors; 6 = passerines (excluding dippers), and 7 = other landbirds. Bolded species are priority species. Bolded and underlined species are SAR. ACCDC rankings retrieved from: http://accdc.com/webranks/NSall.htm (February 2023). "-" represents no federal or provincial designation

Table 3: Individual Abundance and Species Abundance by PC Location – Spring Migratio *Project # 24-9952*

PC Location	Total # of Individuals	Total Number of Species
1	112	36
2	77	27
3	49	22
4	42	17
5	60	24
6	62	17
7	44	20
8	107	32
9	77	21
10	44	20
11	72	26
12	74	24
13	49	19
14	121	32
15	33	16
16	29	14
17	72	19
18	66	22
19	34	16
20	59	24
21	58	18
22	103	19
23	115	32
24	95	32
25	51	19
26	46	18
27	31	14
28	40	13
29	36	18
30	37	17
31	70	22
32	61	22
33	33	16
34	38	17
35	31	15
36	42	17
37	63	23
38	89	23
39	47	22
40	70	26
41	62	19
Total	**2501**	**81***

Notes: incidental observations not included (those observed outside of point count locations). Total number of individuals observed include observations that were not able to be identified at the species level. * Total number of unique species observed (does not include unknowns).

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Table 4: Diurnal Watch Count Survey Dates and Weather Conditions ***Project # 24-9952***

Survey Round	Date	Temperature (°C)	Wind (Beaufort Scale)	Precipitation	Notes
Spring Migration					
Round 1	12-Apr-22	10-Apr	02-Jan	0	
	13-Apr-22	07-Jan	0-3	0	Ended approx. half-way through due to high winds at end (above 3). Redone on April 20 (see below)
	14-Apr-22	07-Jun	0-1	0	
	20-Apr-22	10-Sep	1-2 (gusts of 3)	0	DWC 2 surveyed twice during round 1 due to ending early the first time and was also relocated to a higher spot for better visibility (moved approx. 120 m on the same road to the same habitat type) – this results in five dates for round 1
	21-Apr-22	08-Jun	-1 (gusts of 2 at star	0	
Round 2	25-Apr-22	11-Jun	02-Jan	0	
	26-Apr-22	15-Sep	0-1	0-1 (1 only at start)	
Round 3	04-May-22	09-Aug	0-1	0	
	09-May-22	11-Aug	0-1	0	
Round 4	18-May-22	13-Oct	2	0	May 19, 2022 – DWCs cut short by approx. 1 hour due to wind increasing
	19-May-22	11-Sep	2-3 (3 only at end)	0	
Round 5	25-May-22	14-Dec	2	0	
	26-May-22	14-Dec	1	0	
Fall Migration					
Round 1	15-Aug-22	17-19	3	0	60% cloud cover
	16-Aug-22	19	2	0	20-90% cloud cover
Round 2	29-Aug-22	-*	2 (gusts of 3 at start)	0	30-80% cloud cover
	30-Aug-22	-*	03-Jan	0	10-20% cloud cover
	03-Sep-22	21-23	1-3 (3 at end)	0	0-10% cloud cover
	04-Sep-22	20-23	1-3 (3 at end)	0	0-10% cloud cover
Round 3	12-Sep-22	21-22	03-Feb	0	40-60% cloud cover
	13-Sep-22	20	02-Jan	0	0-20% cloud cover. Fog over valley and strait, did not impact view of sky
	19-Sep-22	15-17	2-3 (3 at end)	0	50-80% cloud cover
	29-Sep-22	14	2-3 (3 at end)	0	90-100% cloud cover
Round 4	10-Oct-22	10-Aug	(3 at end with gusts	0	50-80% cloud cover
	11-Oct-22	11-Jun	(3 at end with gusts	0	0% cloud cover
	12-Oct-22	14-Oct	02-Jan	0	0% cloud cover
	13-Oct-22	13-16	0-2	0	30-90% cloud cover
Round 5	24-Oct-22	15-23	02-Jan	0	50-75% cloud cover
	26-Oct-22	19-20	0-2	0	80-100% cloud cover
	28-Oct-22	08-Jul	3-4 (gusts of 4)	0	20-50% cloud cover
	29-Oct-22	3.5-6	03-Jan	0	0% cloud cover

*Notes: weather conditions represent the entire survey (surveyors recorded weather conditions at the start and end of each survey). Precipitation scale is as follows: 0 = none, 1 = drizzle, and 2 = light/moderate. Wind scale (Beaufort scale) is as follows: 0 = <1 km/hr, 1 = 1-5 km/hr, 2 = 6-11 km/hr, and 3 = 12-19 km/hr. DWC 1, spring migration round 2 missed by surveyors. Number of dates vary per round depending on number of surveyors. * "-" means no temperature was recorded due to the temperature not changing since the morning PC survey.*

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Table 5: Individual Abundance and Species of Birds Observed During Diurnal Watch Counts Surveys (Spring Migration) *Project # 24-9952*

Common Name	Scientific Name	Code	Bird Group	*SARA*	*ESA*	NS S-Rank	Number Observed	Age	Sex	DWC Observations
Peregrine falcon	***Falco peregrinus***	***PEFA***	4	-	V	**S1B, SUM**	**1**	**A**	-	**DWC 3**
Boreal chickadee	***Poecile hudsonica***	***BOCH***	**6**	-	-	**S3**	**15**	**A**	-	**DWC 1, 2, 3, 4**
Canada jay	***Perisoreus canadensis***	***CAJA***	**6**	-	-	**S3**	**2**	**A**	-	**DWC 2, 4**
Cape May warbler	***Setophaga tigrina***	***CMWA***	**6**	-	-	**S3B, SUM**	**1**	**A**	-	**DWC 1**
Pine siskin	***Spinus pinus***	***PISI***	**6**	-	-	**S3**	**23**	**A**	-	**DWC 1, 2, 3, 4**
Alder flycatcher	*Empidonax alnorum*	*ALFL*	6	-	-	S5B	1	A	-	DWC 3
American crow	*Corvus brachyrhynchos*	*AMCR*	6	-	-	S5	23	A	-	DWC 1, 2, 3, 4
American goldfinch	*Carduelis tristis*	*AMGO*	6	-	-	S5	155	A	-	DWC 1, 2, 3, 4
American kestrel	*Falco sparverius*	*AMKE*	4	-	-	S3B, S4S5M	1	A	-	DWC 3
American redstart	*Setophaga ruticilla*	*AMRE*	6	-	-	S5B	1	A	-	DWC 3
American robin	*Turdus migratorius*	*AMRO*	6	-	-	S5B, S3N	64	A	-	DWC 1, 2, 3, 4
Bald eagle	*Haliaeetus leucocephalus*	*BAEA*	4	-	-	S5	8	A	-	DWC 1, 2, 3
Barred owl	*Strix varia*	*BDOW*	5	-	-	S5	1	A	-	DWC 4
Black-and-white warbler	*Mniotilta varia*	*BAWW*	6	-	-	S5B	4	A	-	DWC 1, 3, 4
Black-capped chickadee	*Poecile atricapilla*	*BCCH*	6	-	-	S5	45	A	2 M, 2 F	DWC 1, 2, 3, 4
Black-throated green warbler	*Dendroica virens*	*BTNW*	6	-	-	S5B	11	A	-	DWC 1, 2, 3, 4
Blue jay	*Cyanocitta cristata*	*BLJA*	6	-	-	S5	14	A	-	DWC 1, 2, 3, 4
Blue-headed vireo	*Vireo solitarius*	*BHVI*	6	-	-	S5B	2	A	-	DWC 2, 4
Broad-winged hawk	*Buteo platypterus*	*BWHA*	4	-	-	S5B	2	A	-	DWC 3, 4
Brown creeper	*Certhia americana*	*BRCR*	6	-	-	S5	1	A	-	DWC 1
Chestnut-sided warbler	*Setophaga pensylvanica*	*CSWA*	6	-	-	S5B	1	A	-	DWC 4
Common raven	*Corvus corax*	*CORA*	6	-	-	S5	21	A	-	DWC 1, 2, 3, 4
Common yellowthroat	*Geothlypis trichas*	*COYE*	6	-	-	S5B	1	A	-	DWC 3
Dark-eyed junco	*Junco hyemalis*	*DEJU*	6	-	-	S4S5	39	A	-	DWC 1, 2, 3, 4
Downy woodpecker	*Dryobates pubescens*	*DOWO*	7	-	-	S5	5	A	-	DWC 1, 2, 3
Golden-crowned kinglet	*Regulus satrapa*	*GCKI*	6	-	-	S5	17	A	-	DWC 1, 2, 3, 4
Hermit thrush	*Catharus guttatus*	*HETH*	6	-	-	S5B	14	A	-	DWC 1, 2, 3, 4
Herring gull	*Larus argentatus*	*HERG*	2	-	-	S5	1	A	-	DWC 1
Least flycatcher	*Empidonax minimus*	*LEFL*	6	-	-	S4S5B, S5M	1	A	-	DWC 4
Lincoln's sparrow	*Melospiza lincolnii*	*LISP*	6	-	-	S4B, S5M	2	A	-	DWC 3
Magnolia warbler	*Dendroica magnolia*	*MAWA*	6	-	-	S5B	8	A	-	DWC 1, 2, 3, 4
Merlin	*Falco columbarius*	*MERL*	4	-	-	S5B	1	A	-	DWC 2
Mourning dove	*Zenaida macroura*	*MODO*	7	-	-	S5	1	A	-	DWC 1
Nashville warbler	*Vermivora ruficapilla*	*NAWA*	6	-	-	S4B, S5M	1	A	-	DWC 4
Northern flicker	*Colaptes auratus*	*NOFL*	7	-	-	S5B	15	A	-	DWC 1, 2, 3, 4
Northern harrier	*Circus hudsonius*	*NOHA*	4	-	-	S4B, S4S5M	1	A	-	DWC 1
Northern parula	*Parula americana*	*NOPA*	6	-	-	S5B	1	A	-	DWC 4
Ovenbird	*Seiurus aurocapilla*	*OVEN*	6	-	-	S5B	8	A	-	DWC 1, 2, 3
Palm warbler	*Dendroica palmarum*	*PAWA*	6	-	-	S5B	2	A	-	DWC 3
Pileated woodpecker	*Dryocopus pileatus*	*PIWO*	7	-	-	S5	1	A	-	DWC 3
Purple finch	*Carpodacus purpureus*	*PUFI*	6	-	-	S4S5B, S3S4N, S5M	52	A	1 M, 2 F	DWC 1, 2, 3, 4
Red-breasted nuthatch	*Sitta canadensis*	*RBNU*	6	-	-	S4S5	2	A	-	DWC 1, 3
Red-eyed vireo	*Vireo olivaceus*	*REVI*	6	-	-	S5B	1	A	-	DWC 1
Red-tailed hawk	*Buteo jamaicensis*	*RTHA*	4	-	-	S5	7	A	-	DWC 3, 4
Ring-necked pheasant	*Phasianus colchicus*	*RIPH*	7	-	-	SNA	1	A	-	DWC 4
Ruby-crowned kinglet	*Regulus calendula*	*RCKI*	6	-	-	S4B, S5M	18	A	-	DWC 1, 2, 3, 4
Ruffed grouse	*Bonasa umbellus*	*RUGR*	7	-	-	S5	3	A	-	DWC 4
Savannah sparrow	*Passerculus sandwichensis*	*SAVS*	6	-	-	S4S5B, S5M	2	A	-	DWC 3
Song sparrow	*Melospiza melodia*	*SOSP*	6	-	-	S5B	9	A	-	DWC 3
Wilson's warbler	*Cardellina pusilla*	*WIWA*	6	-	-	S3B, S5M	1	A	-	DWC 4
White-breasted nuthatch	*Sitta carolinensis*	*WBNU*	6	-	-	S4	2	A	-	DWC 1, 4
White-throated sparrow	*Zonotrichia albicollis*	*WTSP*	6	-	-	S4S5B, S5M	20	A	-	DWC 1, 2, 3, 4
White-winged crossbill	*Loxia leucoptera*	*WWCR*	6	-	-	S4S5	31	A	-	DWC 1, 3, 4
Yellow-rumped warbler	*Dendroica coronata*	*YRWA*	6	-	-	S5B	21	A	1 M, 1 F	DWC 1, 2, 3, 4
Unknown passerine	-	-	6	-	-	-	16	A	-	DWC 1, 2, 3, 4
Unknown sparrow	-	-	6	-	-	-	5	A	-	DWC 3, 4
Unknown woodpecker (hairy or downy woodpecker)	-	-	7	-	-	-	2	A	-	DWC 3
Unknown woodpecker	-	-	7	-	-	-	2	A	-	DWC 1, 3

Total Number of Species (does not include unknowns)	54
Total Number of Individuals	711

Notes: incidental observations not included (those observed outside of point count locations). A=Adult; J=Juvenile. Bird group is coded as: 1 = waterfowl; 2 = shorebirds; 3 = other waterbirds (i.e., that are not waterfowl or shorebirds); 4 = diurnal raptors; 5 = nocturnal raptors; 6 = passerines (excluding dippers), and 7 = other landbirds. Bolded species are priority species. Bolded and underlined species are SAR. ACCDC rankings retrieved from: http://accdc.com/webranks/NSall.htm (February 2023). "-" represents no federal or provincial designation

Common Name	Scientific Name	Code	Group	*SARA*	*ESA*	NS S-Rank	Number Observed	Age	Sex	Point Count Observations
Canada warbler	***Cardellina canadensis***	**CAWA**	**6**	**T**	**E**	**S3B**	**3**	**A**	**-**	**34, 40**
Boreal chickadee	***Poecile hudsonica***	**BOCH**	**6**	**-**	**-**	**S3**	**26**	**A**	**-**	**9, 17, 22, 23, 24, 27, 34, 36**
Canada jay	***Perisoreus canadensis***	**CAJA**	**6**	**-**	**-**	**S3**	**17**	**A**	**-**	**15, 16, 17, 24, 33, 34**
Northern goshawk	***Accipiter gentilis***	**NOGO**	**4**	**-**	**-**	**S3S4**	**2**	**A**	**1 M**	**28, 34**
Pine siskin	***Spinus pinus***	**PISI**	**6**	**-**	**-**	**S3**	**10**	**A**	**-**	**41**
American black duck	*Anas rubripes*	ABDU	1	-	-	S5B, S5N	6	A	-	11
American crow	*Corvus brachyrhynchos*	AMCR	6	-	-	S5	4	A	-	14, 18, 33, 39
American goldfinch	*Carduelis tristis*	AMGO	6	-	-	S5	13	A	-	4, 5, 11, 21, 29, 32, 39
American kestrel	*Falco sparverius*	AMKE	4	-	-	S3B, S4S5M	2	A	-	32
American redstart	*Setophaga ruticilla*	AMRE	6	-	-	S5B	7	A	-	28, 35, 38, 40
American robin	*Turdus migratorius*	AMRO	6	-	-	S5B, S3N	93	A	-	4, 5, 6, 11, 12, 13, 14, 16, 17, 18, 19, 21, 22, 24, 25, 26, 27, 28, 29, 31, 32, 34, 36, 38, 39, 41
American woodcock	*Scolopax minor*	AMWO	2	-	-	S5B	2	A	-	14
Bald eagle	*Haliaeetus leucocephalus*	BAEA	4	-	-	S5	2	A	-	12, 17
Bay-breasted warbler	*Setophaga castanea*	BBWA	6	-	-	S3S4B, S4S5M	5	A	-	9, 20, 34, 35
Blackburnian warbler	*Setophaga fusca*	BLBW	6	-	-	S4B, S5M	15	A	-	5, 11, 20, 21, 27, 28, 31, 34
Black-and-white warbler	*Mniotilta varia*	BAWW	6	-	-	S5B	18	A	1 M	5, 15, 19, 20, 22, 24, 27, 33, 34, 36
Black-capped chickadee	*Poecile atricapilla*	BCCH	6	-	-	S5	161	A	-	4, 5, 6, 9, 10, 15, 16, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41
Black-throated green warbler	*Dendroica virens*	BTNW	6	-	-	S5B	19	A	-	11, 13, 24, 26, 28, 31, 33, 34, 35, 39, 40
Blackpoll warbler	*Setophaga striata*	BLPW	6	-	-	S3B, S5M	1	A	-	27
Blue jay	*Cyanocitta cristata*	BLJA	6	-	-	S5	58	A	-	4, 5, 9, 11, 12, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 27, 29, 31, 32, 34, 35, 37, 38, 39, 40
Blue-headed vireo	*Vireo solitarius*	BHVI	6	-	-	S5B	12	A	-	13, 19, 29, 30, 36, 38, 40
Blue-winged warbler	*Vermivora cyanoptera*	BWWA	6	-	-	SNA	6	A	-	23, 29, 30, 31, 36
Brown creeper	*Certhia americana*	BRCR	6	-	-	S5	4	A	-	6, 10, 17, 41
Cedar waxwing	*Bombycilla cedrorum*	CEDW	6	-	-	S5B	38	A	-	12, 13, 18, 29, 32, 38
Common raven	*Corvus corax*	CORA	6	-	-	S5	26	A	-	6, 10, 12, 13, 16, 17, 18, 19, 25, 26, 28, 29, 34, 38, 39, 40
Common yellowthroat	*Geothlypis trichas*	COYE	6	-	-	S5B	18	A	4 M, 2 F	4, 11, 13, 14, 19, 24, 32, 33, 36, 38, 40
Dark-eyed junco	*Junco hyemalis*	DEJU	6	-	-	S4S5	67	A	-	4, 5, 6, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 22, 23, 24, 25, 26, 27, 28, 29, 30, 32, 33, 34, 36, 37, 39
Double-crested cormorant	*Nannopterum auritum*	DCCO	2	-	-	S5B	28	A	-	11
Downy woodpecker	*Dryobates pubescens*	DOWO	7	-	-	S5	9	A	1 F	4, 11, 23, 25, 26, 37, 39
Fox sparrow	*Passerella iliaca*	FOSP	6	-	-	S3S4B, S5M	2	A	-	23, 25
Golden-crowned kinglet	*Regulus satrapa*	GCKI	6	-	-	S5	67	A	-	6, 10, 11, 12, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 27, 28, 29, 30, 31, 34, 35, 36, 37, 40, 41
Great horned owl	*Bubo virginatus*	GHOW	5	-	-	S4	2	A	-	19, 23
Hairy woodpecker	*Picoides villosus*	HAWO	7	-	-	S5	15	A	3 M	10, 13, 16, 17, 19, 23, 25, 26, 35, 37, 39, 40
Hermit thrush	*Catharus guttatus*	HETH	6	-	-	S5B	21	A	-	4, 11, 13, 15, 16, 18, 24, 28, 30, 39
Lincoln's sparrow	*Melospiza lincolnii*	LISP	6	-	-	S4B, S5M	2	A	-	39, 40
Magnolia warbler	*Dendroica magnolia*	MAWA	6	-	-	S5B	14	A	-	9, 11, 13, 15, 21, 25, 27, 28, 34
Merlin	*Falco columbarius*	MERL	4	-	-	S5B	2	A	-	17, 29
Mourning warbler	*Geothlypis philadelphia*	MOWA	6	-	-	S4B, S5M	1	A	-	32
Nashville warbler	*Vermivora ruficapilla*	NAWA	6	-	-	S4B, S5M	5	A	-	11, 25, 30, 34
Northern flicker	*Colaptes auratus*	NOFL	7	-	-	S5B	46	A	1 M	4, 5, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 20, 21, 22, 24, 28, 31, 32, 33, 35, 36, 38, 39, 40, 41
Northern waterthrush	*Parkesia noveboracensis*	NOWA	6	-	-	S4B, S5M	1	A	-	37
Ovenbird	*Seiurus aurocapilla*	OVEN	6	-	-	S5B	3	A	-	5, 21
Palm warbler	*Dendroica palmarum*	PAWA	6	-	-	S5B	12	A	-	12, 13, 20, 24, 25, 27, 30, 34
Pileated woodpecker	*Dryocopus pileatus*	PIWO	7	-	-	S5	6	A	1 M	5, 20, 26, 32
Red-breasted nuthatch	*Sitta canadensis*	RBNU	6	-	-	S4S5	19	A	-	9, 16, 22, 23, 24, 26, 28, 29, 30, 31, 34, 36, 37
Red-eyed vireo	*Vireo olivaceus*	REVI	6	-	-	S5B	9	A	-	6, 11, 20, 30, 37, 40, 41
Red-tailed hawk	*Buteo jamaicensis*	RTHA	4	-	-	S5	2	A	-	12, 22
Ring-necked duck	*Aythya collaris*	RNDU	1	-	-	S5B	1	A	-	9
Ruby-crowned kinglet	*Regulus calendula*	RCKI	6	-	-	S4B, S5M	18	A	-	11, 12, 13, 19, 20, 21, 23, 25, 27, 28, 30, 34, 36, 39, 40
Ruby-throated hummingbird	*Archilochus colubris*	RTHU	6	-	-	S5B	1	A	-	39
Ruffed grouse	*Bonasa umbellus*	RUGR	7	-	-	S5	14	A	-	10, 26, 31, 33, 35, 37, 39, 41
Sharp-shinned hawk	*Accipiter striatus*	SSHA	4	-	-	S5	5	A	-	9, 17, 38
Song sparrow	*Melospiza melodia*	SOSP	6	-	-	S5B	4	A	-	12, 14, 22, 38
Spotted sandpiper	*Actitis macularius*	SPSA	2	-	-	S3S4B, S5M	1	A	-	11
Spruce grouse	*Canachites canadensis*	SPGR	7	-	-	S4	6	A	-	16, 17, 22, 31, 35
Swainson's thrush	*Catharus ustulatus*	SWTH	6	-	-	S4B, S5M	4	A	-	30, 36
Swamp sparrow	*Melospiza georgiana*	SWSP	6	-	-	S5B	4	A	-	9, 11, 13
White-throated sparrow	*Zonotrichia albicollis*	WTSP	6	-	-	S4S5B, S5M	43	A	1 M	4, 6, 11, 13, 14, 15, 20, 22, 23, 24, 25, 26, 32, 33, 34, 35, 36, 37, 38, 39, 40
White-winged crossbill	*Loxia leucoptera*	WWCR	6	-	-	S4S5	7	A	-	15
Wilson's snipe	*Gallinago delicata*	WISN	2	-	-	S3B, S5M	2	A	-	24
Yellow-bellied sapsucker	*Sphyrapicus varius*	YBSA	7	-	-	S5B	1	A	-	26
Yellow warbler	*Dendroica petechia*	YWAR	6	-	-	S5B	1	A	-	35

Common Name	Scientific Name	Code	Group	*SARA*	*ESA*	NS S-Rank	Number Observed	Age	Sex	Point Count Observations
Yellow-rumped warbler	*Dendroica coronata*	YRWA	6	-	-	S5B	62	A	-	5, 9, 10, 11, 13, 15, 16, 19, 20, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 36, 39, 40
Unknown sparrow	-	-	6	-	-	-	1	A	-	9
Unknown warbler	-	-	6	-	-	-	17	A	-	6, 16, 21, 24, 35

Total Number of Species (does not include unknowns)	63
Total Number of Individuals	1093

Notes: incidental observations not included (those observed outside of point count locations). A=Adult; J=Juvenile. Bird group is coded as: 1 = waterfowl; 2 = shorebirds; 3 = other waterbirds (i.e., that are not waterfowl or shorebirds); 4 = diurnal raptors; 5 = nocturnal raptors; 6 = passerines (excluding dippers), and 7 = other landbirds. Bolded species are priority species. Bolded and underlined species are SAR. ACCDC rankings retrieved from: http://accdc.com/webranks/NSall.htm (February 2023). "-" represents no federal or provincial designation.

Table 7: Individual Abundance and Species Abundance by PC - Fall Migration Surveys *Project # 24-9952*

PC Location	Total # of Individuals	Total Number of Species
4	14	10
5	19	11
6	9	8
9	19	11
10	16	9
11	76	21
12	32	12
13	47	16
14	19	8
15	40	10
16	32	13
17	31	14
18	18	10
19	29	13
20	24	14
21	16	10
22	32	14
23	28	14
24	60	17
25	18	13
26	42	14
27	30	13
28	31	15
29	37	13
30	23	13
31	29	12
32	37	13
33	19	11
34	46	21
35	30	12
36	46	15
37	22	11
38	25	12
39	41	18
40	29	16
41	27	8
Total	**1093**	**63***

Notes: incidental observations not included (those observed outside of point count locations). Total number of individuals observed include observations that were not able to be identified at the species level. * Total number of unique species observed (does not include unknowns).
There were 41 PCs for spring migration surveys and the same PC locations were surveyed for fall migration surveys with the exception of PCs 1, 2, 3, 7, and 8 due to the exclusion of a proposed transmission line from the Project Area.

Common Name	Scientific Name	Code	Bird Group	*SARA*	*ESA*	NS S-Rank	Number Observed	Age	Sex	DWC Observations
Olive-sided flycatcher	***Contopus cooperi***	***OSFL***	6	SC	**T**	**S3B**	**2**	**A**	-	**DWC 3**
Boreal chickadee	***Poecile hudsonica***	***BOCH***	**6**	**-**	**-**	**S3**	**12**	**A**	-	**DWC 1, 2, 4**
Canada jay	***Perisoreus canadensis***	***CAJA***	**6**	**-**	**-**	**S3**	**14**	**A**	-	**DWC, 1, 2, 3, 4**
Northern goshawk	***Accipiter gentilis***	***NOGO***	**4**	**-**	**-**	**S3S4**	**1**	**A**	-	**DWC 2**
Pine siskin	***Spinus pinus***	***PISI***	**6**	**-**	**-**	**S3**	**3**	**A**	-	**DWC 2**
American goldfinch	*Carduelis tristis*	*AMGO*	6	-	-	S5	15	A	-	DWC 2, 3
American kestrel	*Falco sparverius*	*AMKE*	4	-	-	S3B, S4S5M	1	A	-	DWC 3
American robin	*Turdus migratorius*	*AMRO*	6	-	-	S5B, S3N	82	A	-	DWC 1, 2, 3, 4
American redstart	*Setophaga ruticilla*	*AMRE*	6	-	-	S5B	2	A	-	DWC 3, 4
Bald eagle	*Haliaeetus leucocephalus*	*BAEA*	4	-	-	S5	6	A	-	DWC 2, 3
Blackburnian warbler	*Setophaga fusca*	*BLBW*	6	-	-	S4B, S5M	6	A	-	DWC 1, 3, 4
Black-and-white warbler	*Mniotilta varia*	*BAWW*	6	-	-	S5B	5	A	-	DWC 2, 4
Black-capped chickadee	*Poecile atricapilla*	*BCCH*	6	-	-	S5	74	A	-	DWC 1, 2, 3, 4
Black-throated green warbler	*Dendroica virens*	*BTNW*	6	-	-	S5B	6	A	-	DWC 2, 3, 4
Blue jay	*Cyanocitta cristata*	*BLJA*	6	-	-	S5	45	A	-	DWC, 1, 2, 3, 4
Blue-headed vireo	*Vireo solitarius*	*BHVI*	6	-	-	S5B	4	A	-	DWC 3, 4
Cedar waxwing	*Bombycilla cedrorum*	*CEDW*	6	-	-	S5B	15	A	-	DWC 3, 4
Common raven	*Corvus corax*	*CORA*	6	-	-	S5	22	A	-	DWC 1, 2, 3, 4
Common yellowthroat	*Geothlypis trichas*	*COYE*	6	-	-	S5B	5	A	-	DWC 3
Dark-eyed Junco	*Junco hyemalis*	*DEJU*	6	-	-	S4S5	73	A	-	DWC 1, 2, 3, 4
Double-crested cormorant	*Nannopterum auritum*	*DCCO*	2	-	-	S5B	1	A	-	DWC 1
Downy woodpecker	*Dryobates pubescens*	*DOWO*	7	-	-	S5	2	A	1 M	DWC 3
Golden-crowned kinglet	*Regulus satrapa*	*GCKI*	6	-	-	S5	23	A	-	DWC, 1, 2, 4
Hairy woodpecker	*Picoides villosus*	*HAWO*	7	-	-	S5	2	A	1 M	DWC 2, 3
Hermit thrush	*Catharus guttatus*	*HETH*	6	-	-	S5B	4	A	-	DWC 1, 2
Magnolia warbler	*Dendroica magnolia*	*MAWA*	6	-	-	S5B	7	A	-	DWC 2, 3, 4
Merlin	*Falco columbarius*	*MERL*	4	-	-	S5B	1	A	-	DWC 2
Nashville warbler	*Vermivora ruficapilla*	*NAWA*	6	-	-	S4B, S5M	2	A	-	DWC 2
Northern Flicker	*Colaptes auratus*	*NOFL*	7	-	-	S5B	14	A	-	DWC 1, 2, 3, 4
Palm warbler	*Dendroica palmarum*	*PAWA*	6	-	-	S5B	5	A	-	DWC 3, 4
Pileated woodpecker	*Dryocopus pileatus*	*PIWO*	7	-	-	S5	3	A	-	DWC 2, 4
Pine grosbeak	*Pinicola enucleator*	*PIGR*	6	-	-	S3B, S5N, S5M	1	A	-	DWC 4
Red-breasted nuthatch	*Sitta canadensis*	*RBNU*	6	-	-	S4S5	14	A	-	DWC 1, 2, 3, 4
Red-eyed vireo	*Vireo olivaceus*	*REVI*	6	-	-	S5B	5	A	-	DWC 1, 2, 3, 4
Red-tailed hawk	*Buteo jamaicensis*	*RTHA*	4	-	-	S5	2	A	-	DWC 1, 2
Ruby-crowned kinglet	*Regulus calendula*	*RCKI*	6	-	-	S4B, S5M	6	A	-	DWC 1, 2, 3, 4
Ruby-throated hummingbird	*Archilochus colubris*	*RTHU*	6	-	-	S5B	1	A	1 M	DWC 1
Sharp-shinned hawk	*Accipiter striatus*	*SSHA*	4	-	-	S5	1	A	-	DWC 3
Song sparrow	*Melospiza melodia*	*SOSP*	6	-	-	S5B	6	A	-	DWC 3
Swainson's thrush	*Catharus ustulatus*	*SWTH*	6	-	-	S4B, S5M	4	A	-	DWC 1, 4
White-throated sparrow	*Zonotrichia albicollis*	*WTSP*	6	-	-	S4S5B, S5M	5	A	-	DWC 3, 4
Yellow-bellied flycatcher	*Empidonax flaviventris*	*YBFL*	6	-	-	S4B, S5M	1	A	-	DWC 4
Yellow-rumped warbler	*Dendroica coronata*	*YRWA*	6	-	-	S5B	21	A	-	DWC 1, 2, 3, 4
Unknown flycatcher	-	-	6	-	-	-	3	A	-	DWC 1, 2, 3
Unknown passerine	-	-	6	-	-	-	1	A	-	DWC 4
Unknown thrush	-	-	6	-	-	-	1	A	-	DWC 4
Unknown warbler	-	-	6	-	-	-	28	A	-	DWC 1, 2, 3

Total Number of Species (does not include unknowns)	43
Total Number of Individuals	557

Notes: incidental observations not included (those observed outside of point count locations). A=Adult; J=Juvenile. Bird group is coded as: 1 = waterfowl; 2 = shorebirds; 3 = other waterbirds (i.e., that are not waterfowl or shorebirds); 4 = diurnal raptors; 5 = nocturnal raptors; 6 = passerines (excluding dippers), and 7 = other landbirds. Bolded species are priority species. Bolded and underlined species are SAR. ACCDC rankings retrieved from: http://accdc.com/webranks/NSall.htm (February 2023). "-" represents no federal or provincial designation

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Common Name	Scientific Name	Code	Group	*SARA*	*ESA*	NS S-Rank	Number Observed	Age	Sex	Breeding Evidence	Point Count Observations
Canada warbler	***Cardellina canadensis***	**CAWA**	**6**	**T**	**E**	**S3B**	**15**	**A**	**4 M**	**Probable**	**5, 11, 12, 14, 17, 18, Area Search**
Common nighthawk	***Chordeiles minor***	**CONI**	**5**	**SC**	**T**	**S3B**	**1**	**A**	**-**	**Possible**	**17**
Olive-sided flycatcher	***Contopus cooperi***	**OSFL**	**6**	**SC**	**T**	**S3B**	**4**	**A**	**-**	**Possible**	**23, Area Search**
Bay-breasted warbler	***Setophaga castanea***	**BBWA**	**6**	**-**	**-**	**S3S4B, S4S5M**	**6**	**A**	**-**	**Possible**	**13, Area Search**
Blackpoll warbler	***Setophaga striata***	**BLPW**	**6**	**-**	**-**	**S3B, S5M**	**1**	**A**	**-**	**Possible**	**Area Search**
Boreal chickadee	***Poecile hudsonica***	**BOCH**	**6**	**-**	**-**	**S3**	**20**	**A**	**-**	**Possible**	**12, 14, 17, 18, 22, 23, 24, 35, 40, 41, Area Search**
Canada jay	***Perisoreus canadensis***	**CAJA**	**6**	**-**	**-**	**S3**	**7**	**A, 1 J**	**-**	**Confirmed**	**4, 14, 19, 24, Area Search**
Cape May warbler	***Setophaga tigrina***	**CMWA**	**6**	**-**	**-**	**S3B, SUM**	**4**	**A**	**-**	**Possible**	**32, Area Search**
Northern goshawk	***Accipiter gentilis***	**NOGO**	**4**	**-**	**-**	**S3S4**	**2**	**1 A, 1 J**	**-**	**Confirmed**	**16**
Northern mockingbird	***Mimus polyglottos***	**NOMO**	**6**	**-**	**-**	**S1B**	**2**	**A**	**-**	**Possible**	**31, Area Search**
Pine siskin	***Spinus pinus***	**PISI**	**6**	**-**	**-**	**S3**	**16**	**A**	**-**	**Possible**	**5, 9, 11, 24, 29, 31, 32, 41, Area Search**
Red crossbill	***Loxia curvirostra***	**RECR**	**6**	**-**	**-**	**S3S4**	**3**	**A**	**-**	**Possible**	**5, 8, 10**
Rose-breasted grosbeak	***Pheucticus ludovicianus***	**RBGR**	**6**	**-**	**-**	**S3B**	**1**	**A**	**-**	**Possible**	**23**
Spotted sandpiper	***Actitis macularius***	**SPSA**	**2**	**-**	**-**	**S3S4B, S5M**	**11**	**A, 2 J**	**-**	**Confirmed**	**4, 11, Area Search**
Tennessee warbler	***Leiothlypis peregrina***	**TEWA**	**6**	**-**	**-**	**S3S4B, S5M**	**1**	**A**	**-**	**Possible**	**1**
Alder flycatcher	*Empidonax alnorum*	ALFL	6	-	-	S5B	27	A	-	Possible	1, 8, 9, 11, 12, 17, 23, 25, 32, 38, Area Search
American crow	*Corvus brachyrhynchos*	AMCR	6	-	-	S5	4	A	-	Possible	4, 7, 17, 41
American goldfinch	*Carduelis tristis*	AMGO	6	-	-	S5	8	A	1 M, 1 F	Probable	17, Area Search
American redstart	*Setophaga ruticilla*	AMRE	6	-	-	S5B	6	A	-	Possible	1, 9, 40, Area Search
American robin	*Turdus migratorius*	AMRO	6	-	-	S5B, S3N	52	A	1 M, 1 F	Probable	1, 2, 3, 4, 6, 8, 9, 10, 11, 12, 14, 19, 20, 21, 22, 24, 25, 27, 29, 31, 34, 35, 41, Area Search
Belted kingfisher	*Megaceryle alcyon*	BEKI	3	-	-	S4S5B	1	A	-	Possible	Area Search
Blackburnian warbler	*Setophaga fusca*	BLBW	6	-	-	S4B, S5M	16	A	1 M, 1 F	Probable	4, 5, 8, 30, 33, 37, 41, Area Search
Black-and-white warbler	*Mniotilta varia*	BAWW	6	-	-	S5B	67	A	1 M, 1 F	Confirmed	1, 3, 5, 7, 9, 10, 11, 13, 14, 16, 17, 18, 22, 23, 25, 29, 32, 35, 36, 37, 39, 40, Area Search
Black-capped chickadee	*Poecile atricapilla*	BCCH	6	-	-	S5	23	A	-	Possible	1, 5, 8, 10, 12, 23, 24, 35, 37, Area Search
Black-throated blue warbler	*Setophaga caerulescens*	BTBW	6	-	-	S5B	4	A	-	Possible	18, 37, Area Search
Black-throated green warbler	*Dendroica virens*	BTNW	6	-	-	S5B	84	A	-	Confirmed	1, 2, 3, 4, 5, 6, 8, 9, 10, 12, 13, 17, 18, 19, 21, 23, 24, 25, 26, 27, 30, 31, 32, 33, 34, 35, 39, 41, Area Search
Blue jay	*Cyanocitta cristata*	BLJA	6	-	-	S5	29	A	-	Probable	4, 7, 9, 11, 17, 20, 27, 28, 31, 32, 34, 36, 41, Area Search
Blue-headed vireo	*Vireo solitarius*	BHVI	6	-	-	S5B	33	A	-	Possible	4, 7, 8, 11, 16, 17, 20, 22, 24, 28, 30, 33, 35, 36, 37, 40, 41, Area Search
Cedar waxwing	*Bombycilla cedrorum*	CEDW	6	-	-	S5B	21	A	-	Possible	1, 4, 8, 11, 23, 24, 39, 41, Area Search
Chestnut-sided warbler	*Setophaga pensylvanica*	CSWA	6	-	-	S5B	3	A	-	Possible	41, Area Search
Common raven	*Corvus corax*	CORA	6	-	-	S5	7	A	-	Possible	5, 6, 9, 11, 17, Area Search
Common yellowthroat	*Geothlypis trichas*	COYE	6	-	-	S5B	48	A	-	Possible	1, 8, 9, 10, 11, 12, 14, 17, 23, 24, 31, 32, 38, 40, Area Search
Dark-eyed junco	*Junco hyemalis*	DEJU	6	-	-	S4S5	38	A	1 M, 1 F	Confirmed	1, 4, 5, 8, 10, 11, 12, 14, 17, 22, 23, 24, 25, 29, 30, 31, 34, 38, 39, 41, Area Search
Downy woodpecker	*Dryobates pubescens*	DOWO	7	-	-	S5	6	A	-	Possible	13, 29, Area Search
Golden-crowned kinglet	*Regulus satrapa*	GCKI	6	-	-	S5	15	A	-	Confirmed	5, 18, 36, Area Search
Gray catbird	*Dumetella carolinensis*	GRCA	6	-	-	S4B	1	A	-	Possible	1
Hairy woodpecker	*Picoides villosus*	HAWO	7	-	-	S5	14	A, 2 J	2 M, 2 F	Confirmed	2, 13, 16, 18, 37, 39, Area Search
Hermit thrush	*Catharus guttatus*	HETH	6	-	-	S5B	96	A	-	Confirmed	1, 5, 6, 8, 9, 11, 12, 15, 16, 18, 20, 21, 22, 24, 25, 26, 27, 28, 29, 30, 34, 35, 36, 37, 38, 40, 41, Area Search
Least flycatcher	*Empidonax minimus*	LEFL	6	-	-	S4S5B, S5M	18	A	-	Possible	7, 9, 14, 24, 36, 40, Area Search
Lincoln's sparrow	*Melospiza lincolnii*	LISP	6	-	-	S4B, S5M	16	A	-	Possible	1, 12, 23, 24, 30, 32, 38, Area Search
Magnolia warbler	*Dendroica magnolia*	MAWA	6	-	-	S5B	86	A	-	Probable	1, 3, 5, 8, 9, 10, 11, 12, 14, 17, 18, 19, 20, 21, 22, 23, 24, 25, 28, 31, 32, 34, 35, 36, 40, 41, Area Search
Mourning dove	*Zenaida macroura*	MODO	7	-	-	S5	1	A	-	Possible	Area Search
Mourning warbler	*Geothlypis philadelphia*	MOWA	6	-	-	S4B, S5M	27	A	-	Confirmed	1, 8, 11, 19, 22, 24, 28, 32, 33, 38, Area Search
Nashville warbler	*Vermivora ruficapilla*	NAWA	6	-	-	S4B, S5M	17	A	-	Confirmed	1, 8, 9, 12, 31, 36, 40, Area Search
Northern flicker	*Colaptes auratus*	NOFL	7	-	-	S5B	10	A	-	Possible	1, 3, 6, 8, 14, 17, 39, Area Search
Northern parula	*Parula americana*	NOPA	6	-	-	S5B	12	A	-	Possible	1, 7, 8, 35, 37, 39, Area Search
Ovenbird	*Seiurus aurocapilla*	OVEN	6	-	-	S5B	104	A	-	Possible	1, 2, 3, 5, 6, 7, 10, 12, 13, 16, 18, 20, 21, 23, 25, 26, 27, 29, 30, 31, 32, 33, 34, 35, 36, 37, 39, 40, 41, Area Search
Palm warbler	*Dendroica palmarum*	PAWA	6	-	-	S5B	4	A	-	Possible	11, 25, Area Search
Pileated woodpecker	*Dryocopus pileatus*	PIWO	7	-	-	S5	4	A	-	Probable	8, 23, Area Search
Purple finch	*Carpodacus purpureus*	PUFI	6	-	-	S4S5B, S3S4N, S5M	14	A	1 M, 1 F	Probable	2, 10, 11, 15, 17, 22, 24, 28, 36, 38, 41, Area Search
Red-breasted nuthatch	*Sitta canadensis*	RBNU	6	-	-	S4S5	5	A	-	Possible	16, 35, 41, Area Search
Red-eyed vireo	*Vireo olivaceus*	REVI	6	-	-	S5B	57	A	2 M, 2 F	Probable	1, 2, 3, 4, 6, 7, 8, 9, 10, 16, 17, 22, 23, 25, 26, 28, 29, 30, 32, 33, 36, 37, 39, 40, 41, Area Search
Red-tailed hawk	*Buteo jamaicensis*	RTHA	4	-	-	S5	6	A	2 M, 2 F	Probable	9, 19, 39, Area Search

Common Name	Scientific Name	Code	Group	*SARA*	*ESA*	NS S-Rank	Number Observed	Age	Sex	Breeding Evidence	Point Count Observations
Red-winged blackbird	*Agelaius phoeniceus*	RWBL	6	-	-	S4B	1	A	-	Possible	10
Ring-necked duck	*Aythya collaris*	RNDU	1	-	-	S5B	3	A	1 M, 1 F	Probable	9, 11
Ruby-crowned kinglet	*Regulus calendula*	RCKI	6	-	-	S4B, S5M	49	A	-	Confirmed	1, 2, 5, 9, 12, 13, 14, 15, 18, 21, 22, 23, 24, 25, 28, 34, 36, 40, Area Search
Ruby-throated hummingbird	*Archilochus colubris*	RTHU	6	-	-	S5B	1	A	-	Possible	12
Ruffed grouse	*Bonasa umbellus*	RUGR	7	-	-	S5	5	A, 2 J	1 F	Confirmed	16, 30, Area Search
Savannah sparrow	*Passerculus sandwichensis*	SAVS	6	-	-	S4S5B, S5M	1	A	-	Possible	Area Search
Song sparrow	*Melospiza melodia*	SOSP	6	-	-	S5B	4	A	-	Probable	8, Area Search
Spruce grouse	*Canachites canadensis*	SPGR	7	-	-	S4	3	A	-	Possible	30, Area Search
Swainson's thrush	*Catharus ustulatus*	SWTH	6	-	-	S4B, S5M	25	A	-	Probable	2, 5, 8, 9, 12, 15, 16, 19, 20, 22, 28, 29, 30, 31, 37, 41, Area Search
Swamp sparrow	*Melospiza georgiana*	SWSP	6	-	-	S5B	17	A	-	Possible	1, 9, 11, 12, 23, Area Search
White-throated sparrow	*Zonotrichia albicollis*	WTSP	6	-	-	S4S5B, S5M	64	A	-	Probable	1, 2, 8, 11, 12, 14, 17, 19, 22, 24, 25, 28, 31, 32, 35, 37, 38, Area Search
White-winged crossbill	*Loxia leucoptera*	WWCR	6	-	-	S4S5	29	A	-	Possible	17, 19, 24, 28, 31, 41, Area Search
Winter wren	*Troglodytes troglodytes*	WIWR	6	-	-	S5B	1	A	-	Possible	1
Yellow-bellied flycatcher	*Empidonax flaviventris*	YBFL	6	-	-	S4B, S5M	18	A	-	Possible	1, 9, 10, 11, 12, 14, 16, 17, 23, 24, 33, Area Search
Yellow-bellied sapsucker	*Sphyrapicus varius*	YBSA	7	-	-	S5B	12	A	-	Possible	1, 2, 7, 8, 15, 36, 38, Area Search
Yellow warbler	*Dendroica petechia*	YWAR	6	-	-	S5B	1	A	-	Possible	10
Yellow-rumped warbler	*Dendroica coronata*	YRWA	6	-	-	S5B	38	A, 1 J	-	Confirmed	6, 9, 10, 11, 15, 18, 19, 20, 21, 25, 29, 33, 40, 41, Area Search
Unknown flycatcher (least or yellow-bellied flycatcher)	-	-	6	-	-	-	1	A	-	Possible	Area Search
Unknown passerine	-	-	6	-	-	-	5	A	-	Possible	6, 33, Area Search
Unknown sparrow	-	-	6	-	-	-	2	A	-	Probable	8, Area Search
Unknown thrush	-	-	6	-	-	-	1	A	-	Possible	33
Unknown warbler	-	-	6	-	-	-	1	A	-	Possible	5
Unknown woodpecker	-	-	7	-	-	-	1	A	-	Possible	Area Search

Total Number of Species (does not include unknowns)	70
Total Number of Individuals	1361

Notes: incidental observations not included (those observed outside of point count locations). A=Adult; J=Juvenile. Bird group is coded as: 1 = waterfowl; 2 = shorebirds; 3 = other waterbirds (i.e., that are not waterfowl or shorebirds); 4 = diurnal raptors; 5 = nocturnal raptors; 6 = passerines (excluding dippers), and 7 = other landbirds. Bolded species are priority species. Bolded and underlined species are SAR. ACCDC rankings retrieved from: http://accdc.com/webranks/NSall.htm (February 2023). "-" represents no federal or provincial designation. Breeding status qualifiers are defined in the Maritime Breeding Bird Atlas (http://www.mba-aom.ca/jsp/codes.jsp?lang=en&pg=breeding). Where multiple observations of breeding evidence were observed, the highest breeding evidence is presented in the table.

Table 11: Individual Abundance and Species Abundance - Breeding Bird Surveys *Project # 24-9952*

PC Location	Total # of Individuals	Total Number of Species
1	52	26
2	16	10
3	9	7
4	17	11
5	19	15
6	15	8
7	15	9
8	42	22
9	34	21
10	23	15
11	41	22
12	39	19
13	12	7
14	16	13
15	8	6
16	21	11
17	27	20
18	18	12
19	15	10
20	10	8
21	12	7
22	18	13
23	31	18
24	35	20
25	26	13
26	7	4
27	6	5
28	21	11
29	14	10
30	13	11
31	20	13
32	27	13
33	13	8
34	12	8
35	22	12
36	23	13
37	22	12
38	15	9
39	14	10
40	22	13
41	35	20
Area Search	504	58
Total	**1361**	**70***

Notes: total number of individuals observed include observations that were not able to be identified at the species level. * Total number of unique species observed (does not include unknowns).

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Survey Round	Date	Temperature (°C)	Wind (Beaufort Scale)	Precipitation	Notes
Round 1	15-Jun-22	13	0-1	0	0-40% cloud cover, no moon, no traffic (0 cars at each CONI PC), and moderate noise at CONI PCs 8, 9, 11, and 12 (slight wind, bugs, moose/deer making noise, fireworks in distance, and/or distant highway noise) and high noise at CONI PC 10 (nearby river was loud)
	16-Jun-22	18	0-1	0	0-10% cloud cover, no moon, no traffic (0 cars at each CONI PC), and none or slight noise at CONI PCs 1, 2, 4, 5, 6, and 7 (no noise, slight wind, bugs, or a quiet stream) and high noise at CONI PC 3 (nearby stream was loud)
Round 2	11-Jul-22	17-18	2-3 (gusts of 4 at CONI PC 12 only)	0	10-50% cloud cover, moon visible at 2/4 CONI PCs (PCs 3 and 7), no traffic (0 cars at each CONI PC), and no noise at CONI PC 4, moderate noise at CONI PCS 7 and 12 (slight wind and/or logging machinery in distance), and high noise at CONI PC 3 from wind
	12-Jul-22	19	04-Jan	0	0% cloud cover, moon visible at 2/8 CONI PCs (PCs 10 and 11), no traffic (0 cars at each CONI PC), and no noise at CONI PC 8 and moderate noise at CONI PCs 1, 2, 5, 6, 9, 10, and 11 (noise from nearby highway, slight noise from wind, or water running nearby)

Notes: weather conditions represent the entire survey (surveyors recorded weather conditions at the start and end of each survey). Precipitation scale is as follows: 0 = none, 1 = drizzle, and 2 = light/moderate. Wind scale (Beaufort scale) is as follows: 0 = <1 km/hr, 1 = 1-5 km/hr, 2 = 6-11 km/hr, and 3 = 12-19 km/hr.

Common Name	Scientific Name	Code	Group	*SARA*	*ESA*	NS S-Rank	Number Observed	Age	Sex	Survey Location
Canada warbler	***Cardellina canadensis***	**CAWA**	**6**	**T**	**E**	**S3B**	**3**	**A**	**-**	**Near BB PC 12 (623686 5067532, adjacent to WL 77), WLs 32 and 51* (623383 5070558, 623439, 5071234)**
Olive-sided flycatcher	***Contopus cooperi***	**OSFL**	**6**	**SC**	**T**	**S3B**	**2**	**A**	**-**	**BB PC 40 and near BB PC 31 (620934 5071614)**
American kestrel	***Falco sparverius***	**AMKE**	**4**	**-**	**-**	**S3B, S4S5M**	**2**	**A**	**-**	**CONI 7, DWC 4**
Black-billed cuckoo	***Coccyzus erythropthalmus***	**BBCU**	**7**	**-**	**-**	**S3B**	**1**	**A**	**-**	**BB PC 7**
Boreal chickadee	***Poecile hudsonica***	**BOCH**	**6**	**-**	**-**	**S3**	**20**	**A**	**-**	**Figure 5, Appendix A for 3 locations during Lichen / Early Botany Surveys (1 in WL 13*)**
Canada jay	***Perisoreus canadensis***	**CAJA**	**6**	**-**	**-**	**S3**	**2**	**A**	**-**	**Refer to Figure 5, Appendix A for locations (1 in WL17*)**
Northern goshawk	***Accipiter gentilis***	**NOGO**	**4**	**-**	**-**	**S3S4**	**1**	**A**	**-**	**FM PC 5**
Pine Siskin	***Spinus pinus***	**PISI**	**6**	**-**	**-**	**S3**	**2**	**A**	**-**	**SM PC 39**
American crow	*Corvus brachyrhynchos*	AMCR	6	-	-	S5	1	A	-	-
Black-capped chickadee	*Poecile atricapilla*	BCCH	6	-	-	S5	3	A	-	-
Common raven	*Corvus corax*	CORA	6	-	-	S5	1	A	-	-
Swainson's thrush	*Catharus ustulatus*	SWTH	6	-	-	S4B, S5M	9	A	-	CONI 3, 8, and 10
Unknown grouse (ruffed or spruce grouse)	-	-	7	-	-	-	28	A	-	-

Total Number of Species	12
Total Number of Individuals	75

*Notes: bird group is coded as: 1 = waterfowl; 2 = shorebirds; 3 = other waterbirds (i.e., that are not waterfowl or shorebirds); 4 = diurnal raptors; 5 = nocturnal raptors; 6 = passerines (excluding dippers), and 7 = other landbirds. ACCDC rankings retrieved from: http://accdc.com/webranks/NSall.htm (February 2023). Spring/fall migration, breeding bird, and nightjar survey locations can be viewed in Figures 1 - 4, Appendix A. *Note that wetland delineation surveys occurred from June - September, 2022 and lichen/early botany surveys occurred from mid-June to mid-July, 2022. *WL = wetland numbers.*

ATLAS DES OISEAUX NICHEURS DES MARITIMES
BREEDING BIRD ATLAS

Square Summary (20PR17)

#species (1st atlas)				#species (2nd atlas)				#hours		#pc done	
poss	prob	conf	total	poss	prob	conf	total	1st	2nd	road	offrd
1	0	0	1	35	8	6	49	0	4.8	0	0

Region summary (#24: Southwest Cape Breton Island)

#squares	#sq with data		#species		#pc done	target #pc
	1st	2nd	1st	2nd		
61	52	59	137	147	420	228

Target number of point counts in this square: 13 road side, 2 off road (2 in Mature deciduous). Please try to ensure that each off-road station is located such that the entire 100m radius circle is within the prescribed habitat.

SPECIES	Code		%		SPECIES	Code		%		SPECIES	Code		%	
	1st	2nd	1st	2nd		1st	2nd	1st	2nd		1st	2nd	1st	2nd
Canada Goose			7	50	Northern Goshawk			7	16	Yellow-bellied Sapsucker			19	50
Wood Duck			9	23	Broad-winged Hawk ‡			3	11	Downy Woodpecker		H	40	77
American Wigeon ‡			3	13	Red-tailed Hawk		H	40	67	Hairy Woodpecker		CF	40	77
American Black Duck			40	67	Sora			15	18	Black-back Woodpecker			11	6
Mallard			3	20	Piping Plover †			0	6	Northern Flicker		FY	57	94
Mallard x Am. Black Duck			0	5	Killdeer			25	13	Pileated Woodpecker			25	55
Blue-winged Teal			21	13	Spotted Sandpiper		P	53	72	American Kestrel			48	59
Northern Pintail ‡			0	0	Greater Yellowlegs †			1	6	Merlin			26	33
Green-winged Teal			17	27	Willet			17	20	Olive-sided Flycatcher †			42	67
Ring-necked Duck			32	61	Wilson's Snipe		S	46	64	Eastern Wood-Pewee			38	30
Common Eider §			5	10	American Woodcock		D	15	47	Yellow-bellied Flycatcher			44	57
Common Goldeneye			17	18	Ring-billed Gull ‡§			0	1	Alder Flycatcher			61	86
Hooded Merganser ‡			0	1	Herring Gull §		H	36	45	Least Flycatcher		S	32	74
Common Merganser			11	30	Great Black-backed Gull §		H	46	47	Eastern Phoebe			5	3
Red-breast Merganser			15	25	Common Tern §			36	32	Eastern Kingbird			23	15
Ring-necked Pheasant			3	11	Arctic Tern ‡§			1	1	Blue-headed Vireo		S	55	91
Ruffed Grouse			30	67	Razorbill ‡§			1	0	Philadelphia Vireo ‡			1	0
Spruce Grouse			9	16	Black Guillemot ‡§			7	11	Red-eyed Vireo		H	57	93
Common Loon			25	35	Rock Pigeon			19	59	Gray Jay			44	47
Pied-billed Grebe			11	8	Mourning Dove			9	50	Blue Jay		H	50	91
Northern Gannet ‡			0	0	Black-billed Cuckoo ‡			1	1	American Crow		H	63	98
Double-crest Cormorant §			36	30	Great Horned Owl			11	25	Common Raven			57	84
Great Cormorant ‡§			9	1	Barred Owl			11	54	Tree Swallow		H	59	88
American Bittern			9	16	Short-eared Owl †			0	0	Bank Swallow §			50	25
Great Blue Heron §			48	35	North Saw-whet Owl			1	28	Cliff Swallow §			23	23
Osprey			36	49	Common Nighthawk †			23	13	Barn Swallow			67	55
Bald Eagle ¤		H	71	81	Chimney Swift †			17	6	Black-capp Chickadee		P	51	93
Northern Harrier			32	38	Ruby-thr Hummingbird		H	34	77	Boreal Chickadee		H	50	86
Sharp-shinned Hawk			23	23	Belted Kingfisher		H	55	84	Red-breast Nuthatch		S	40	76

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Maritimes Breeding Bird Atlas - Summary Sheet for Square 20PR17 (page 2 of 2)

SPECIES	Code		%		SPECIES	Code		%		SPECIES	Code		%	
	1st	2nd	1st	2nd		1st	2nd	1st	2nd		1st	2nd	1st	2nd
White-breast Nuthatch			0	6	Blackpoll Warbler			13	25	Pine Siskin			46	44
Brown Creeper		H	13	28	Black-thr Blue Warbler			7	8	American Goldfinch			61	91
Winter Wren			36	38	Palm Warbler			25	40	Evening Grosbeak		P	30	55
Golden-crown Kinglet		FY	46	84	Yellow-rumped Warbler		H	51	91	House Sparrow			32	37
Ruby-crown Kinglet		H	55	91	Black-thr Green Warbler		H	38	77					
Veery			7	25	Canada Warbler †			32	15					
Bicknell's Thrush †			1	0	Wilson's Warbler			7	11					
Swainson's Thrush		S	59	84	Chipping Sparrow		CF	50	42					
Hermit Thrush		S	57	91	Vesper Sparrow †			3	0					
American Robin		P	65	100	Savannah Sparrow		S	57	77					
Gray Catbird			13	18	Nelson's Sh.-tail Sparrow			7	13					
Northern Mockingbird †			5	3	Fox Sparrow			17	25					
European Starling		AE	55	81	Song Sparrow		S	63	98					
Cedar Waxwing		P	48	93	Lincoln's Sparrow			51	74					
Ovenbird		S	48	79	Swamp Sparrow			53	77					
North Waterthrush		S	21	47	White-throat Sparrow		S	59	94					
Black-white Warbler		H	55	89	Dark-eyed Junco		P	61	93					
Tennessee Warbler			48	15	Scarlet Tanager †	H		3	1					
Nashville Warbler			42	71	Rose-breast Grosbeak			32	25					
Mourning Warbler		S	46	76	Bobolink			36	30					
Common Yellowthroat		H	59	93	Red-wing Blackbird		AE	61	81					
American Redstart			57	88	Rusty Blackbird †			26	8					
Cape May Warbler			15	5	Common Grackle		H	61	86					
Northern Parula		H	53	89	Brown-head Cowbird			17	1					
Magnolia Warbler		H	59	94	Baltimore Oriole ‡			1	0					
Bay-breasted Warbler			30	28	Pine Grosbeak			26	33					
Blackburnian Warbler		S	50	77	Purple Finch		P	51	91					
Yellow Warbler		S	57	86	Red Crossbill †			1	5					
Chestn-sided Warbler			15	47	White-winged Crossbill			21	23					

This list includes all species found during the Maritimes Breeding Bird Atlas (1st atlas: 1986-1990, 2nd atlas: 2006-2010) in the region #24 (Southwest Cape Breton Island). Underlined species are those that you should try to add to this square (20PR17). They have not yet been reported during the 2nd atlas, but were found during the 1st atlas in this square or have been reported in more than 50% of the squares in this region during the 2nd atlas so far. "Code" is the code for the highest breeding evidence for that species in square 20PR17 during the 2nd and 1st atlas respectively. The % columns give the percentage of squares in that region where that species was reported during the 2nd and 1st atlas (this gives an idea of the expected chance of finding that species in region #24). Rare/Colonial Species Report Forms should be completed for species marked: § (Colonial), ‡ (regionally rare), † (rare in the Maritimes) or ¤ (rare in the Maritimes, documentation only required for confirmed records). Current as of 8/02/2023. An up-to-date version of this sheet is available from http://www.mba-aom.ca/jsp/summaryform.jsp?squareID=20PR17?lang=en

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ATLAS DES OISEAUX NICHEURS DES MARITIMES
BREEDING BIRD ATLAS

Square Summary (20PR26)

#species (1st atlas)				#species (2nd atlas)				#hours		#pc done	
poss	prob	conf	total	poss	prob	conf	total	1st	2nd	road	offrd
48	8	10	66	33	30	9	72	10	26.5	16	0

Region summary (#24: Southwest Cape Breton Island)

#squares	#sq with data		#species		#pc done	target #pc
	1st	2nd	1st	2nd		
61	52	59	137	147	420	228

Target number of point counts in this square: 13 road side, 2 off road (2 in Mature deciduous). Please try to ensure that each off-road station is located such that the entire 100m radius circle is within the prescribed habitat.

SPECIES	Code		%		SPECIES	Code		%		SPECIES	Code		%	
	1st	2nd	1st	2nd		1st	2nd	1st	2nd		1st	2nd	1st	2nd
Canada Goose			7	50	Northern Goshawk			7	16	Yellow-bellied Sapsucker	H	H	19	50
Wood Duck			9	23	Broad-winged Hawk ‡			3	11	Downy Woodpecker	H	T	40	77
American Wigeon ‡			3	13	Red-tailed Hawk	H	T	40	67	Hairy Woodpecker	A	T	40	77
American Black Duck		FY	40	67	Sora			15	18	Black-back Woodpecker			11	6
Mallard			3	20	Piping Plover †			0	6	Northern Flicker	P	H	57	94
Mallard x Am. Black Duck			0	5	Killdeer		FY	25	13	Pileated Woodpecker	H		25	55
Blue-winged Teal			21	13	Spotted Sandpiper	H	DD	53	72	American Kestrel			48	59
Northern Pintail ‡			0	0	Greater Yellowlegs †			1	6	Merlin	H		26	33
Green-winged Teal		H	17	27	Willet		A	17	20	Olive-sided Flycatcher †	H	T	42	67
Ring-necked Duck		P	32	61	Wilson's Snipe			46	64	Eastern Wood-Pewee	H	S	38	30
Common Eider §			5	10	American Woodcock		D	15	47	Yellow-bellied Flycatcher	H	S	44	57
Common Goldeneye			17	18	Ring-billed Gull ‡§			0	1	Alder Flycatcher	H	T	61	86
Hooded Merganser ‡			0	1	Herring Gull §		H	36	45	Least Flycatcher	H	T	32	74
Common Merganser			11	30	Great Black-backed Gull §			46	47	Eastern Phoebe			5	3
Red-breast Merganser			15	25	Common Tern §		H	36	32	Eastern Kingbird			23	15
Ring-necked Pheasant			3	11	Arctic Tern ‡§			1	1	Blue-headed Vireo	A	A	55	91
Ruffed Grouse			30	67	Razorbill ‡§			1	0	Philadelphia Vireo ‡			1	0
Spruce Grouse			9	16	Black Guillemot ‡§			7	11	Red-eyed Vireo	AY	A	57	93
Common Loon			25	35	Rock Pigeon			19	59	Gray Jay	FL	H	44	47
Pied-billed Grebe			11	8	Mourning Dove		P	9	50	Blue Jay	H	T	50	91
Northern Gannet ‡			0	0	Black-billed Cuckoo ‡			1	1	American Crow	H	T	63	98
Double-crest Cormorant §	H		36	30	Great Horned Owl			11	25	Common Raven	H	FY	57	84
Great Cormorant ‡§			9	1	Barred Owl		S	11	54	Tree Swallow	ON	NB	59	88
American Bittern			9	16	Short-eared Owl †			0	0	Bank Swallow §	H	H	50	25
Great Blue Heron §	H	H	48	35	North Saw-whet Owl			1	28	Cliff Swallow §			23	23
Osprey		H	36	49	Common Nighthawk †			23	13	Barn Swallow	H		67	55
Bald Eagle ¤	H	H	71	81	Chimney Swift †			17	6	Black-capp Chickadee	H	S	51	93
Northern Harrier		H	32	38	Ruby-thr Hummingbird		H	34	77	Boreal Chickadee	H	S	50	86
Sharp-shinned Hawk			23	23	Belted Kingfisher	ON	H	55	84	Red-breast Nuthatch		P	40	76

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Maritimes Breeding Bird Atlas - Summary Sheet for Square 20PR26 (page 2 of 2)

SPECIES	Code		%		SPECIES	Code		%		SPECIES	Code		%	
	1st	2nd	1st	2nd		1st	2nd	1st	2nd		1st	2nd	1st	2nd
White-breast Nuthatch			0	6	Blackpoll Warbler			13	25	Pine Siskin	H		46	44
Brown Creeper			13	28	Black-thr Blue Warbler	H		7	8	American Goldfinch	P	T	61	91
Winter Wren	H	S	36	38	Palm Warbler	H	A	25	40	Evening Grosbeak	H	H	30	55
Golden-crown Kinglet	H	A	46	84	Yellow-rumped Warbler	P	S	51	91	House Sparrow			32	37
Ruby-crown Kinglet	AY	S	55	91	Black-thr Green Warbler	H	T	38	77					
Veery			7	25	Canada Warbler †	H		32	15					
Bicknell's Thrush †			1	0	Wilson's Warbler			7	11					
Swainson's Thrush	H	S	59	84	Chipping Sparrow	H		50	42					
Hermit Thrush	H	P	57	91	Vesper Sparrow †			3	0					
American Robin	AY	S	65	100	Savannah Sparrow			57	77					
Gray Catbird			13	18	Nelson's Sh.-tail Sparrow		T	7	13					
Northern Mockingbird †			5	3	Fox Sparrow			17	25					
European Starling		CF	55	81	Song Sparrow	AY	A	63	98					
Cedar Waxwing	H	T	48	93	Lincoln's Sparrow	A	S	51	74					
Ovenbird	H	S	48	79	Swamp Sparrow	H	S	53	77					
North Waterthrush		S	21	47	White-throat Sparrow	H	CF	59	94					
Black-white Warbler	H	S	55	89	Dark-eyed Junco	H	CF	61	93					
Tennessee Warbler	H		48	15	Scarlet Tanager †			3	1					
Nashville Warbler		S	42	71	Rose-breast Grosbeak			32	25					
Mourning Warbler	AY	A	46	76	Bobolink	H		36	30					
Common Yellowthroat	AY	T	59	93	Red-wing Blackbird	P	S	61	81					
American Redstart	H	P	57	88	Rusty Blackbird †	H		26	8					
Cape May Warbler			15	5	Common Grackle	H	CF	61	86					
Northern Parula	H	S	53	89	Brown-head Cowbird			17	1					
Magnolia Warbler	AY	T	59	94	Baltimore Oriole ‡			1	0					
Bay-breasted Warbler	H		30	28	Pine Grosbeak	H		26	33					
Blackburnian Warbler	H	T	50	77	Purple Finch	P	D	51	91					
Yellow Warbler	H	S	57	86	Red Crossbill †			1	5					
Chestn-sided Warbler		T	15	47	White-winged Crossbill			21	23					

This list includes all species found during the Maritimes Breeding Bird Atlas (1st atlas: 1986-1990, 2nd atlas: 2006-2010) in the region #24 (Southwest Cape Breton Island). Underlined species are those that you should try to add to this square (20PR26). They have not yet been reported during the 2nd atlas, but were found during the 1st atlas in this square or have been reported in more than 50% of the squares in this region during the 2nd atlas so far. "Code" is the code for the highest breeding evidence for that species in square 20PR26 during the 2nd and 1st atlas respectively. The % columns give the percentage of squares in that region where that species was reported during the 2nd and 1st atlas (this gives an idea of the expected chance of finding that species in region #24). Rare/Colonial Species Report Forms should be completed for species marked: § (Colonial), ‡ (regionally rare), † (rare in the Maritimes) or ¤ (rare in the Maritimes, documentation only required for confirmed records). Current as of 8/02/2023. An up-to-date version of this sheet is available from http://www.mba-aom.ca/jsp/summaryform.jsp?squareID=20PR26?lang=en

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ATLAS DES OISEAUX NICHEURS DES MARITIMES
BREEDING BIRD ATLAS

Square Summary (20PR27)

#species (1st atlas)				#species (2nd atlas)				#hours		#pc done	
poss	prob	conf	total	poss	prob	conf	total	1st	2nd	road	offrd
0	0	0	0	20	11	6	37	0	7.2	0	0

Region summary (#24: Southwest Cape Breton Island)

#squares	#sq with data		#species		#pc done	target #pc
	1st	2nd	1st	2nd		
61	52	59	137	147	420	228

Target number of point counts in this square: 12 road side, 3 off road (3 in Mature deciduous). Please try to ensure that each off-road station is located such that the entire 100m radius circle is within the prescribed habitat.

SPECIES	Code		%		SPECIES	Code		%		SPECIES	Code		%	
	1st	2nd	1st	2nd		1st	2nd	1st	2nd		1st	2nd	1st	2nd
Canada Goose			7	50	Northern Goshawk			7	16	Yellow-bellied Sapsucker			19	50
Wood Duck			9	23	Broad-winged Hawk ‡			3	11	Downy Woodpecker		H	40	77
American Wigeon ‡			3	13	Red-tailed Hawk		H	40	67	Hairy Woodpecker			40	77
American Black Duck			40	67	Sora			15	18	Black-back Woodpecker			11	6
Mallard			3	20	Piping Plover †			0	6	Northern Flicker		FY	57	94
Mallard x Am. Black Duck			0	5	Killdeer			25	13	Pileated Woodpecker		H	25	55
Blue-winged Teal			21	13	Spotted Sandpiper		H	53	72	American Kestrel			48	59
Northern Pintail ‡			0	0	Greater Yellowlegs †			1	6	Merlin			26	33
Green-winged Teal			17	27	Willet			17	20	Olive-sided Flycatcher †		S	42	67
Ring-necked Duck			32	61	Wilson's Snipe			46	64	Eastern Wood-Pewee			38	30
Common Eider §			5	10	American Woodcock			15	47	Yellow-bellied Flycatcher			44	57
Common Goldeneye			17	18	Ring-billed Gull ‡§			0	1	Alder Flycatcher			61	86
Hooded Merganser ‡			0	1	Herring Gull §			36	45	Least Flycatcher		A	32	74
Common Merganser			11	30	Great Black-backed Gull §			46	47	Eastern Phoebe			5	3
Red-breast Merganser			15	25	Common Tern §			36	32	Eastern Kingbird			23	15
Ring-necked Pheasant			3	11	Arctic Tern ‡§			1	1	Blue-headed Vireo		H	55	91
Ruffed Grouse		FY	30	67	Razorbill ‡§			1	0	Philadelphia Vireo ‡			1	0
Spruce Grouse			9	16	Black Guillemot ‡§			7	11	Red-eyed Vireo		A	57	93
Common Loon			25	35	Rock Pigeon			19	59	Gray Jay		FY	44	47
Pied-billed Grebe			11	8	Mourning Dove			9	50	Blue Jay		P	50	91
Northern Gannet ‡			0	0	Black-billed Cuckoo ‡			1	1	American Crow		H	63	98
Double-crest Cormorant §			36	30	Great Horned Owl			11	25	Common Raven			57	84
Great Cormorant ‡§			9	1	Barred Owl			11	54	Tree Swallow			59	88
American Bittern			9	16	Short-eared Owl †			0	0	Bank Swallow §			50	25
Great Blue Heron §			48	35	North Saw-whet Owl			1	28	Cliff Swallow §			23	23
Osprey			36	49	Common Nighthawk †			23	13	Barn Swallow			67	55
Bald Eagle ¤		H	71	81	Chimney Swift †			17	6	Black-capp Chickadee		P	51	93
Northern Harrier			32	38	Ruby-thr Hummingbird		H	34	77	Boreal Chickadee			50	86
Sharp-shinned Hawk			23	23	Belted Kingfisher			55	84	Red-breast Nuthatch		H	40	76

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Maritimes Breeding Bird Atlas - Summary Sheet for Square 20PR27 (page 2 of 2)

SPECIES	Code		%		SPECIES	Code		%		SPECIES	Code		%	
	1st	2nd	1st	2nd		1st	2nd	1st	2nd		1st	2nd	1st	2nd
White-breast Nuthatch			0	6	Blackpoll Warbler			13	25	Pine Siskin			46	44
Brown Creeper			13	28	Black-thr Blue Warbler			7	8	American Goldfinch		P	61	91
Winter Wren		S	36	38	Palm Warbler			25	40	Evening Grosbeak			30	55
Golden-crown Kinglet		H	46	84	Yellow-rumped Warbler			51	91	House Sparrow			32	37
Ruby-crown Kinglet		S	55	91	Black-thr Green Warbler		S	38	77					
Veery			7	25	Canada Warbler †			32	15					
Bicknell's Thrush †			1	0	Wilson's Warbler			7	11					
Swainson's Thrush			59	84	Chipping Sparrow			50	42					
Hermit Thrush		S	57	91	Vesper Sparrow †			3	0					
American Robin		P	65	100	Savannah Sparrow			57	77					
Gray Catbird			13	18	Nelson's Sh.-tail Sparrow			7	13					
Northern Mockingbird †			5	3	Fox Sparrow			17	25					
European Starling			55	81	Song Sparrow		S	63	98					
Cedar Waxwing		P	48	93	Lincoln's Sparrow			51	74					
Ovenbird			48	79	Swamp Sparrow			53	77					
North Waterthrush			21	47	White-throat Sparrow		CF	59	94					
Black-white Warbler		S	55	89	Dark-eyed Junco		CF	61	93					
Tennessee Warbler			48	15	Scarlet Tanager †			3	1					
Nashville Warbler		CF	42	71	Rose-breast Grosbeak			32	25					
Mourning Warbler		P	46	76	Bobolink			36	30					
Common Yellowthroat		S	59	93	Red-wing Blackbird			61	81					
American Redstart			57	88	Rusty Blackbird †		A	26	8					
Cape May Warbler			15	5	Common Grackle			61	86					
Northern Parula		H	53	89	Brown-head Cowbird			17	1					
Magnolia Warbler		P	59	94	Baltimore Oriole ‡			1	0					
Bay-breasted Warbler			30	28	Pine Grosbeak			26	33					
Blackburnian Warbler			50	77	Purple Finch		P	51	91					
Yellow Warbler		S	57	86	Red Crossbill †			1	5					
Chestn-sided Warbler			15	47	White-winged Crossbill			21	23					

This list includes all species found during the Maritimes Breeding Bird Atlas (1st atlas: 1986-1990, 2nd atlas: 2006-2010) in the region #24 (Southwest Cape Breton Island). Underlined species are those that you should try to add to this square (20PR27). They have not yet been reported during the 2nd atlas, but were found during the 1st atlas in this square or have been reported in more than 50% of the squares in this region during the 2nd atlas so far. "Code" is the code for the highest breeding evidence for that species in square 20PR27 during the 2nd and 1st atlas respectively. The % columns give the percentage of squares in that region where that species was reported during the 2nd and 1st atlas (this gives an idea of the expected chance of finding that species in region #24). Rare/Colonial Species Report Forms should be completed for species marked: § (Colonial), ‡ (regionally rare), † (rare in the Maritimes) or ¤ (rare in the Maritimes, documentation only required for confirmed records). Current as of 8/02/2023. An up-to-date version of this sheet is available from http://www.mba-aom.ca/jsp/summaryform.jsp?squareID=20PR27?lang=en

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Rhodena Wind Project
2022 Radar and Acoustic Monitoring

Prepared for:

ABO Wind Canada Ltd.
210 3015 – 12 Street NE
Calgary, AB T2E 7J2

Project No. 106536-01

March 29, 2023

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Appendices

Appendix A Complete Spring Radar Data
Appendix B Complete Fall Radar Data

List of Acronyms and Abbreviations

Acronym / Abbreviation	Definition
ABO Wind	ABO Wind Canada Ltd.
AI	artificial intelligence
agl	above ground level
Ausenco	Ausenco Sustainability Inc.
CMT	Cognitive Marine Tracker
CWS	Canadian Wildlife Service
ECCC	Environment and Climate Change Canada
NB	New Brunswick
NS	Nova Scotia
NCEP	National Centers for Environmental Prediction
NFC	Nocturnal Flight Call
NSECC	Nova Scotia Environment and Climate Change
NSESA	Nova Scotia Endangered Species Act
rpm	revolutions per minute
RSA	Rotor Swept Area
SARA	Species at Risk Act

List of Symbols and Units of Measure

Symbol / Unit of Measure	Definition
kHz	kilohertz
km	kilometre
kW	kilowatt
m	metre
MW	megawatt
MHz	Megahertz

1.0 Introduction

ABO Wind Canada Ltd. (ABO Wind) retained Ausenco Sustainability Inc. (Ausenco), a wholly owned subsidiary of Ausenco Engineering Inc. (formally known as Hemmera), to conduct spring and fall radar and acoustic monitoring of nocturnal migrating birds at the Rhodena Wind Project (the Project) in 2022. The Project is located approximately 13 kilometers (km) north of the Town of Port Hastings, Nova Scotia (NS).

The *Guide to Preparing an EA Registration Document for Wind Power Projects in Nova Scotia* (Government of Nova Scotia 2021) specifies that avian radar studies are required for projects that include turbines greater than 150 m in height. Also, the Canadian Wildlife Service's (CWS) *Wind Energy & Birds Environmental Assessment Guidance Update* (Government of Canada 2022), created in April 2022, specifies that migratory avian radar and acoustic studies be completed for projects that include turbines greater than 150 m in height. Given that the Project turbine will have a maximum total height greater than 150 m, an avian radar and acoustics study was conducted.

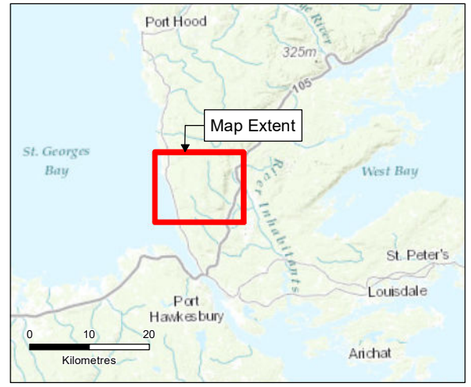
Ausenco, in partnership with Dr. Phil Taylor of Tabanid Consulting and Acadia University, completed spring and fall avian radar and acoustic monitoring at the Project in 2022. This report provides a summary of the avian radar and acoustic monitoring conducted in the spring and fall migration seasons of 2022.

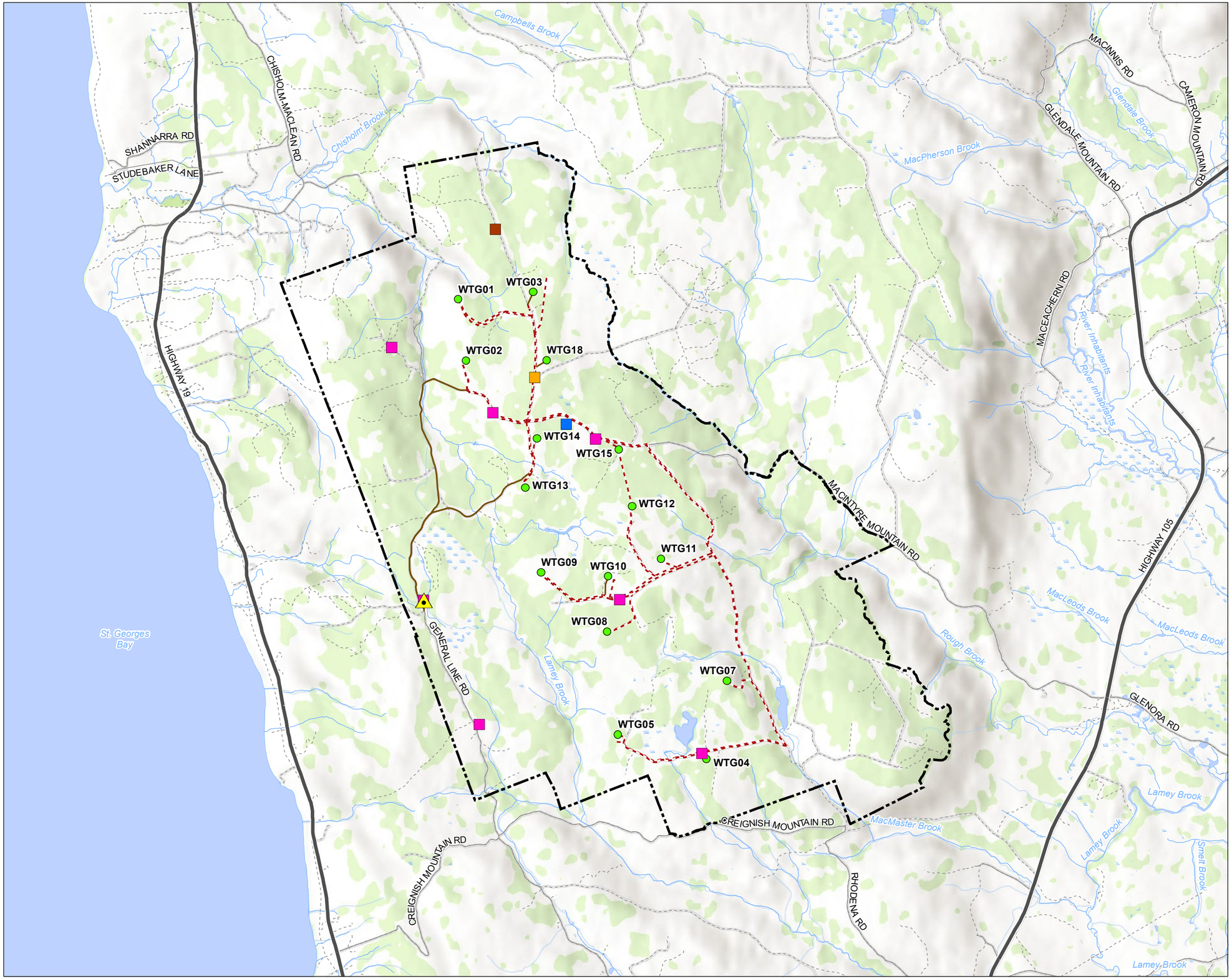
1.1 Project Details

ABO Wind is proposing 15 turbine locations for the Project (**Figure 1.1**), which will be 6.8 megawatts (MW) in size, bringing the total Project nameplate capacity up to 102 MW. ABO is considering other turbine models but has chosen the NORDEX N163/6.8 for this assessment as it is the largest model under consideration and will provide a conservative assessment for potential impacts. The 6.8 MW turbine model has a hub height of 118 meters (m), rotor diameter of 163 m, and a total turbine height (i.e., tip of blade) of 199.5 m above ground level (agl). The potential rotor swept area (RSA) of each turbine will be 20,867 m^2.

Rhodena Wind Power Project

Radar and Acoustic Survey Locations





Legend

- Substation
- Turbine Location
- Collector Line
- Access Road
- Project Area
- 2022 Radar Location

Audio Sensor Locations

- Spring and Fall
- Spring and Mid-Fall
- Spring and Late-Fall

Basemap Layers

- Highway
- Road
- Trail
- Mapped Watercourse
- Mapped Waterbody
- Mapped Wetland

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Contains information licensed under the Open Government Licence(s) - Nova Scotia
- Project Features: ABO Wind Canada Ltd, 2022
- Basemap: ESRI World Topographic Map
- Inset Basemap: ESRI World Topographic Map

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Ausenco

ABO Wind Canada Ltd

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2.0 Methods

The following section provides a summary of the methodology used to collect and analyse the radar and acoustic data during the spring and fall of 2022.

2.1 Radar Monitoring

The following radar monitoring survey methods and system have been used in the past to assess migratory bird movements at 4 proposed wind energy projects in NS and 6 projects in New Brunswick (NB) to provide an adequate representation of bird passage rates and heights. These projects have included the Burchill Wind Project (Taylor et al. 2020), Benjamins Mill Wind Project (Hemmera 2021), and Westchester Wind Project (Ausenco 2022) as well as several successful Master of Science degrees (Peckford 2006; Matkovich 2011). The radar monitoring system was initially developed through federal (i.e., CWS) grant funding and has been improved upon through multiple iterations over more than 15 years.

The radar location was chosen based on access to the Project area, site security and clear sight lines. The radar was deployed within the northern portion of the Project area (**Figure 1.1**), approximately 1,500 m from the nearest proposed turbine.

The radar used was a Furuno (Camas, Washington, USA) 1962 BB marine radar that operated in the microwave X-band (9410 ± 30 Megahertz (MHz), 25 kilowatt (kW)) with a 6-foot XN13A open-array antenna with a beam width of approximately 22 degrees in the horizontal plane and approximately 1.35 degrees in the vertical plane. The radar was mounted on a custom support framework in a vertical orientation to monitor the altitude of targets and was run in short pulse mode (2100 pulses per second) at 24 revolutions per minute (rpm).

Prior to deployment, the radar was calibrated while in a horizontal orientation using targets at a known distance. The radar signal was digitized at 4.5 m range resolution with an azimuth resolution of 1.35 degrees using a DSPNOR ScanStreamer (Bergen, Norway). Data were saved on external hard drives and later analyzed using Cognitive Marine Tracker (CMT) radar analysis software, from the Cognitive Radar Corporation (Waterloo, Ontario).

During the spring season, radar data were collected from April 13 to June 7, 2022. Environment and Climate Change Canada (ECCC) recommends that spring radar monitoring take place from March 15 to June 7 (Government of Canada 2022), but the spring deployment date was delayed into April due to deep snow in the Project area, which hampered access. During this 56-day spring monitoring period, the radar functioned properly for 41 nights (approximately 73% of the spring monitoring period).

During the fall season, radar data were collected from July 7 to November 17, 2022. ECCC recommends that fall radar monitoring take place from July 15 to November 30 (Government of Canada 2022), but predicted heavy snowfall in mid-November prompted the early retrieval of the radar unit. During the 134-day fall monitoring period, the radar functioned properly for 99 nights (approximately 74% of the monitoring period). Much of the interruption in data collection was due to post-tropical storm Fiona on September 23, 2022, resulting in a 15-day gap in radar data. In anticipation of the storm, the radar was removed from the elevated stand and secured. While the radar was not damaged in the storm, 2 solar panels were destroyed and needed replacements. Power outages and intermittent cellular coverage following the storm also caused small gaps in radar data collection.

2.1.1 Radar Data Processing

Targets were defined as radar detections that were extracted over background noise if they were at least 6 pixels in size, and the sensitivity to detect targets over the threshold in the CMT software (Pfa setting) was set at 0.02. These settings allowed for weak targets at long range to be identified over background noise, but also were sensitive enough to pick up insects at short range and birds at the edge of the radar beam. This data analysis assumes that most targets were migratory birds once the data was filtered for non-birds, though targets may have included insects, bats, clutter, or precipitation.

To filter out insects and birds on the periphery of the beam at close range, the peak power of the radar return for each target ("peak_val setting") was used and corrected for range, since returned power decreases with range to the fourth power ("scaled intensity"). The numbers of targets in five-minute intervals across the entire season were then correlated with acoustic data, to determine a threshold above which there was confidence in classifying the target as a bird. The correlation between acoustic and radar detections plateaued at a scaled intensity of 18, so targets below that threshold were removed from the analysis.

Radar data was visually inspected to determine periods of rain, which were excluded from analysis. Targets below 70 m agl were also eliminated because they are contaminated by ground clutter.

Targets were then extracted from individual "columns" of air starting at a distance along the ground between 300 m and 320 m from the radar. This approach allows for smaller birds to be detected at high altitudes, while sampling low altitudes horizontally from the radar.

2.2 Acoustic Monitoring

A network of 8 acoustic sensors (Audiomoths™) were placed throughout the Project area, with one placed at the radar unit, and 7 throughout the Project area (**Figure 1.1**). One sensor location had to be relocated during surveys due to road construction in the mid-fall and was moved 2,000 m further south for the late fall. Sensors were placed a minimum of approximately 500 m apart in open areas with a clear view of the sky to reduce the potential for duplicate sampling of airspace and to capture nocturnal migrants throughout the Project area.

The acoustic sensors were programmed to begin recording approximately one hour before the end of evening civil twilight and finish recording one hour after the beginning of morning civil twilight. It is during this period that birds make nocturnal flight calls (NFCs) while actively migrating (Evans 2005). The sensors were checked approximately every 30 days to replace batteries and download data onto an external hard drive. The detection range of each recording unit is estimated to be up to approximately 100 m for NFCs of migratory birds (primarily passerines). Civil twilight was calculated using the suncalc package in R (v 0.5.1; Thieurmel and Elmarchraoui 2022).

2.2.1 Acoustic Data Processing

All acoustic data were either sampled or resampled to 22 kilohertz (kHz), to encompass the frequency range where most NFCs occur, and then further subset to between the end of evening civil twilight and the beginning of morning civil twilight.

All acoustic files were processed using a custom-built artificial intelligence (AI) NFC detection model developed by Dr. Kitzes' laboratory at the University of Pittsburgh using Open Sound Scape python package. The model was trained using NFCs originally identified by John Kearney of John F. Kearney & Associates (Rhinehart et al. 2022). The NFC model assigned a 'score' to each species group, which is then related to the probability that a specific acoustic detection actually was that species group.

In the spring monitoring period, all detections with scores greater than 2 were visually assessed (by examining a spectrogram) or listened to by an expert (Tabanid Consulting Ltd) to verify the identity of the call or call group. In the fall monitoring period, all files were manually validated except birds within the AMRE, COYE, OVEN or ZEEP, which due to a greater number of detections, were validated using the methods outlined below.

For those calls that were not visually assessed, NFCs detected by the model were sampled for validation. Each NFC was assigned to one of 3 categories related to the time of night, either 'Dusk', 'Dawn' or 'Night'. NFCs categorized as 'Dusk' and 'Dawn' were detected during 30 min from the beginning or end of the civil twilight period, respectively. For validation, up to 100 NFCs were randomly selected (scores > 2; weighted by score) from the Dusk/Dawn period, and up to 200 calls from the Night period. These calls were visually assessed by examining a spectrogram or listened to by an expert (Tabanid Consulting Ltd) to verify the identity of the call or call group. Then, a statistical model was fit to assess the remaining calls. A binomial model, with the response being valid or not valid was fit to model score and time of night and season. These models were then used to predict the probability that all of the other calls with scores > 2was of a given species or species group.

For plotting and analysis, all NFCs were selected that had been validated, or (for those with >300 calls) had predicted probabilities of greater than 85%. The 85% value was chosen to provide a balance between false classifications and false negatives (i.e., overlooking calls that are truly there). Where applicable, classified calls were further assessed (by visually inspecting additional spectrograms) to check that the false positive rate was near 15%.

2.3 Data Analysis

Data analysis was conducted to identify migratory patterns of bird species passing through the Project area using radar and acoustics. All analyses were conducted in Rstudio (V. 2022.12.0) running program R (R Core Team 2023) V 4.0.4) and python V.3.8.

2.3.1 Radar Analysis

The primary objective of radar monitoring was to describe the general patterns of migrating birds at the Project using targets identified by the radar. Once targets were filtered for non-birds, targets were assumed to be birds and used to describe temporal and spatial trends in migratory birds including observations above and below 200 m in altitude, as well as the influence of weather. The 200 m threshold was selected based on the proposed turbine height for the Project.

Two response variables were derived from the compiled radar data. The first was the number of targets detected in each hourly period (excluding rain) across all nights. The second was the ratio of the number of targets detected below and above 200 m in altitude. That ratio is positively related to the proportion of targets flying beneath 200 m but does not represent the actual proportion, since the probability of detecting

targets decreases with increasing altitude due to changes in the shape and size of the radar beam, and the size of the targets. As such, this ratio overestimates the proportion of targets observed at lower altitudes to some unknown extent. Regardless, the ratio serves as a useful indicator to determine under which conditions and times more targets are flying at relatively lower altitudes.

Weather data (wind speed and direction, pressure, temperature, and humidity) were acquired from the National Centers for Environmental Prediction (NCEP) (NOAA 2022) downloaded via the RNCEP package in program R (R Core Team 2023) V 4.0.4). They were interpolated to an hourly value at the location using an approach identical to that employed in the function NECP.interp. For this report, wind data from an altitude of approximately 700 m were used.

The effect of weather (tailwind assistance, barometric pressure, change in barometric pressure and humidity) on the log of the number of targets detected and the proportion of targets below 200 m (relative to above 200 m) was modelled using generalized linear models. Model support was assessed using Akaike's Information Criterion (package MuMIn; Barton 2012).

The relationship between targets aloft and weather is complex and nonlinear, and as such, statistical models of such relationships can be difficult to interpret. Therefore, simple models were fit to show the dominant relationships between the two response variables described above and the weather variables. Furthermore, since relationships between wind speed, wind direction and the number of birds aloft can also be complex, a 'tailwind assistance' variable was used to provide a measure of how much the wind would assist a given bird flying in a specific direction. It is known that nocturnal migrants fly with positive tailwind assistance (Peckford and Taylor 2008). Tailwind assistance was calculated assuming migrants are flying in a direction of 45 degrees during spring and 225 degrees in the fall. Therefore, for example in the spring, if the wind was flowing from the direction of 45 degrees, then the birds' tailwind assistance would be negative (a headwind); if the wind was flowing towards 45 degrees, the birds' tailwind assistance would be positive. The strength of the assistance is a function of both the direction of the wind, and its speed.

To assess how targets differed at migratory initiation (sunset), cessation (sunrise) and during the night, terms were fit for time of night. Civil twilight was calculated using the suncalc package in R (v.0.5.1; Thieurmel and Elmarchraoui 2022). Time of night was defined as follows:

- sunset – 90 minutes after the end of evening civil twilight
- sunrise – 90 minutes before the beginning of morning civil twilight
- middle – the remainder of the night.

The R package 'tidyverse' (Wickham et al. 2019) was used for data manipulation and visualization and the function 'glmer' in package 'lme4' (Bates et al. 2015) was used for statistical modelling. In all cases, mixed effects models were fit, with the day of the year as a random effect. Treating day as a random effect allows the model to account for additional variation in counts that is not fully captured by the weather or timing variables. Models of the total counts were fitted with a 'poisson' family (i.e., the relationship between the response and the predictor variables was on a log scale) and measure of the proportions were filled using a 'binomial' family, which transforms the response using a log-odds ratio. Model fits were assessed by examining residual plots.

2.3.2 Acoustic Analysis

As outlined in **Section 2.2.1**, acoustic data were processed to identify NFCs, primarily by passerines. The NFC categories for the species and species groups used by the model are presented in **Table 2.1**.

Table 2.1 Nocturnal Flight Call for Potential Species and Species Groups at the Project

Species / Species Group	Potential Species [a]
Cup-Sparrows	· Chipping Sparrow · Field Sparrow · American Tree Sparrow
Fox / Song Sparrow Complex	· Fox Sparrow · Song Sparrow
Zeep	· Bay-breasted Warbler · Blackburnian Warbler · Blackpoll Warbler · Cape May Warbler · Magnolia Warbler · Northern Waterthrush · Yellow Warbler
Single-banded down sweep	· Pine Warbler · Northern Parula · Yellow-throated Warbler (very rare to call) · Prairie Warbler (very rare to call)
Double-up	· Black-throated Green Warbler · Tennessee Warbler · Nashville Warbler · Orange-crowned Warbler
Thrushes	· Hermit Thrush · American Robin · Swainson's Thrush · Veery · Grey-cheeked Thrush (rare) · Bicknell's Thrush (rare) · Eastern Bluebird (rare) · Wood Thrush (rare) · Rose-breasted Grosbeak (rarely calls) · Scarlet Tanager (rare)
Full Species	Sparrows: · White-throated sparrow · Savannah Sparrow Warblers: · American Redstart · Black-and-white Warbler · Black-throated Blue Warbler · **Canada Warbler** · Chestnut-sided Warbler

Species / Species Group	Potential Species [a]
	· Common Yellowthroat · Mourning Warbler · Ovenbird · Palm Warbler · Yellow-rumped Warbler Other: · **Common Nighthawk** · American Woodcock Poorly detected/classified (not included) · Wilson's Warbler · Red-breasted Nuthatch · Pine Siskin · Golden-crowned Kinglet

Note: [a] = Species in bold are federally listed under the *Species At Risk Act* (S.C. 2002, c. 29; Government of Canada 2021).

Following the analysis, the NFCs identified covered a broad range of warbler, sparrow and thrush species found in the region, and are listed below. For auditory and visual examples of these calls, visit www.nocturnalflightcalls.com (Rhinehart et al. 2022).

- "Zeep"
- "Cup Sparrow" (cupsp)
- "Double-Up" (dubup)
- "Single-banded down sweep" (sbds)
- "Fox Sparrow / Song Sparrow" (fssp)
- "Thrushes" (thrushes)
- American Redstart (amre)
- Black and White Warbler (baww)
- Black-throated Blue Warbler (btbw)
- Canada Warbler (cawa)
- Common Yellowthroat (coye)
- Chestnut-sided Warbler (cswa)
- Mourning Warbler (mowa)
- Ovenbird (oven)
- Yellow-rumped Warbler (yrwa)
- Savannah Sparrow (savs)
- White-throated Sparrow (wtsp).

2.3.3 Visualization Patterns

All radar and acoustic detections were plotted to visually explore the patterns of bird movement at the Project in conjunction with wind direction and strength at the ground level and aloft. Analysis within this report is restricted to a summary of those observations.

Nights from both the spring and fall migration seasons were selected for focus within this report. Nights were selected with many radar targets, many acoustic detections, or that showed different patterns of bird behaviour at the Project compared to other nights.

The full set of visualizations for the radar data for the spring and fall are presented in **Appendix A** and **Appendix B**, respectively.

3.0 Results

The results of radar and acoustic monitoring are presented below for data collected during the 2022 spring and fall migration seasons.

3.1 Spring Migration

Radar and acoustic data were collected between April 13 and June 7, 2022, to capture bird migration data on timing, density, intensity, and the influence of season and weather.

3.1.1 Nocturnal Migration Patterns

Most of the migration activity was observed across 5 nights (May 9, May 14, May 18, May 26, and May 30; **Figure 3.1, Figure 3.2**). Most radar detections during the peak nights occurred at altitudes greater than 200 m (high altitude) with no more than 450 targets detected below 200 m (low altitude) on a single night (**Figure 3.1**). The entire dataset of nights for the spring season can be found in the **Appendix A**.

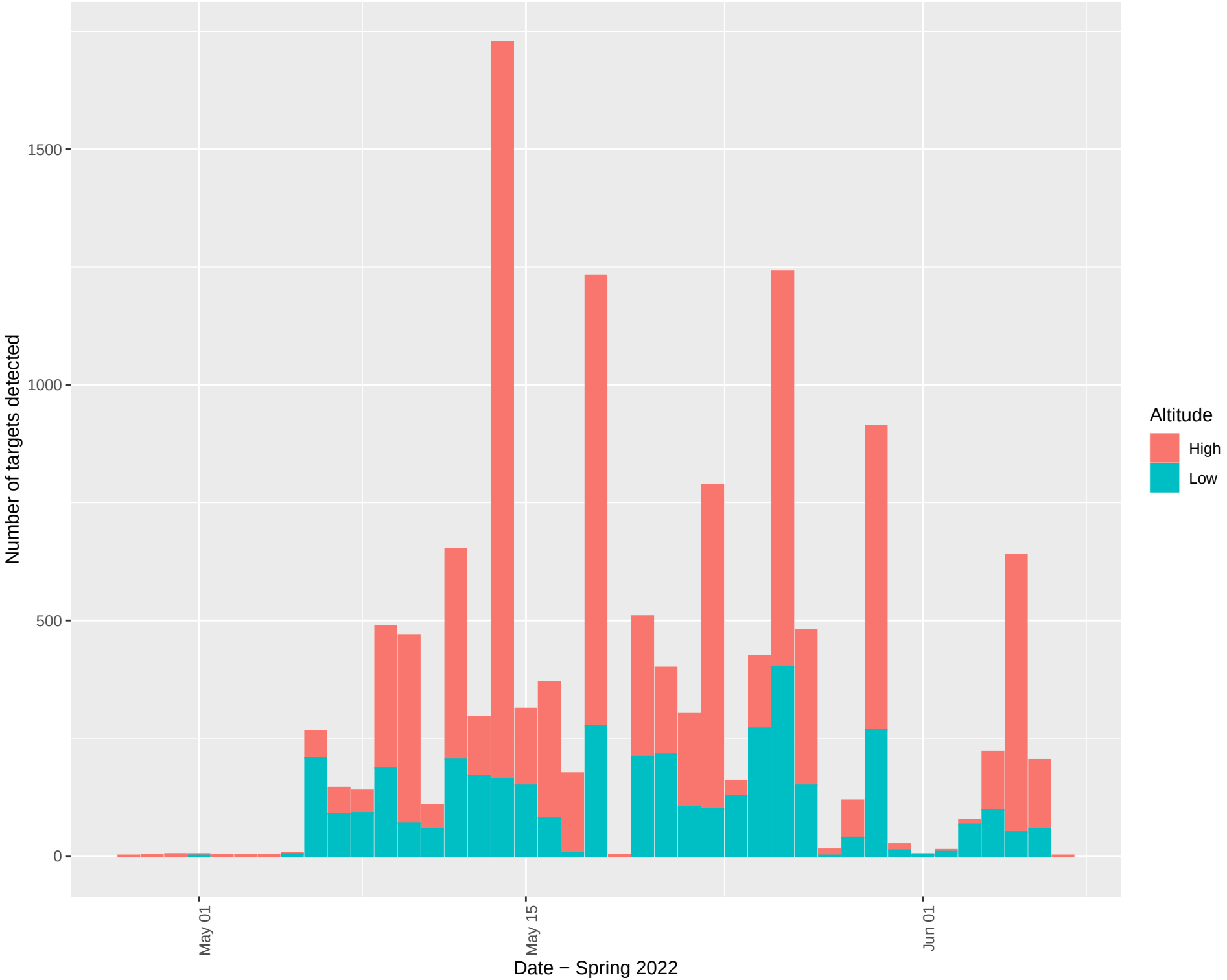

Figure 3.1 Seasonal Change in Radar Detections by Altitude during Spring 2022

The altitudinal, seasonal, and within night distribution of radar targets for select nights in the spring is shown in **Figure 3.2**. Each plot within **Figure 3.2** is a separate night, with the beginning and end of civil twilight indicated by the vertical green and yellow lines, respectively. Date and time are on the x-axis and altitude is on the y-axis. Hexagonal points are radar detections divided into time and altitude bins and are scaled from light grey (few detections) through dark purple, blue, green to yellow (many detections). Wind direction and strength aloft (~700 m) for each hour are displayed at the top of each plot via a red arrow. Red lines represent the approximate altitudinal range of the RSA. Acoustic detections (a single NFC) are red points along the base of each plot.

The nights selected for **Figure 3.2** had either many radar targets, many acoustic detections, or showed different patterns of bird behaviour at the Project compared to other nights. Acoustic detections were more frequent when the radar shows targets at lower altitudes (May 14 and May 26), which is likely a function of the detection range of each recording unit. Additionally, calling frequency is known to not be constant and some species migrate without calling (e.g., vireos and flycatchers; Smith et al. 2014), so the number of radar targets will not always correlate with the number of acoustic detections (see May 14 approximately 5 hours after sunset).

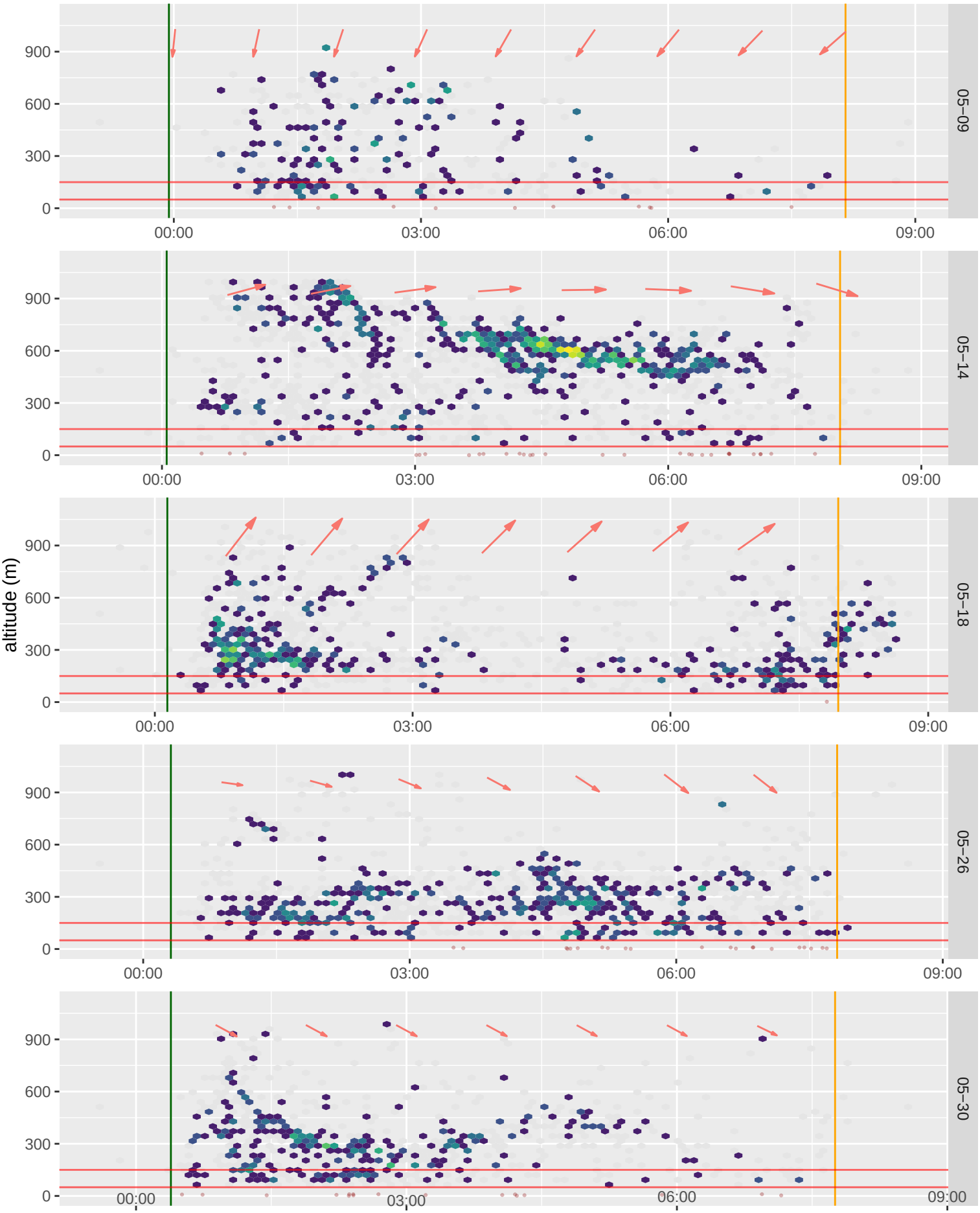

Figure 3.2 Radar and acoustic detections and wind conditions on select nights during Spring 2022

3.1.2 Altitudinal Distribution of Radar Targets

Across all nights, most targets observed were at lower altitudes (i.e., below 200 m) with the number of targets generally decreasing with increasing altitude (**Figure 3.3**). This decline is partly due to an actual decrease in the number of targets, but also reflects the declining probability of detecting targets at more distant ranges. It is difficult to separate the effects of these two variables. The red line shown in **Figure 3.3** represents the maximum potential height of the turbines.

Figure 3.4 shows the density of radar detections by altitude for only the 5 selected nights. The red line indicates the maximum height of the turbines.

The pattern of radar targets by altitude varied across nights. On one of the nights with the largest movements of migration (May 14; **Figure 3.1**) targets were observed to be primarily at higher elevations (e.g., greater than 500 m; **Figure 3.4**). On other peak migration nights, the majority of targets were observed above the RSA, but more were closer to 250 m in elevation (May 18, May 26, May 30). On some nights when migration was less intense, but still elevated compared to most nights (May 9) the peak altitude band was below 200 m, but large numbers of targets were still observed above the RSA.

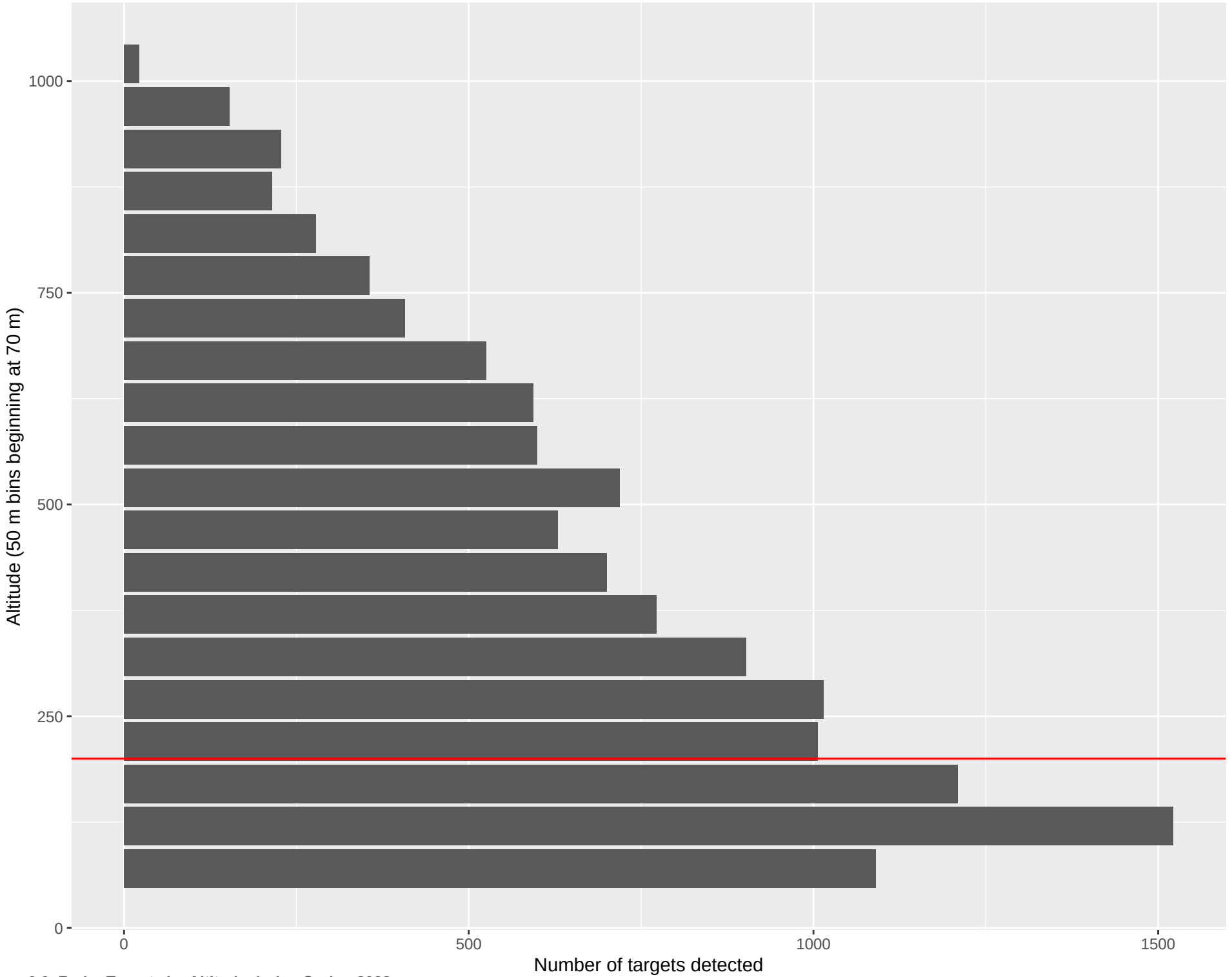

Figure 3.3 Radar Targets by Altitude during Spring 2022

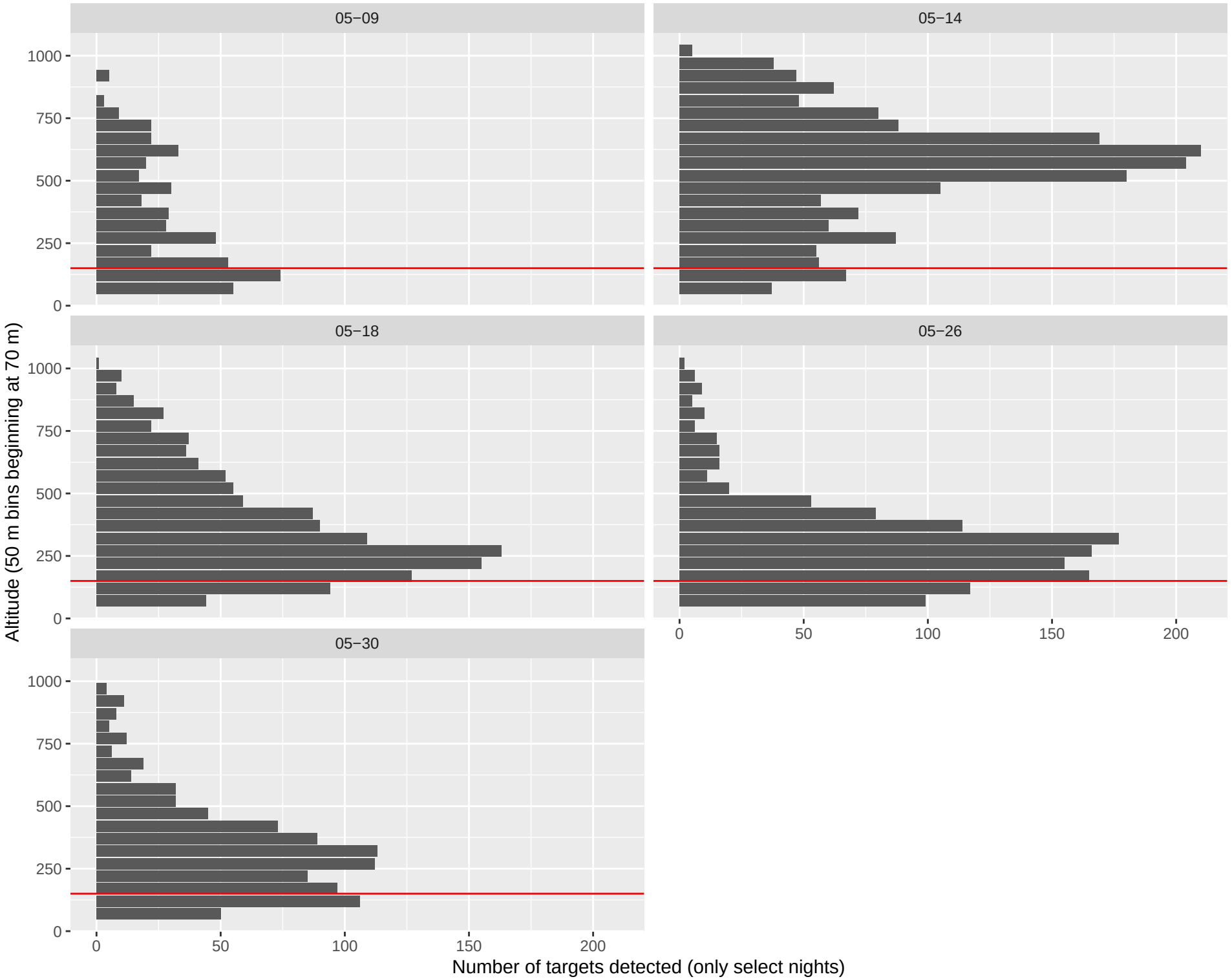

Figure 3.4 Radar Targets by Altitude for Select Nights during Spring 2022

3.1.3 Statistical Analysis of Radar Data

Statistical models provided evidence that the total number of targets per hour was related to tailwind assistance (at 'surface'), time of night (sunset, sunrise, and middle of the night) and weather (temperature, surface pressure and relative humidity). Within **Figure 3.5** each point represents the number of targets in hourly bins, classified by time periods (panels) and month (colours). Tailwind speeds are plotted along the x-axis in km per hour with negative and positive values representing tailwind assistance. To improve data visualization, the total number of targets is represented on the y-axis by taking the log base 10 of the number of targets in hourly bins. The lines are regressions for each group, showing a positive relationship during the middle of the night across May and June. This means that the number of targets detected is low in strong headwinds (negative tailwind assistance) and increases as tailwind strength increases (**Figure 3.5**). This follows a general pattern that birds prefer to migrate with tailwinds or very light headwinds (Peckford 2006).

The most important differences are summarized in **Figure 3.5** and **Figure 3.6** can be attributed to different behaviours through the night. The radar detected numerous targets immediately after the initiation of migration (take-off after sunset) and during the middle of the night (continued migration), and fewer in the morning. That the period immediately before dawn sees many fewer targets may reflect that birds are either not landing within the Project area following migration or they are consistently ending their migration flights early in the night.

In addition, **Figure 3.6** provides evidence that the proportion of birds at a low altitude (i.e., less than 200 m) decreased with increased tailwind assistance. This trend can be attributed to birds flying at a higher altitude (i.e., greater than 200 m) in preferable wind conditions (strong tailwinds).

In addition, throughout the season, the number of targets detected decreased as relative humidity increased. This relationship was strongest in May when more targets were detected but was weaker during the sunrise period when fewer birds were detected overall.

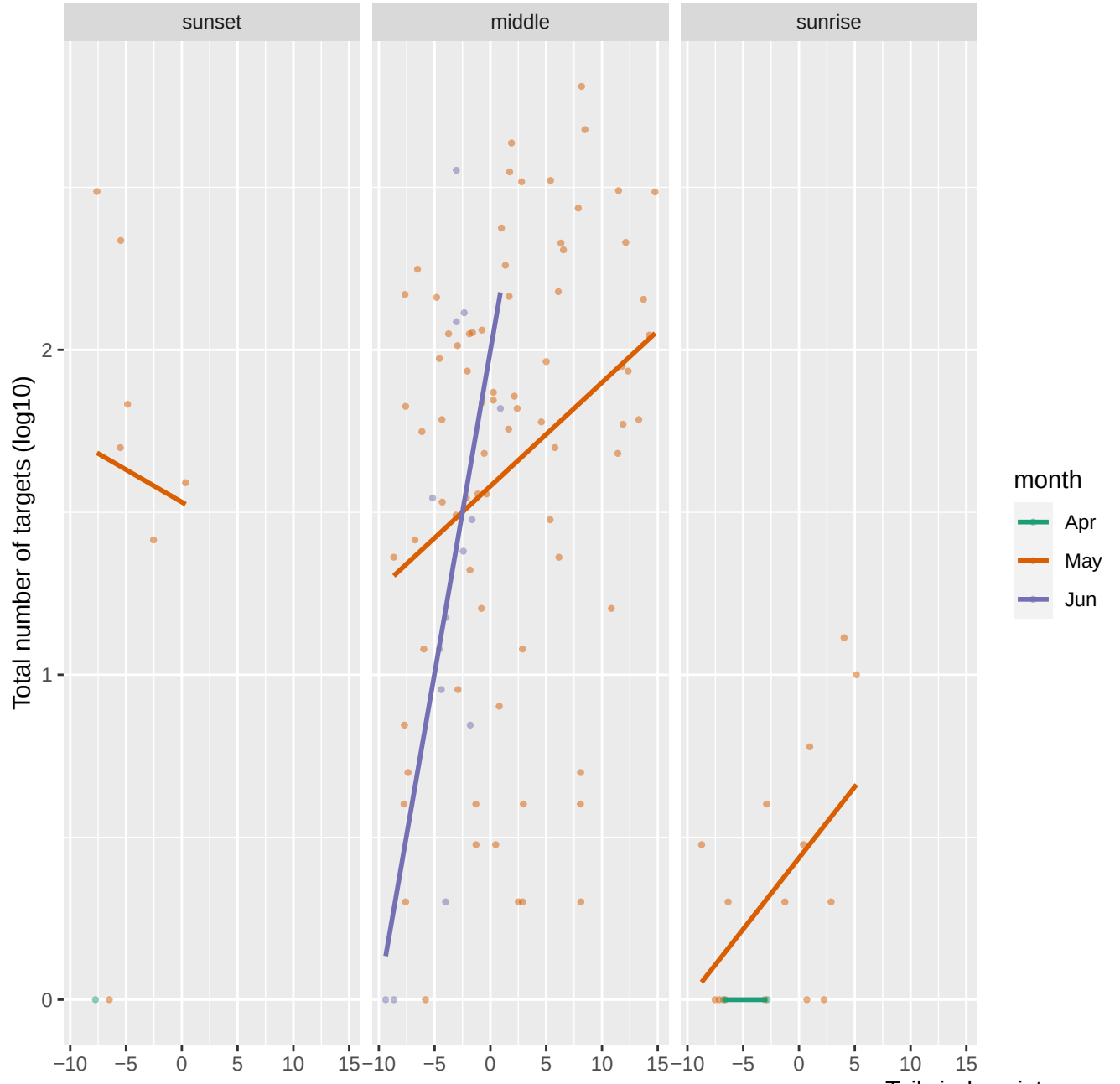

Figure 3.5 Relationship between Tailwind Assistance on Total Number of Targets across Time of Night and Month during Spring 2022

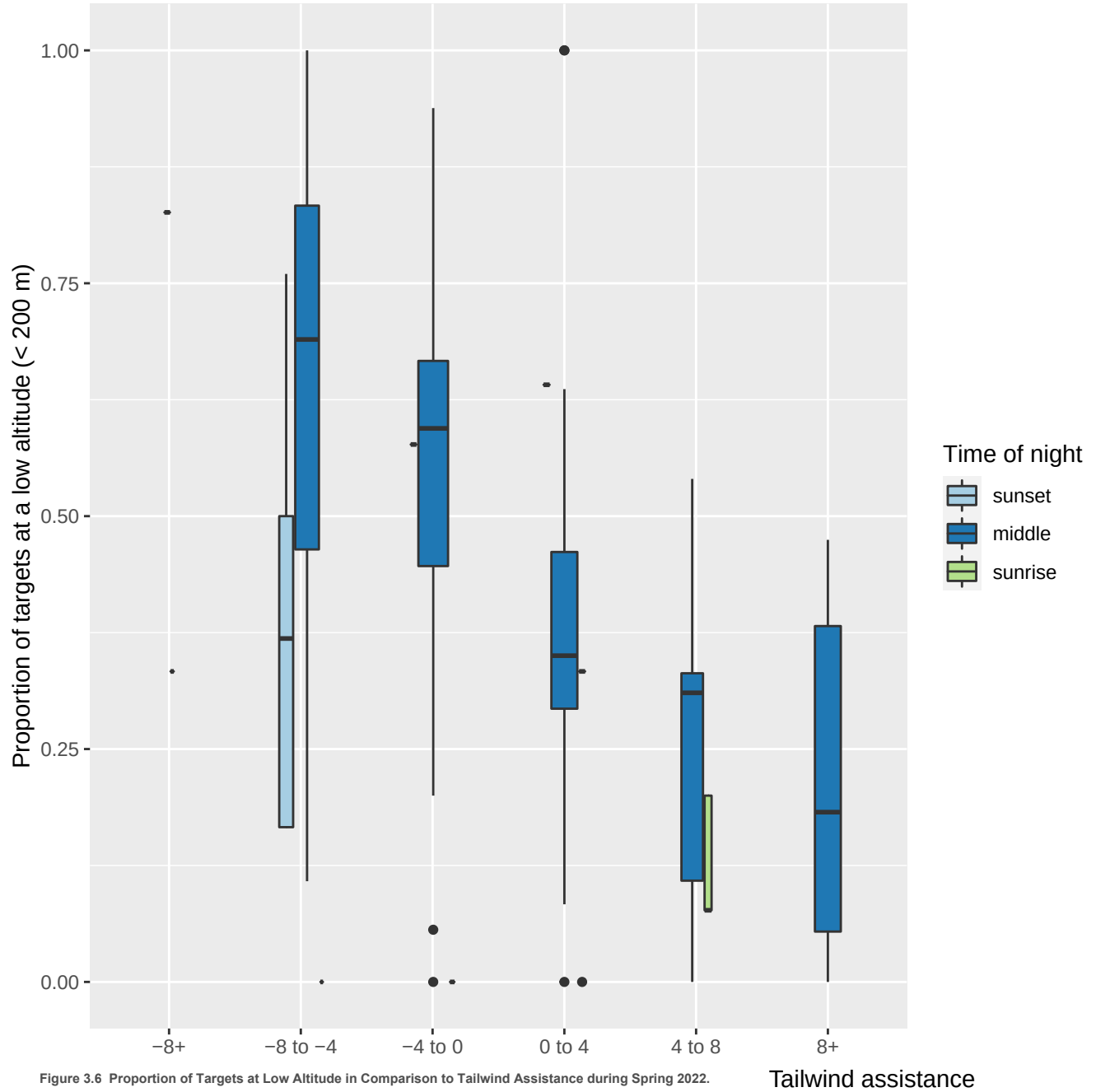

Figure 3.6 Proportion of Targets at Low Altitude in Comparison to Tailwind Assistance during Spring 2022.

3.1.4 Relative Number of Birds at Lower Altitudes

The index of the proportion of targets flying at low altitudes (i.e., less than 200 m) is the proportion of targets below a given altitude (i.e., 200 m) in relation to what is detected above that altitude. This index is related to the overall number of migrants, along with all timing and weather variables.

In **Figure 3.7**, each dot represents the number of birds detected below 200 m divided by the total number of birds observed in each hourly bin classified by time of night. The lines are smoothed relationships between the index, and the total number of targets are presented on a log scale.

On nights when large numbers of targets were detected, as well as during the middle part of the night, there tended to be fewer targets at lower altitudes (**Figure 3.7**). This same pattern is also illustrated in **Figure 3.4.**

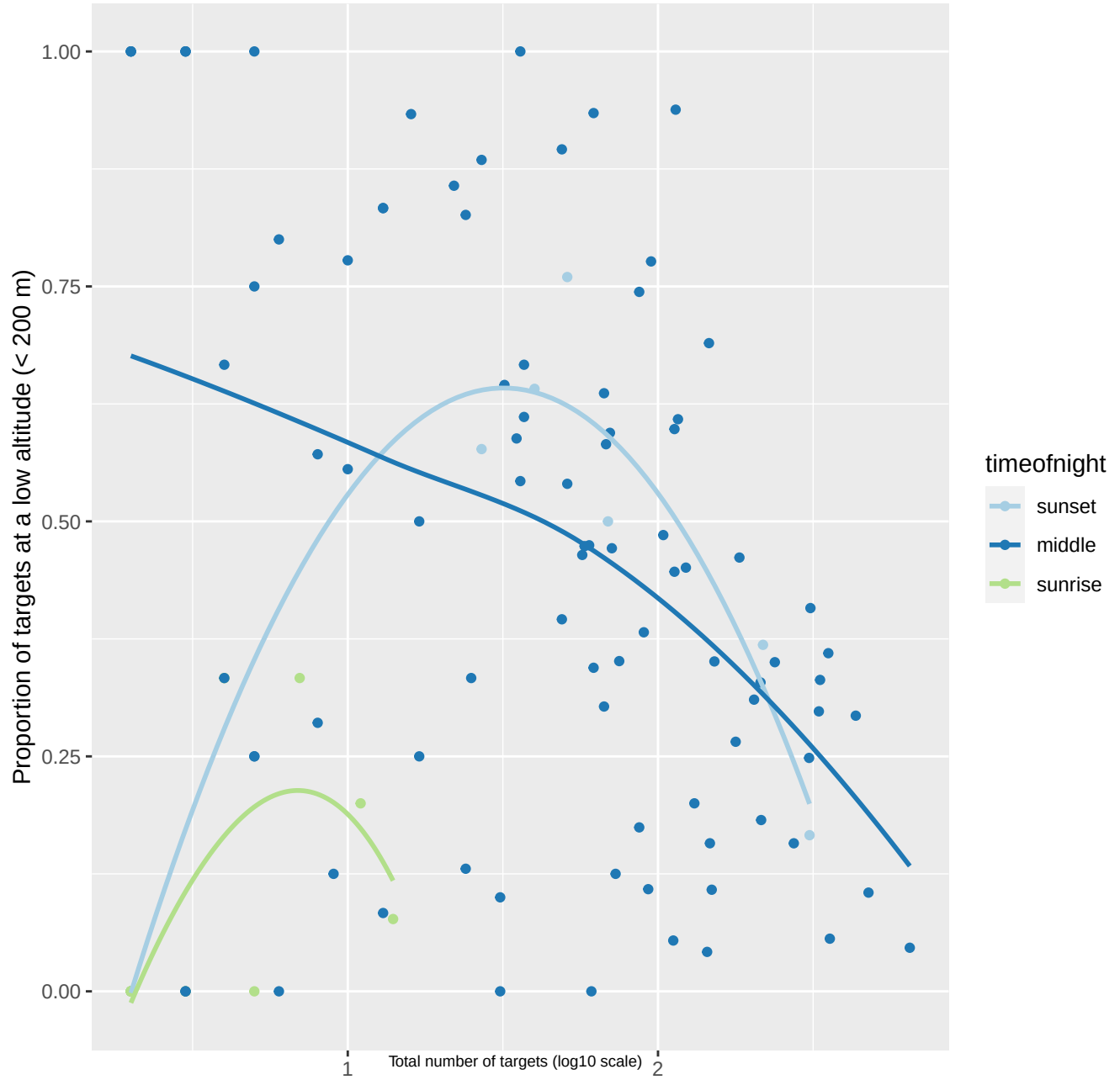

Figure 3.7 Proportion of Targets at Low Altitude in Comparison to Total Number of Targets across Time of Night during Spring 2022

3.1.5 Nocturnal Flight Call Detections

Flight calls were analyzed and grouped into one of 17 species groups with the majority being sparrows (55%), followed by warblers (43%). The most common species / species group observed was savannah sparrow [*Passerculus sandwichensis*], followed by white-throated sparrow [*Zonotrichia albicollis*], which together comprised 53% of the total detections (**Table 3.1**). Two federally listed species under the *Species at Risk Act* (SARA) were observed in the spring: Canada warbler (*Cardellina canadensis*; Threatened) and common nighthawk (Threatened; Government of Canada 2021).

Table 3.1 Nocturnal Flight Call Detections by Species and Species Group

Species / Species Group [a b]	Total Number of Calls Detected	Proportion of Calls Detected (%)
Savannah Sparrow	217	29.7
White-throated Sparrow	170	23.3
Zeep	104	14.2
Ovenbird	72	9.8
Black and White Warbler	38	5.2
American Redstart	34	4.7
Common Yellowthroat	21	2.9
Double Up	16	2.2
Single Banded Down Sweep	16	2.2
Fox Sparrow / Song Sparrow	13	1.8
Common Nighthawk	11	1.5
Canada Warbler	8	1.1
Mourning Warbler	4	0.5
Wilson's Warbler	3	0.4
Thrush 2	2	0.3
Black-throated Blue Warbler	1	0.1
Cup Sprarrow	1	0.1
Total	**731**	**100**

Notes:

(a) "Zeep" species groups includes bay-breasted warbler, blackburnian warbler, blackpoll warbler, Cape May warbler, magnolia warbler, northern waterthrush and yellow warbler; "Cup Sparrow" species group includes chipping sparrow, field sparrow and American tree sparrow; "Double Up" species group includes black-throated green warbler, Tennessee warbler, Nashville warbler and orange crowned warbler; "Single Banded Down Sweep" species includes pine warbler, northern parula, yellow-throated warbler, and prairie warbler, "Thrush 2" includes Swainson's Thrush, Veery, Rose-breasted Grosbeak and Scarlet Tanager.

(b) Species in bold are federally listed under the *Species at Risk Act* (Government of Canada 2021).

Figure 3.8 shows the distribution of acoustic detections by species across the entire spring season. Timing of species detections are as expected with most warblers detected during the mid- to late-May, and sparrows detected through early May. Very few NFCs were detected during April.

The majority of the sparrows were detected prior to May 15 with a peak on May 14. This trend aligns with the increased number of targets detected around 600 m in elevation on May 14 suggesting sparrows represented more of the migrating birds on that day. Most warbler NFCs were concentrated in late May (**Figure 3.8**). Nightjar and thrush detections were sparce and generally occurred in late May and early June.

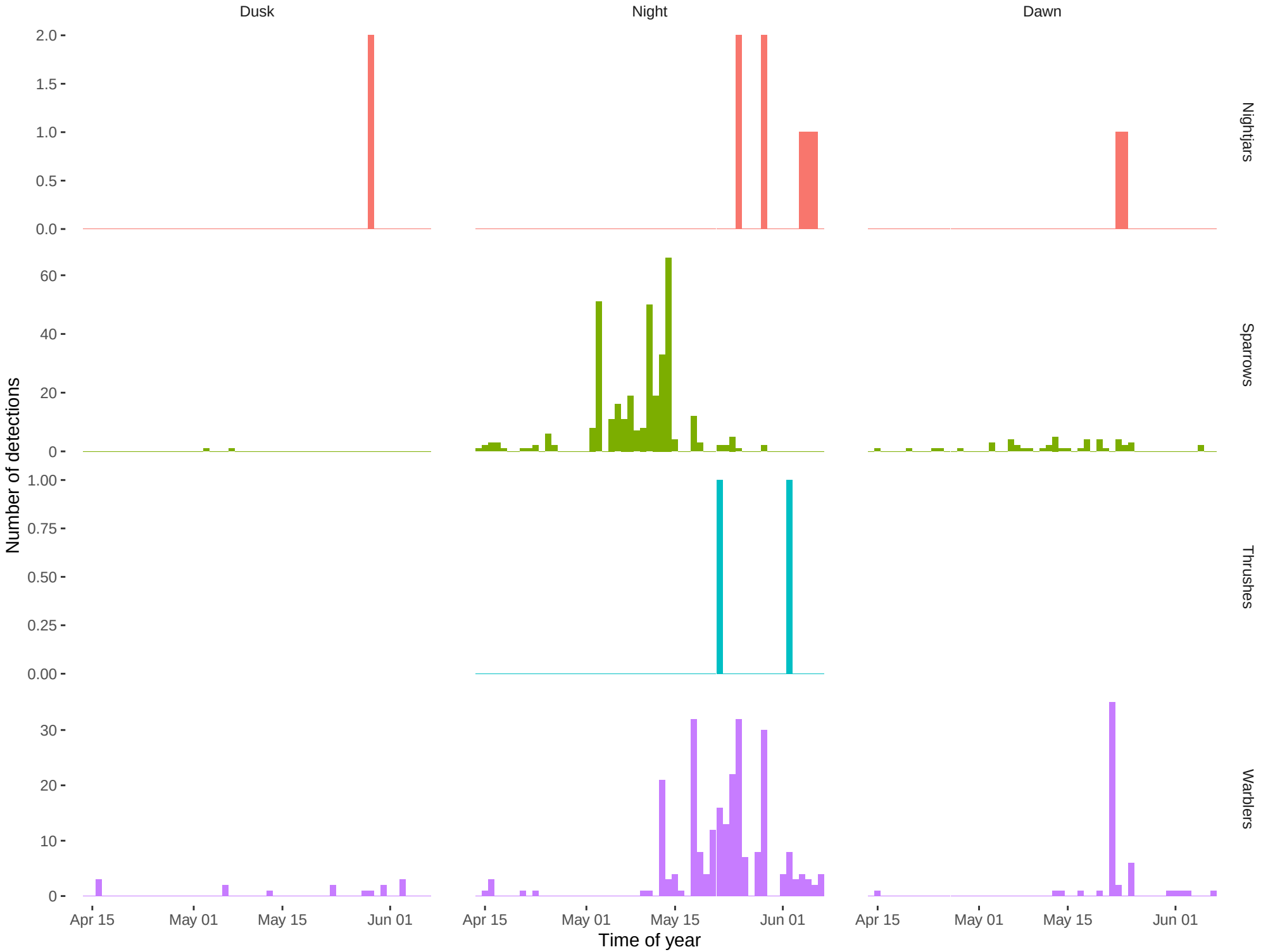

Figure 3.8 Nocturnal Flight Call Detections by Species Group and Time of Year during Spring 2022

Acoustic detections are presented by color for each species group for: warblers (purple), sparrows (green), thrushes (blue) and common nighthawk (orange) across the entire spring season (**Figure 3.9**). The number of detections is the total number of calls detected for that group on that night; also note that the scale differs between groups. Timing of species detections are as expected with most sparrows detected early to mid-May and warblers concentrated in mid to late-May.

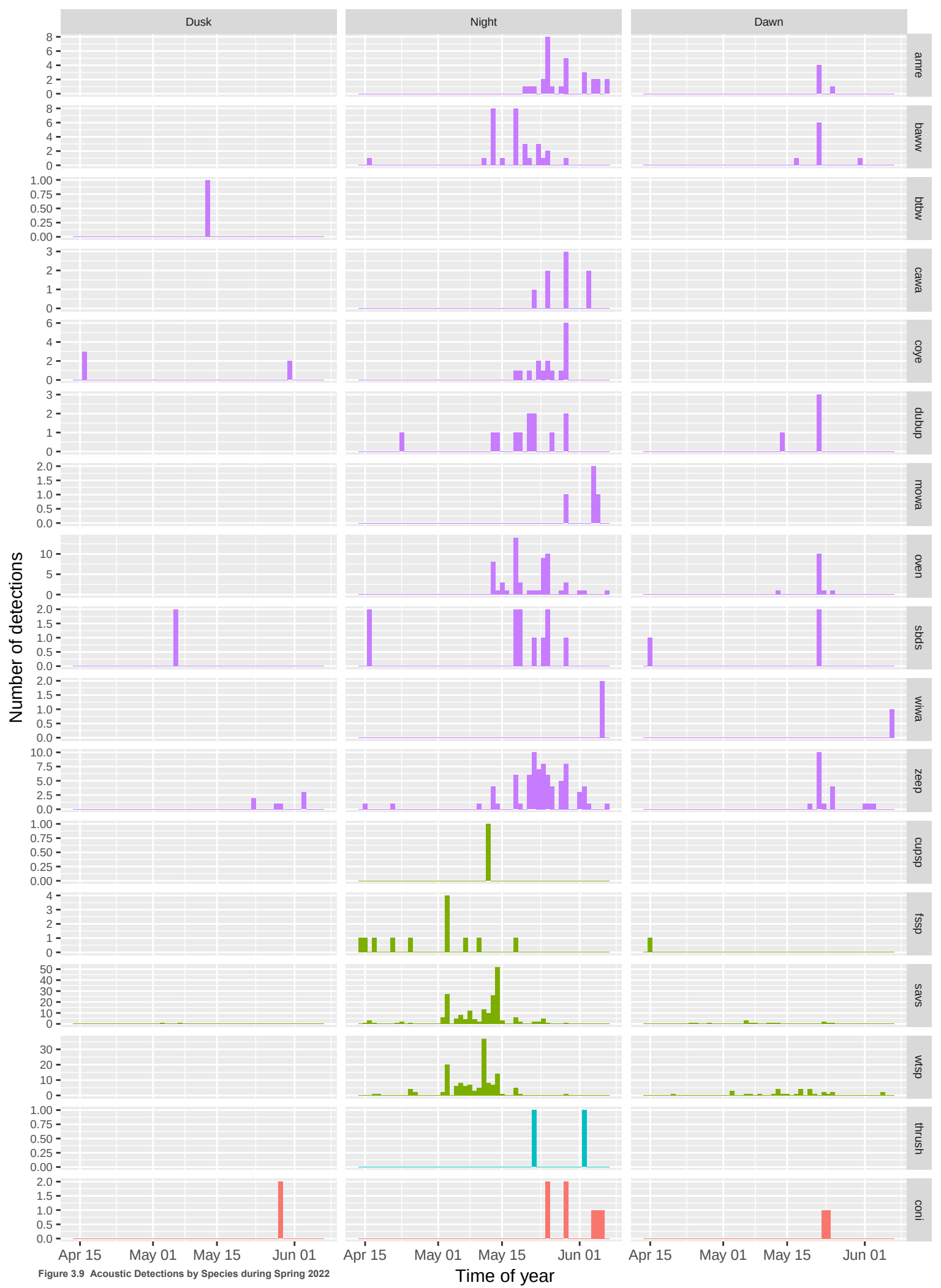

Figure 3.9 Acoustic Detections by Species during Spring 2022

Figure 3.10 shows the occurrence of NFCs detected by time of night during the spring migration season. In April, only small numbers of sparrows and warblers were detected and were generally observed throughout the night. Thrushes and nightjars (i.e., common nighthawk [*Chordeiles minor*]) were detected in May and June and were more commonly detected near dawn. The number of warbler NFCs were concentrated in May, and generally increased as time to sunrise decreased.

Figure 3.10 Nocturnal Flight Calls by Time until Sunrise during Spring 2022

3.2 Fall Migration

Radar and acoustic data were collected between July 7 and November 17, 2022 to capture bird migration data on timing, density, intensity, and the influence of season and weather.

3.2.1 Nocturnal Migration Patterns

Generally, migration intensity increased from the start of monitoring until mid/late September, after which it decreased (**Figure 3.11**). As with the spring migration season, the majority of migration occurred on a small number of nights. These select nights with the majority of peaks occurred in September and October.

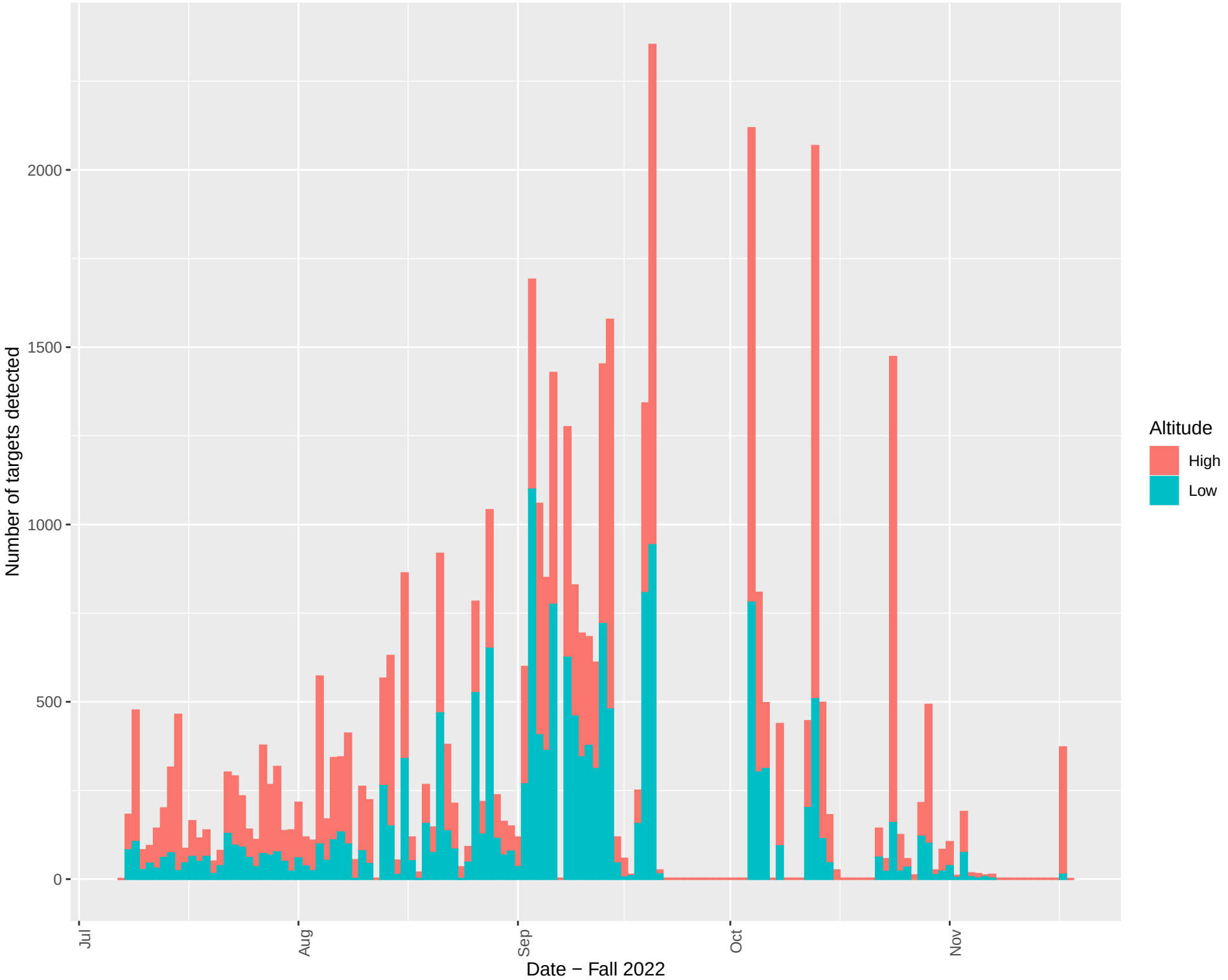

Figure 3.11 Seasonal Change in Radar Detections by Altitude during Fall 2022

During the fall, 9 nights were selected for further focus (see **Appendix B** for the complete fall dataset). The 9 nights selected have either many radar targets, many acoustic detections, or show different patterns of bird behaviour at the Project compared to other nights (**Figure 3.12**).

Each plot within **Figure 3.12** shows the altitudinal distribution of radar targets for each select night in the fall in relation to wind speed, direction and precipitation. The beginning and end of civil twilight indicated by the vertical green and yellow lines, respectively. Date and time are on the x-axis and altitude is on the y-axis. Hexagonal points are radar detections divided into time and altitude bins and are scaled from light grey (few detections) through dark purple, blue, green to yellow (many detections). Wind direction and strength aloft (700 m) for each hour are displayed at the top of each plot via a red arrow. Light blue boxes represent precipitation events where raindrops could not be distinguished from birds. Red lines represent the approximate altitudinal range of the RSA. Acoustic detections (a single NFC) are red points along the base of each plot. The entire dataset of nights for the fall season can be found in the **Appendix B**.

During most nights represented in **Figure 3.12** there was a northernly wind direction. On nights with high density migration (Aug 28. Sept 3, Sept 6), targets detected in these wind conditions were generally at low altitude (i.e., less than 200 m). Migration density was especially high in low tailwinds (Oct 4). In some instances of a westerly wind direction, large numbers of targets detected above the RSA exceeded the number of targets detected at lower altitudes (Oct 13, Oct 24).

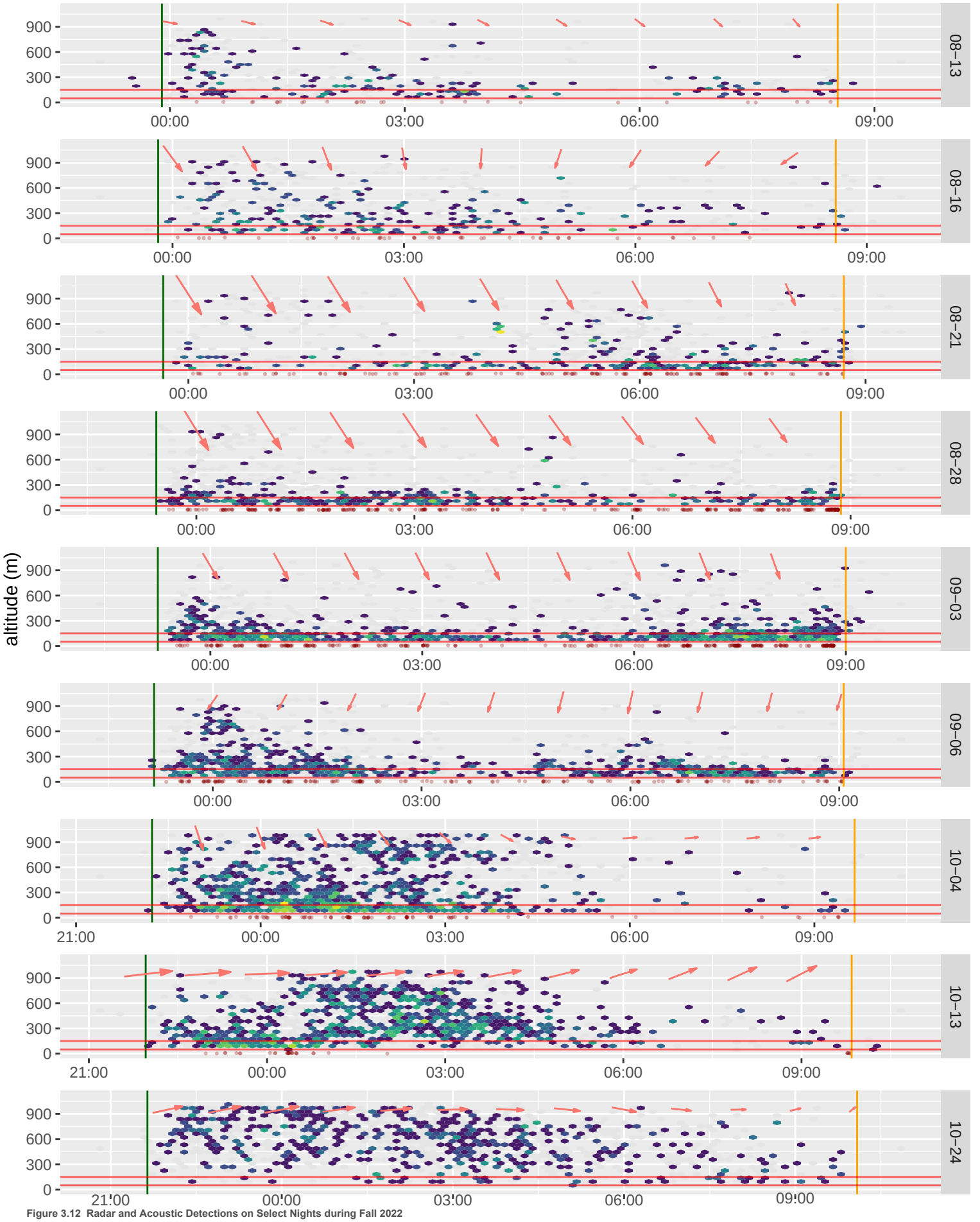

Figure 3.12 Radar and Acoustic Detections on Select Nights during Fall 2022

3.2.2 Altitudinal Distribution of Radar Targets

When viewing all radar detections combined during the fall season the altitudinal band with the most detections is between 120 and 170 m. Across all nights, a somewhat uniform decline in targets detected per 50 m altitudinal band between approximately 220 and 800 m (**Figure 3.13**) is observed. This decline is due in part due to the declining probability of detecting targets at more distant ranges, and potentially, to an actual decrease in the number of birds at increased altitudes. However, it is difficult to separate the effects of these two variables. The red line shown in **Figure 3.13** represents the maximum potential height of the turbines.

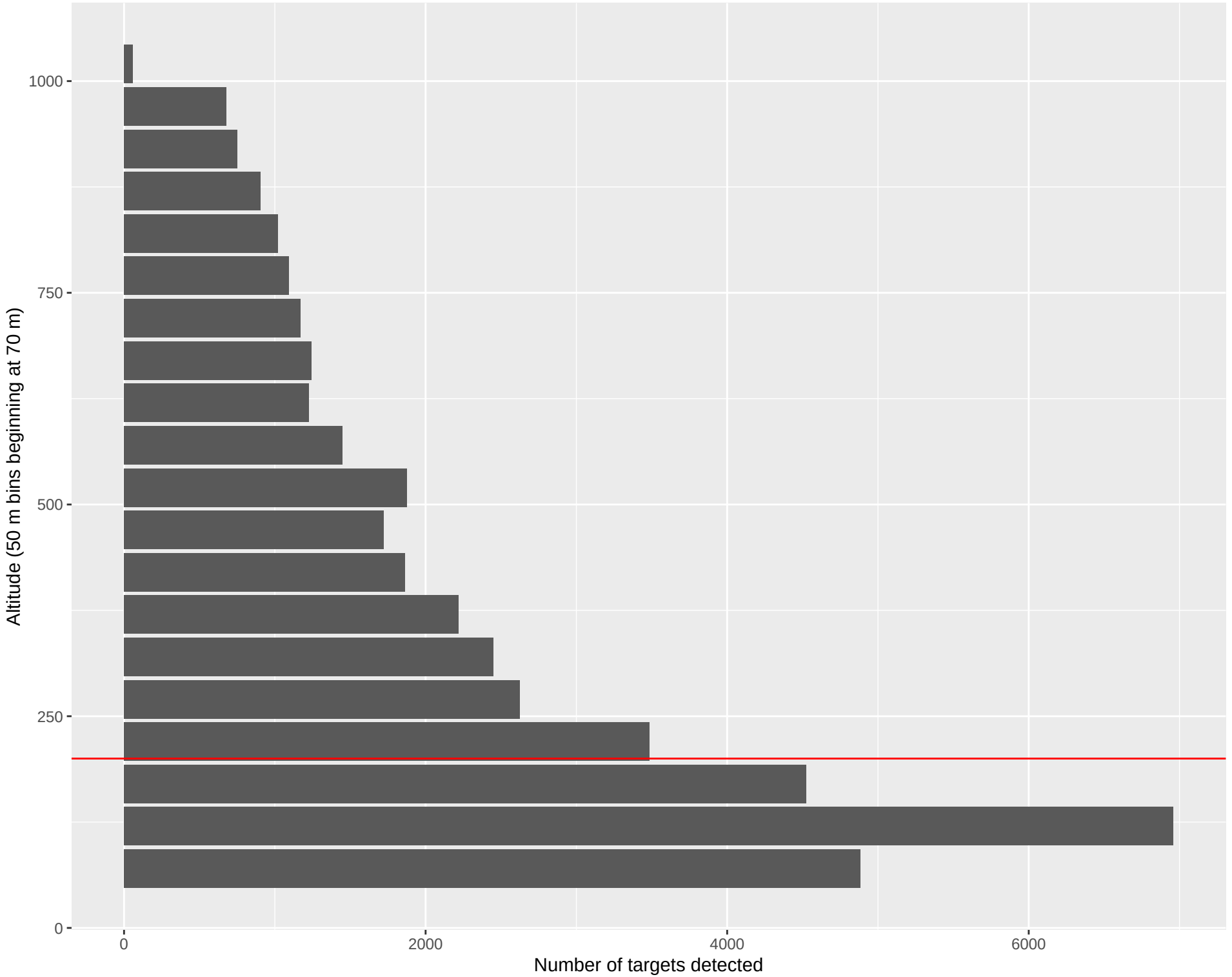

Figure 3.13 Radar Targets by Altitude during Fall 2022

Figure 3.14 shows the density of radar detections by altitude for only the selected nights discussed above. The red line indicates the maximum height of the turbines. The pattern of radar targets by altitude for these nights show a similar pattern with most nights having peak activity at approximately the top of the RSA (i.e., 200 m).

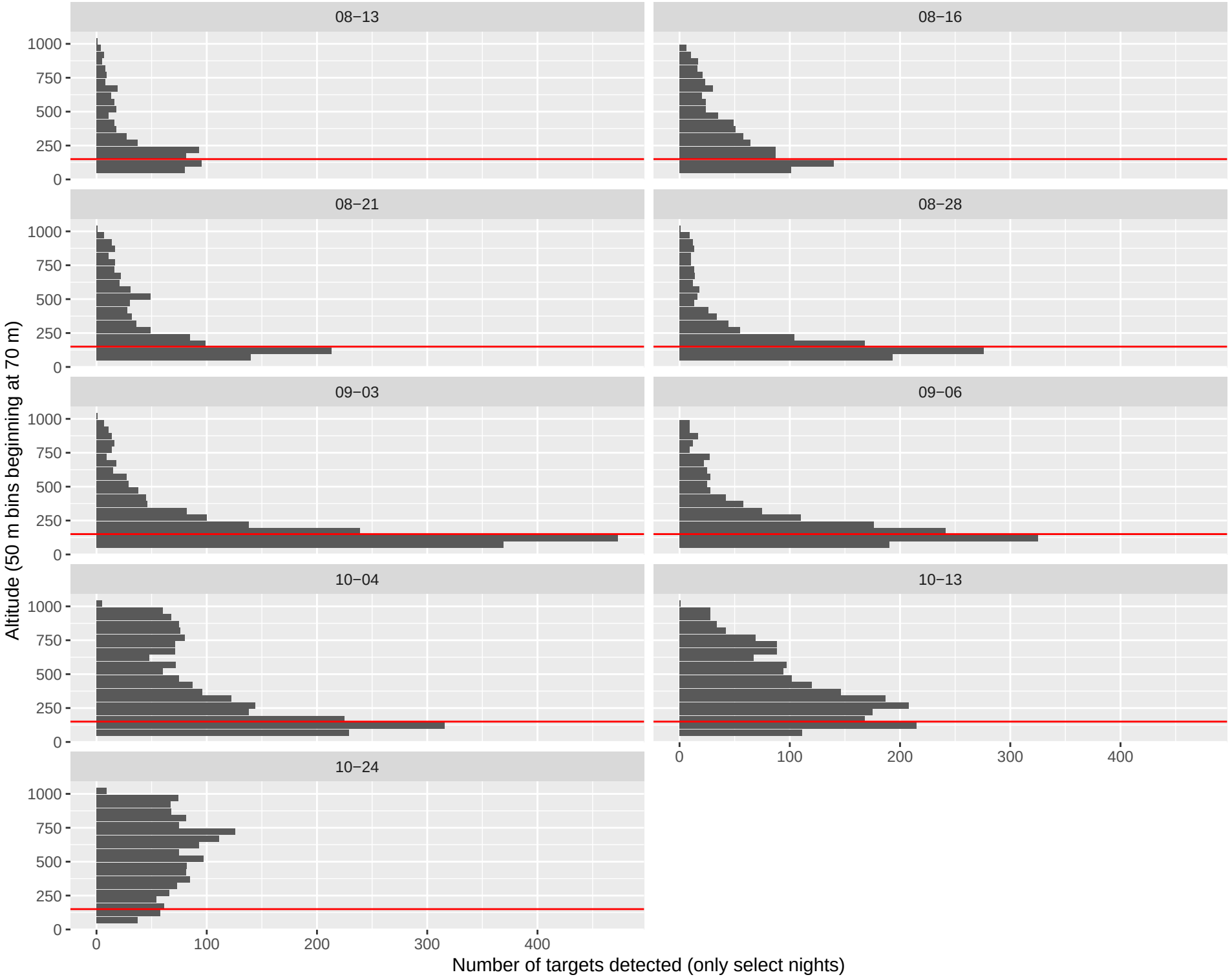

Figure 3.14 Radar Targets by Altitude for Select Nights during Fall 2022

3.2.3 Statistical Analysis of Radar Data

The same statistical models completed for the spring migration, described in **Section 3.1.3**, were completed for the fall data. The same trends observed during the spring, were mostly seen during the fall, with increased targets detected during increased tailwind assistance (**Figure 3.15**) and fewer targets detected during increased relative humidity. **Figure 3.16** shows a different trend than the relationship between proportion of targets at low altitude and tailwind assistance as observed in the spring. There is no, or only a weak positive relationship between the proportion of birds at low altitude and the degree of tailwind assistance. This pattern differs from the spring, and from what is typically observed, which may be related to the geography of this part of Cape Breton Island relative to presumed migratory pathways of birds. This, or other unknown factors, might affect their behaviour differently than at other projects. See **Section 3.1.3** for a description of the symbology presented in the plots below.

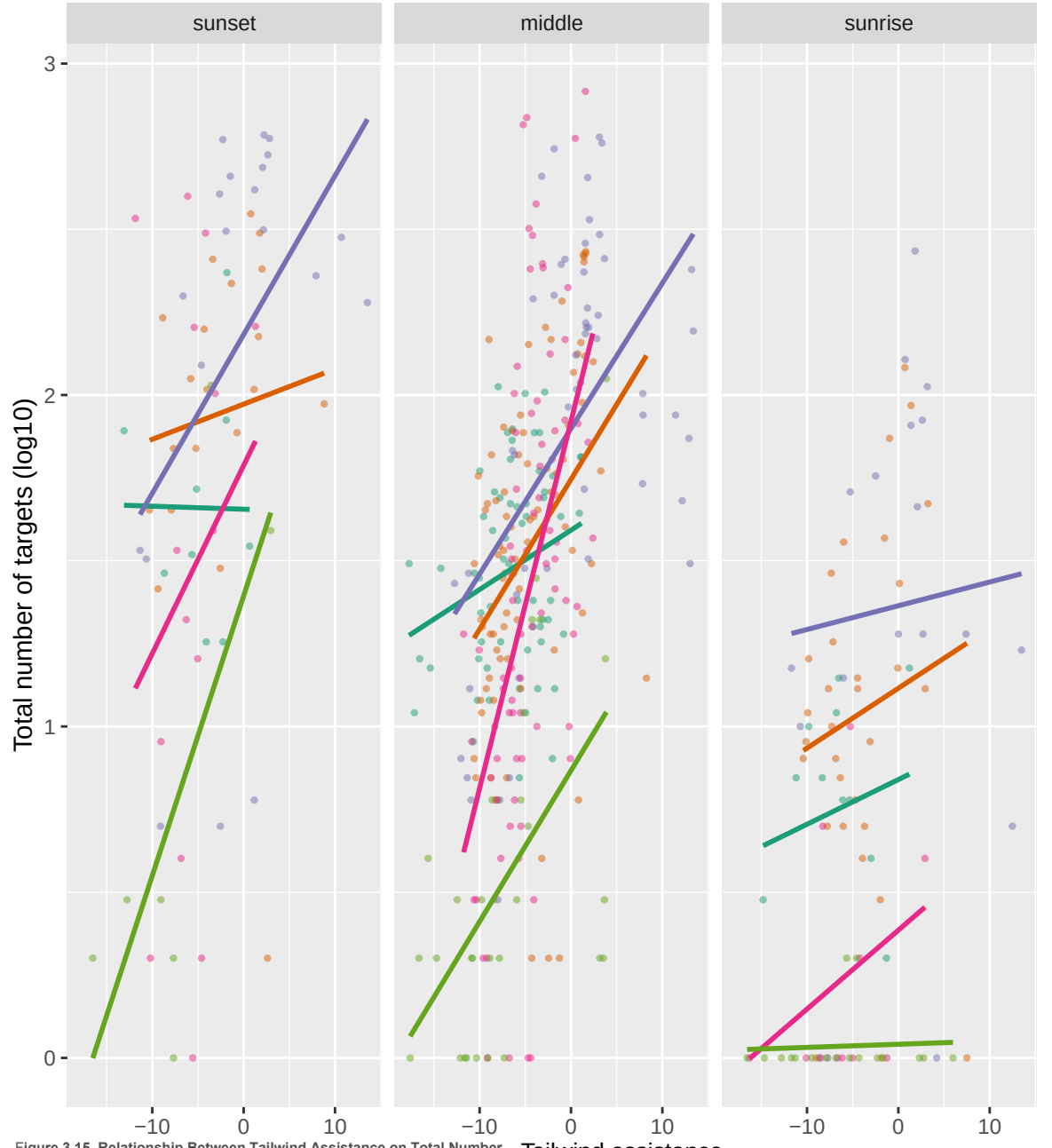

Figure 3.15 Relationship Between Tailwind Assistance on Total Number of Targets across Time of Night and Month during Fall 2022

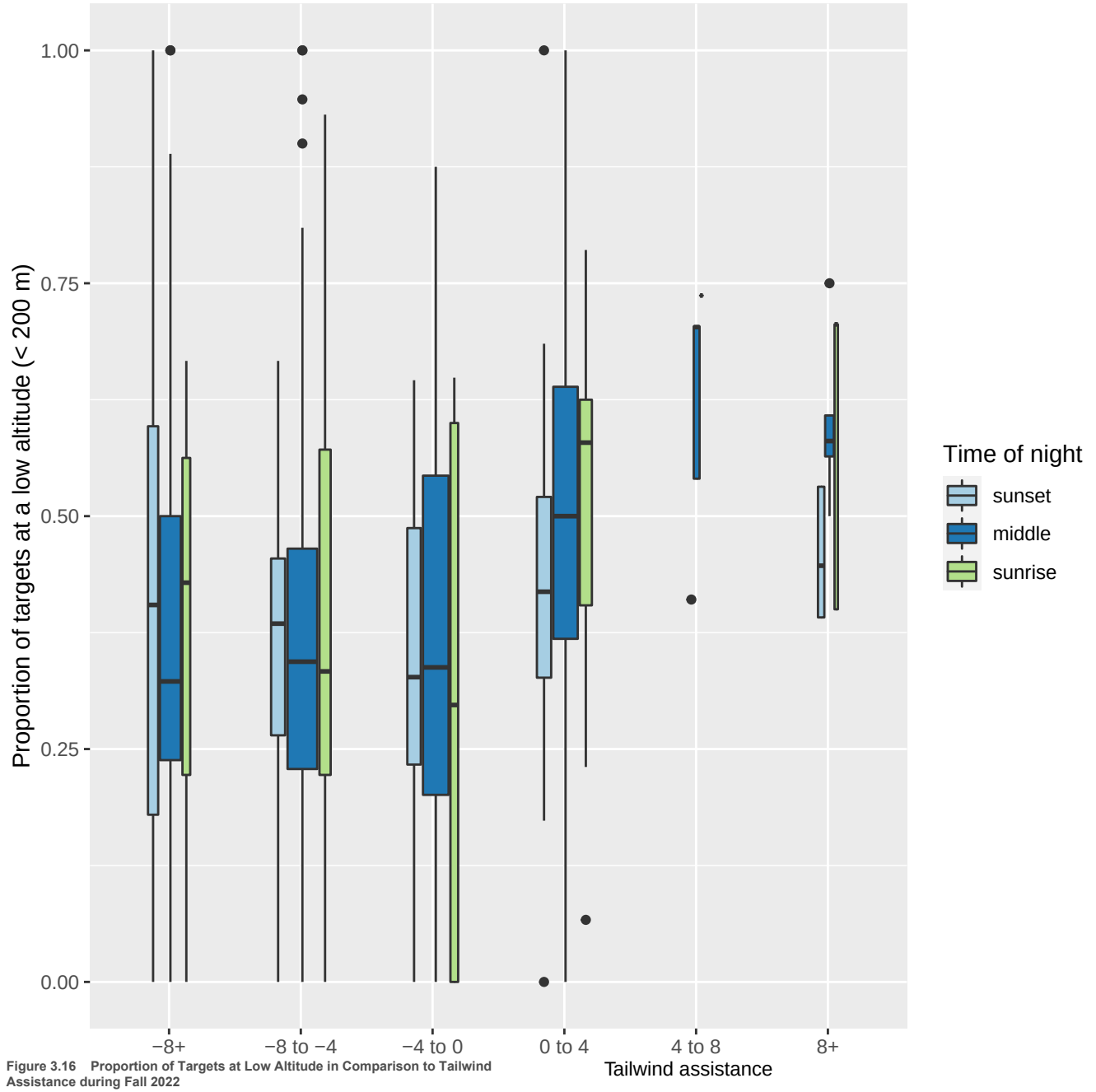

Figure 3.16 Proportion of Targets at Low Altitude in Comparison to Tailwind Assistance during Fall 2022

3.2.4 Relative Number of Birds at Lower Altitudes

Figure 3.17 shows the relationship between the total number of targets aloft, compared to the proportion of those targets below 200 m. This analysis is the same as completed in the spring and shown in **Figure 3.7**. In **Figure 3.17**, each dot represents the number of birds detected below 200 m divided by the total number of birds observed in each hourly bin classified by time of night. The lines are smoothed relationships between the index, and the total number of targets are presented on a log scale.

During the middle part of the night (i.e., the bulk of active migration) there is a constant relationship between the two variables. This means that the proportion of targets below 200 m is consistent, irrespective of the total number of targets detected each night. This pattern is different then what was observed during the spring (Error! Reference source not found.)**.** During the hours before sunrise, a greater proportion of targets are detected at a low altitude (< 200 m) when more targets are detected in total (**Figure 3.8**).

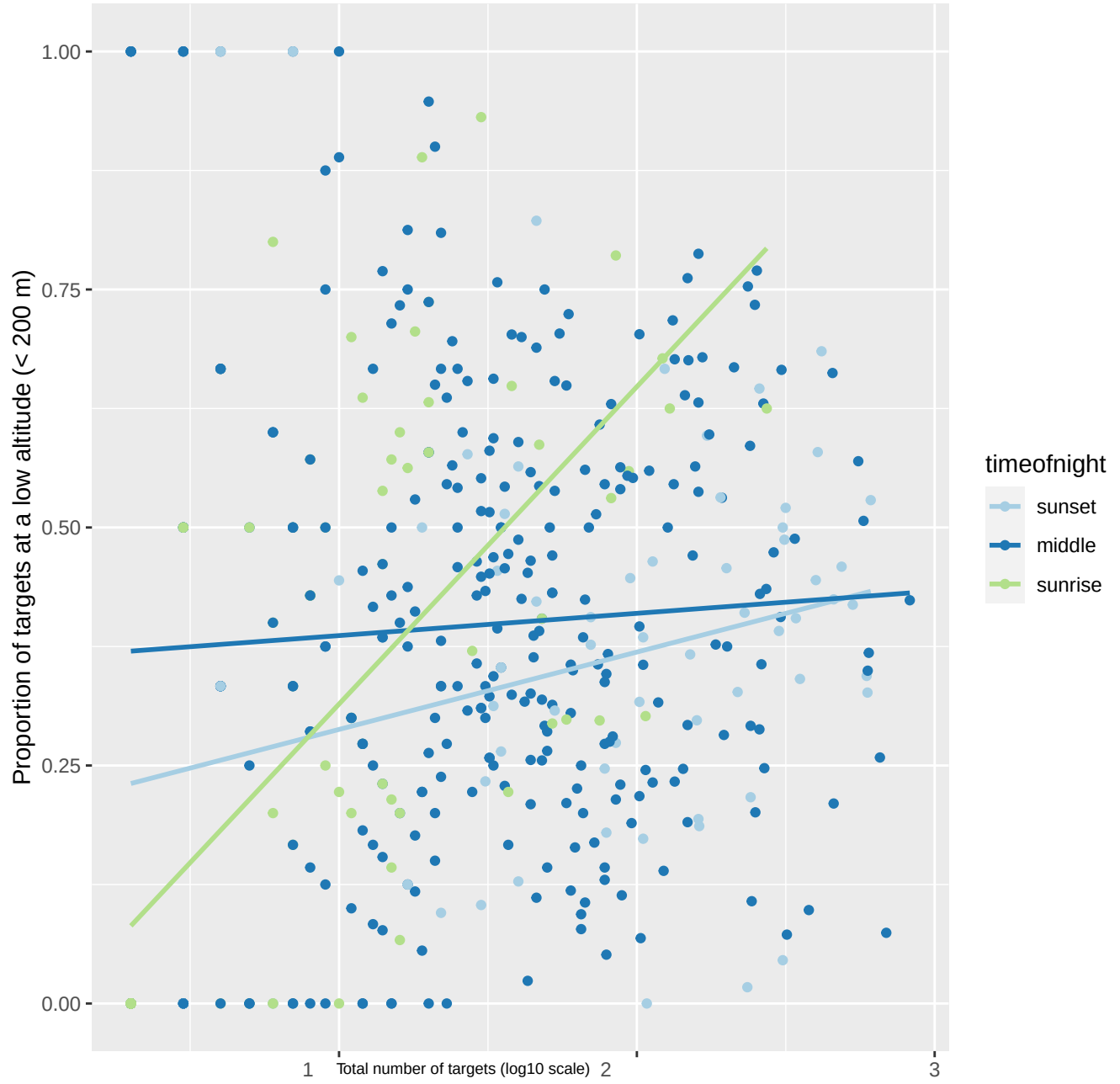

Figure 3.17 Proportion of Targets at Low Altitude in Comparison to Total Number of Targets across Time of Night during Fall 2022

3.2.5 Nocturnal Flight Call Detections

Flight calls were analyzed and grouped into one of 18 species groups. Warblers comprised the majority (88%) of NFCs detected during the fall season. The most common species / species group observed were "zeeps" and ovenbirds [*Seiurus aurocapilla*], which combined comprised 70% of the total detections (**Table 3.2**). Two federally listed species under the SARA were observed in the spring: Canada warbler (Threatened) and common nighthawk (Threatened; Government of Canada 2021).

Table 3.2 Nocturnal Flight Call Detections by Species and Species Group

Species / Species Group[(a)(b)]	Total Number of Calls Detected	Proportion of Calls Detected (%)
Zeep	4,569	54.9
Ovenbird	1,261	15.2
White-throated Sparrow	761	9.1
American Redstart	297	3.6
Black and White Warbler	253	3.0
Double Up	249	3,0
Mourning Warbler	210	2.5
Single Banded Down Sweep	196	2.4
Common Yellowthroat	168	2.0
Thrush 2	105	1.3
Canada Warbler	81	1.0
Savannah Sparrow	76	0.9
Fox/Song Sparrow	34	0.4
Black-throated Blue Warbler	21	0.3
Wilson's Warbler	13	0.2
Common Nighthawk	15	0.2
Chestnut-sided Warbler	10	0.1
Cup Sparrow	1	<0.1
Total	**8,320**	**100**

(a) "Zeep" species groups includes bay-breasted warbler, blackburnian warbler, blackpoll warbler, Cape May warbler, magnolia warbler, northern waterthrush and yellow warbler; "Cup Sparrow" species group includes chipping sparrow, field sparrow and American tree sparrow; "Double Up" species group includes black-throated green warbler, Tennessee warbler, Nashville warbler and orange crowned warbler; "Single Banded Down Sweep" species includes pine warbler, northern parula, yellow-throated warbler, and prairie warbler; "Thrush 2" includes Swainson's Thrush, Veery, Rose-breasted Grosbeak and Scarlet Tanager.

(b) Species in bold are federally listed under the *Species at Risk Act* (Government of Canada 2021).

Considerably more NFCs were recorded in the fall (8,320) than the spring (729). Fewer NFCs were detected at the beginning and end of the monitoring period, indicating that the entirety of the migration season was captured. Also, nearly all warbler NFCs were detected during the middle portion of the night (i.e., not during dusk or dawn) which suggests that most NFCs detected represent migrants passing over the Project area, and not individuals that were stopping over (**Figure 3.18**). The number of detections shown in **Figure 3.18**

is the total number of calls detected for that group on that night; (note that the scale differs between species).

Thrushes were primarily detected in early September and all thrush calls were detected at Dawn when individuals typically call as they descend from migratory flight (**Figure 3.18**).

Sparrows, representing approximately 10% of the NFCs, were detected largely from September through mid-October. Like warblers, most sparrows were observed during the middle part of the night (**Figure 3.18**). Sparrows detected at dawn are likely from that stop over at the Project (**Table 3.2**).

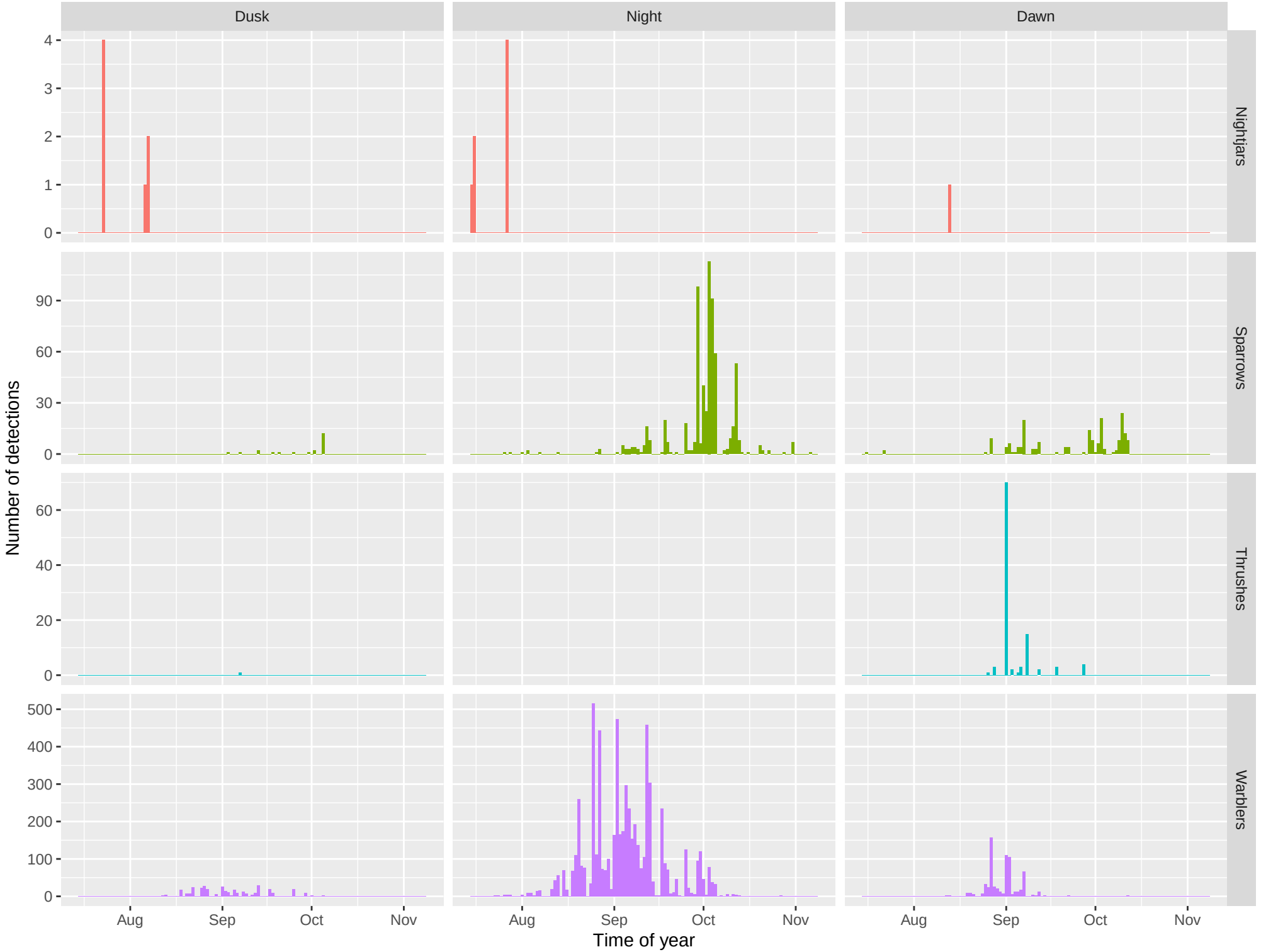

Figure 3.18 Nocturnal Flight Call Detections by Species Group and Time of Year during Fall 2022

The number of detections shown in **Figure 3.19** is the total number of calls detected for that group on that night; (note that the scale differs between species). The pattern of detections reflects the patterns of migration of these species in the region. Acoustic detections are presented by color for each species group for: warblers (purple), sparrows (green), thrushes (blue) and common nighthawk (orange) across the entire fall season.

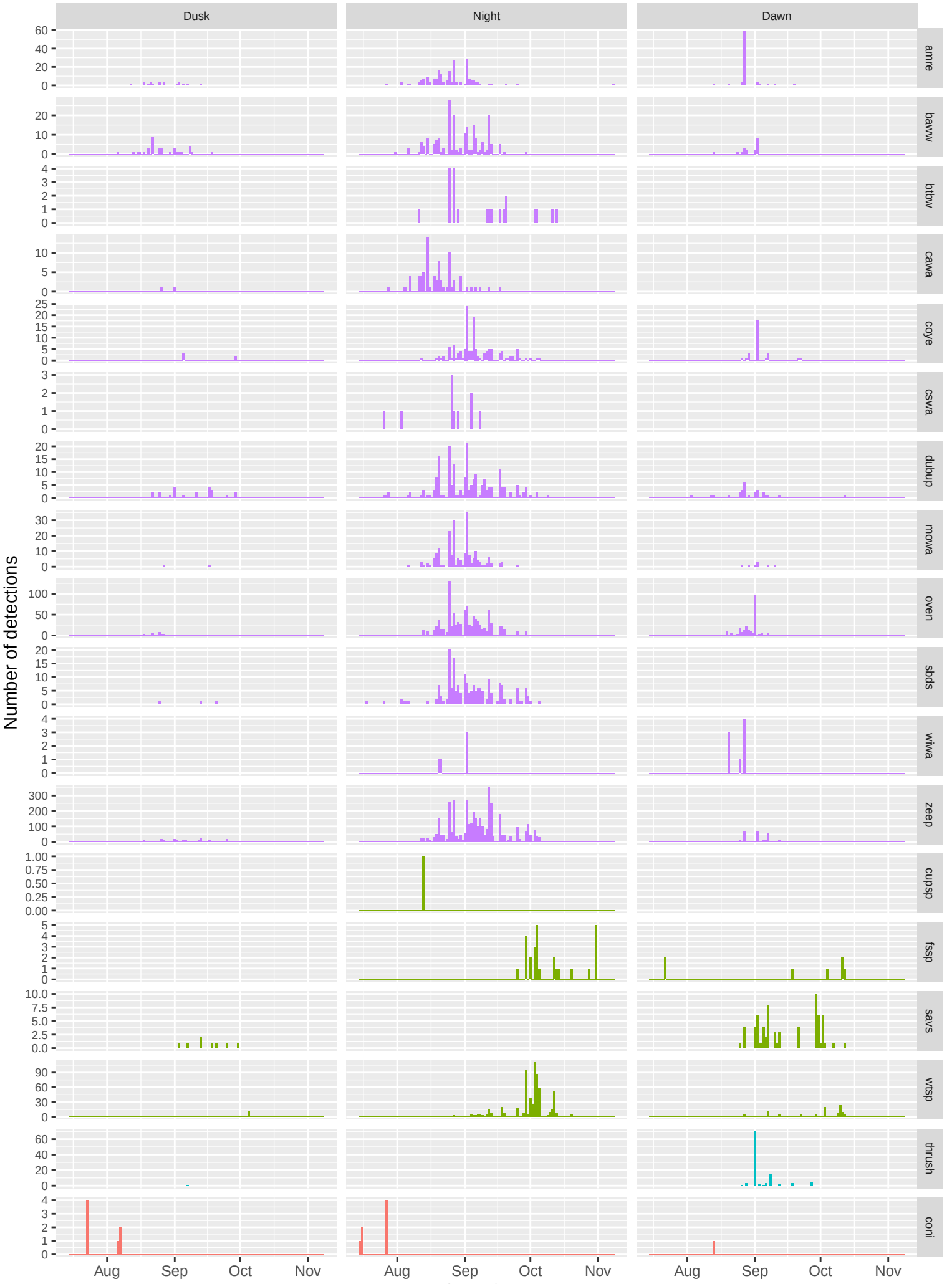

Figure 3.19 Acoustic Detections by Species during Fall 2022

Figure 3.20 shows the occurrence of NFCs detected by time of night during the fall migration season. While sparrows were detected throughout the night, many sparrows and thrushes were detected near dawn. As shown in **Figure 3.18**, most warblers were detected during the middle part of the night, representing individuals in active migration.

As discussed in Section 2.1, radar monitoring was not completed between September 21 and October 11, 2022, due to damage caused by post-tropical storm Fiona. To understand the extent of migration which occurred during this time, a focused summary of the acoustic data (**Figure 3.21**) shows the number of NFC detections by species during that time period. The majority of species observed during the period when the radar was non-operational was primarily white-throated sparrow, which are also captured later in the season with acoustic and radar (**Figure 3.19**) and “zeeps”, which are observed throughout the season.

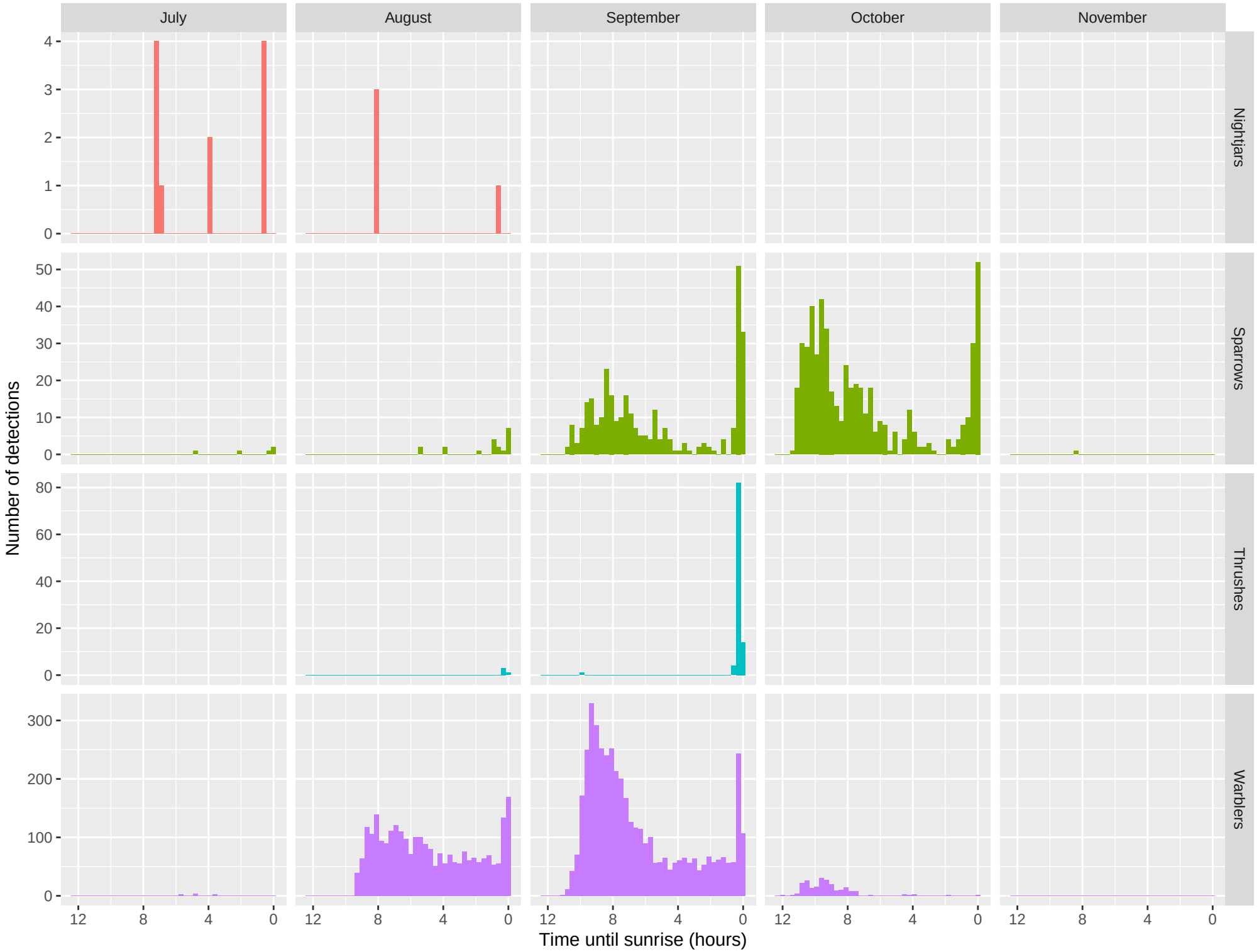

Figure 3.20 Nocturnal Flight Calls by Time until Sunrise during Fall 2022

Figure 3.21 Acoustic Detections by Species between September 21 and October 11, 2022

4.0 Summary

Radar and acoustic monitoring were completed at the Project area during the spring and fall 2022 migration seasons with radar data collected within approximately 1,500 m of the nearest proposed turbine and acoustic data obtained through a network of 8 acoustic sensors located across the Project area.

Radar monitoring was nearly continuous throughout the spring (April 13 to June 7) and fall (July 7 to November 17) seasons and acoustic monitoring was conducted continuously through both seasons apart from a 15-day period where radar data was impacted by post-tropical storm Fiona. Very few targets or NFCs were detected in November, suggesting that the bulk of migration in this area is finished by that time. Considering these dates, and when examining the number of detections observed across both time periods, the entire spring and fall nocturnal migration seasons were monitored at the Project. As is typically seen on similar studies in Nova Scotia (Ausenco 2022), the intensity and duration of the spring migration season is much less compared to the fall.

Targets were detected at heights throughout the area sampled (i.e., between 70 m and approximately 1,000 m). However, given that the probability of detecting small targets decreases as distance from the radar increases, the decrease in number of detections of targets higher than 400 m is likely a combination of fewer birds aloft and a decreased detectability.

When examining the nights with the largest numbers of targets, and therefore the most migration, most targets tended to be above of the RSA (i.e., 200 m). During peak migration nights, the density of targets is generally at higher altitudes (approximately 400 m).

When examining differences in detections within nights, most radar and acoustic activity was observed during the middle portion of the night. While some portion of migrants may be stopping over at the Project area, the consistency in distribution of night migration activity suggest that a large proportion of migrants are not using the Project area for staging during migration.

Most activity was observed when favourable tailwinds were present with little to no precipitation. These findings are consistent with other radar and acoustic studies completed in Nova Scotia (Peckford and Taylor 2008; Hemmera 2021).

The composition of the species detected with acoustic sensors were consistent with the range of species known to migrate into and through Nova Scotia during the spring and fall. The timing of those species was also as expected, with most warblers detected between mid to late May and August to early September, and sparrows observed throughout May and September through October. Very few NFCs were detected at the beginning and end of each season, which suggest that the monitoring program captured the majority of bird migration.

4.1 Species at Risk

Common nighthawk was detected during the acoustic monitoring in spring (11 NFCs) and fall (15 NFCs). Common nighthawk is listed as *Threatened* under the Nova Scotia *Endangered Species Act* (NSESA) and the federal SARA. Given this species is active at night and calls frequently, the number of calls detected do not provide an accurate representation of the number of individuals at the Project, but rather confirms their presence within the Project area.

Canada warbler was detected during acoustic monitoring in spring (8 NFCs) and fall (81 NFCs). Canada warbler is listed as endangered under the Nova Scotia *Endangered Species Act* and Threatened under the federal SARA. Given that Canada warbler NFCs are distinct from other species, it is assumed that most Canada warbler NFCs captured by the sensors were identified. Of the 89 Canada warbler calls detected, only 2 were at dusk, suggesting that the majority of this species are flying over the Project during nocturnal migration.

4.2 Limitations

The following are limitations related to the data collected that should be considered when drawing conclusions from the data presented within this report.

Radar Data

Radar data can provide a good understanding of nocturnal avian migration trends at proposed wind energy projects. However, there are limitations to how the data are collected and can be interpreted, such as:

- While it is assumed that most targets are migratory birds, some proportion of targets may be insects, bats, clutter and or precipitation.
- Bird species identification using radar alone is not possible.
- Detection probability of targets varies with a number of external factors including distance from radar, atmospheric conditions, ground clutter, altitudinal coverage, interference from large objects, and radar orientation. Given that migration density varies with distance and other external factors, the interplay between detection probability and migrant behaviour is difficult to measure.
- Detections at very low altitudes (i.e., below 70 m) are difficult to capture at most onshore wind energy projects due to topography and tree cover which cause clutter in the radar signal.
- Most migration activity occurs on very few nights and some nights may be missed due to weather, equipment failure, or other issues.

Acoustic Data

While NFC calling rates provide a good representation of migratory activity, there are many factors that influence calling rates such as:

- Microphone sensitivity may cause detection rates may change based on weather, background noise, vegetation cover, and technology.
- Behavioral changes from the time of year or time of night may affect the calling rate for a given species. For example, calling rates may be higher during the early portion of the night to entice stopovers to initiate migratory flight, or in the morning, when individuals are choosing to land for the day. The behavioral influence of time of year or night on detection rates is poorly understood.
- Weather conditions have the potential to influence impact calling rates.
- The density of migrants have the potential to impact calling rates.
- Calling rates may vary with species composition as not all species call and some species may call more frequently than others.

5.0 Closure

This work was performed in accordance with the Purchase Order between Ausenco Engineering Canada Inc. (Ausenco), and ABO Wind Canada Ltd., dated February 11, 2022 (Contract). This report has been prepared by Ausenco, based on fieldwork conducted by Ausenco, for the sole benefit and use by ABO Wind Canada Ltd. In performing this work, Ausenco has relied in good faith on information provided by others and has assumed that the information provided by those individuals is both complete and accurate. This work was performed to current industry standard practice for similar environmental work, within the relevant jurisdiction and same locale. The findings presented herein should be considered within the context of the scope of work and Project terms of reference; further, the findings are time sensitive and are considered valid only at the time the report was produced. The conclusions and recommendations contained in this report are based upon the applicable guidelines, regulations, and legislation existing at the time the report was produced; any changes in the regulatory regime may alter the conclusions and/or recommendations.

We sincerely appreciate the opportunity to have assisted you with this Project and if there are any questions, please do not hesitate to contact the undersigned.

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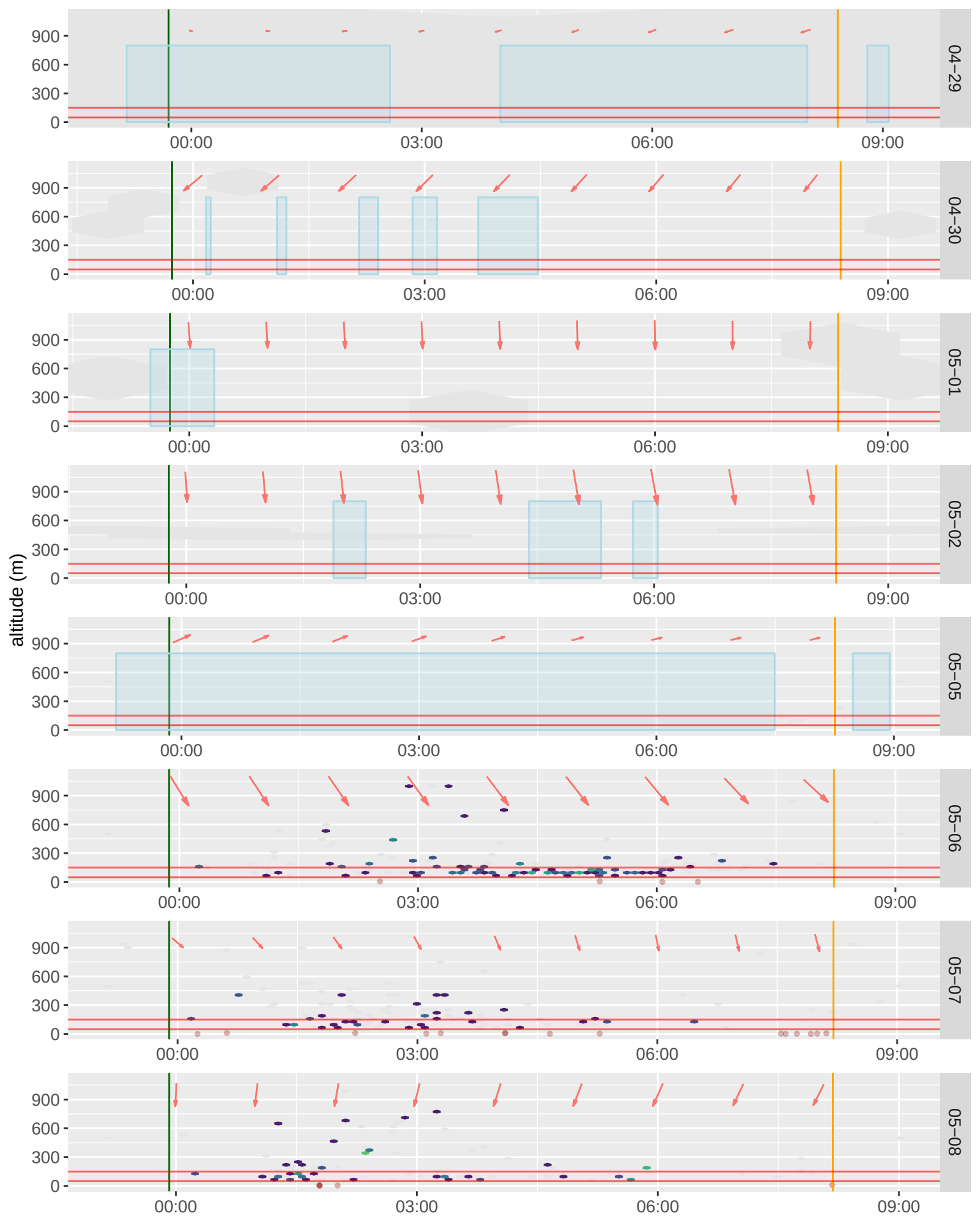
Appendix A

Complete Spring Radar Data

Spring Radar Data Overview

The entire radar and acoustic detections for the spring monitoring period are provided below. Each plot is a separate night, with the beginning and end of civil twilight indicated by the vertical green and yellow lines, respectively. Date and time are on the x-axis and altitude is on the y-axis. Hexagonal points are radar detections divided into time and altitude bins and are scaled from light grey (few detections) through dark purple to yellow (many detections). Acoustic detections (a single NFC) are red points along the base of each plot (these have not been processed, and so on some nights may include insects, raindrops, or other noise). Wind direction and strength at approximately 700 m (red arrow) for each hour are displayed at the top of each plot. The blue box represents a period of rain when raindrops could not be distinguished from bird detections. Red lines represent the approximate altitudinal range of the rotor swept area.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600
300
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00:00
03:00
06:00
09:00
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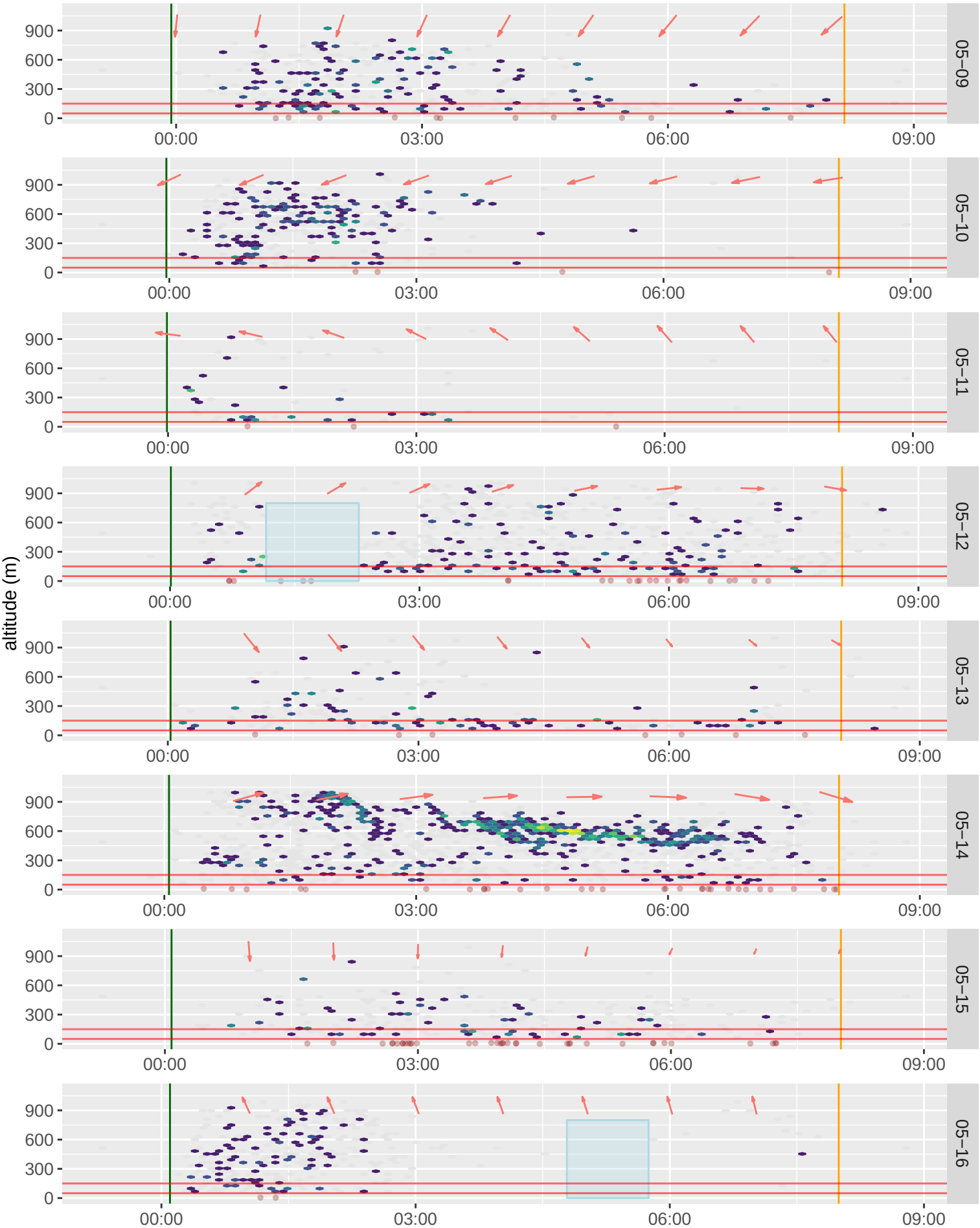
04–30
05–01
05–02
05–05
05–06
05–07
05–08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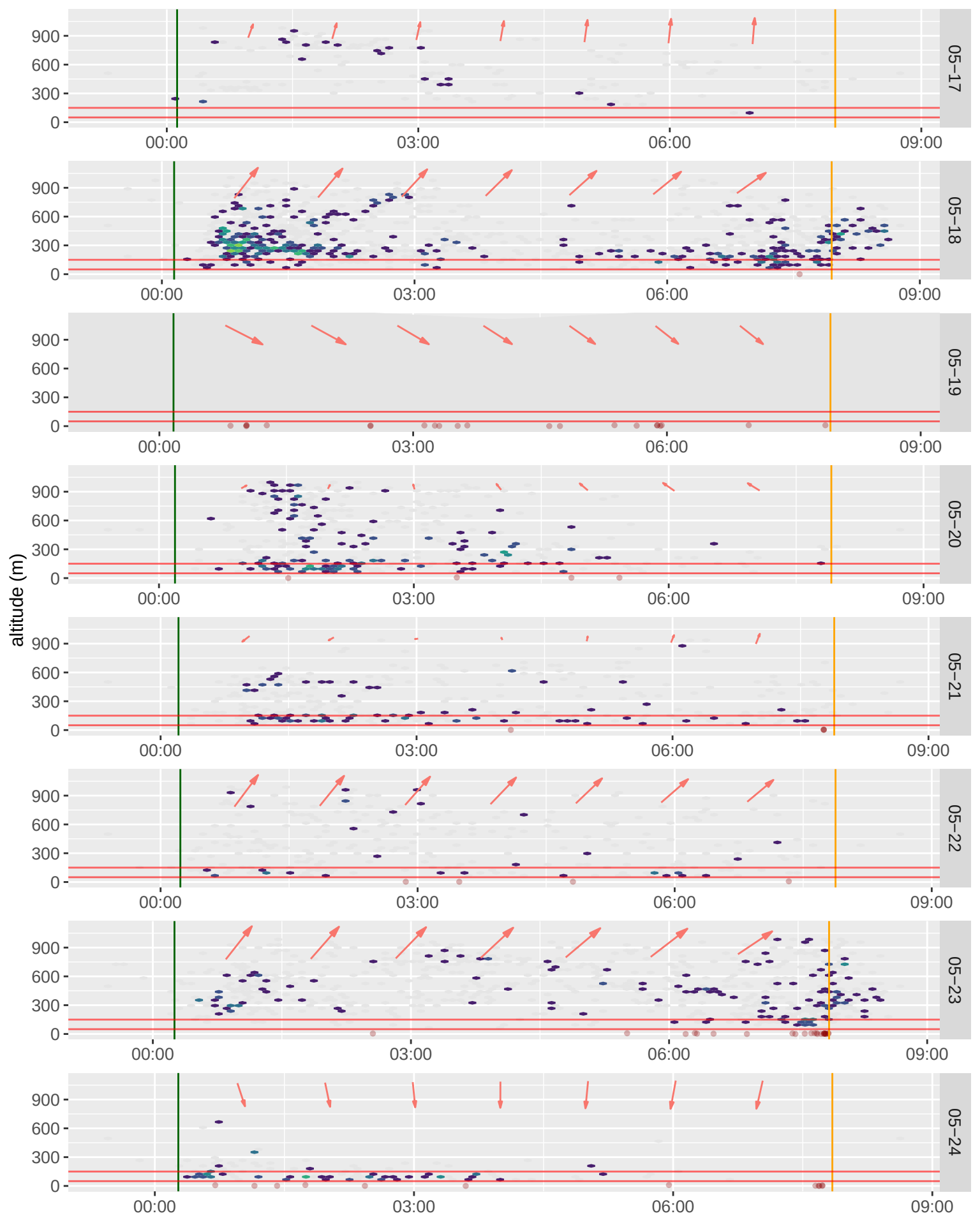
05–16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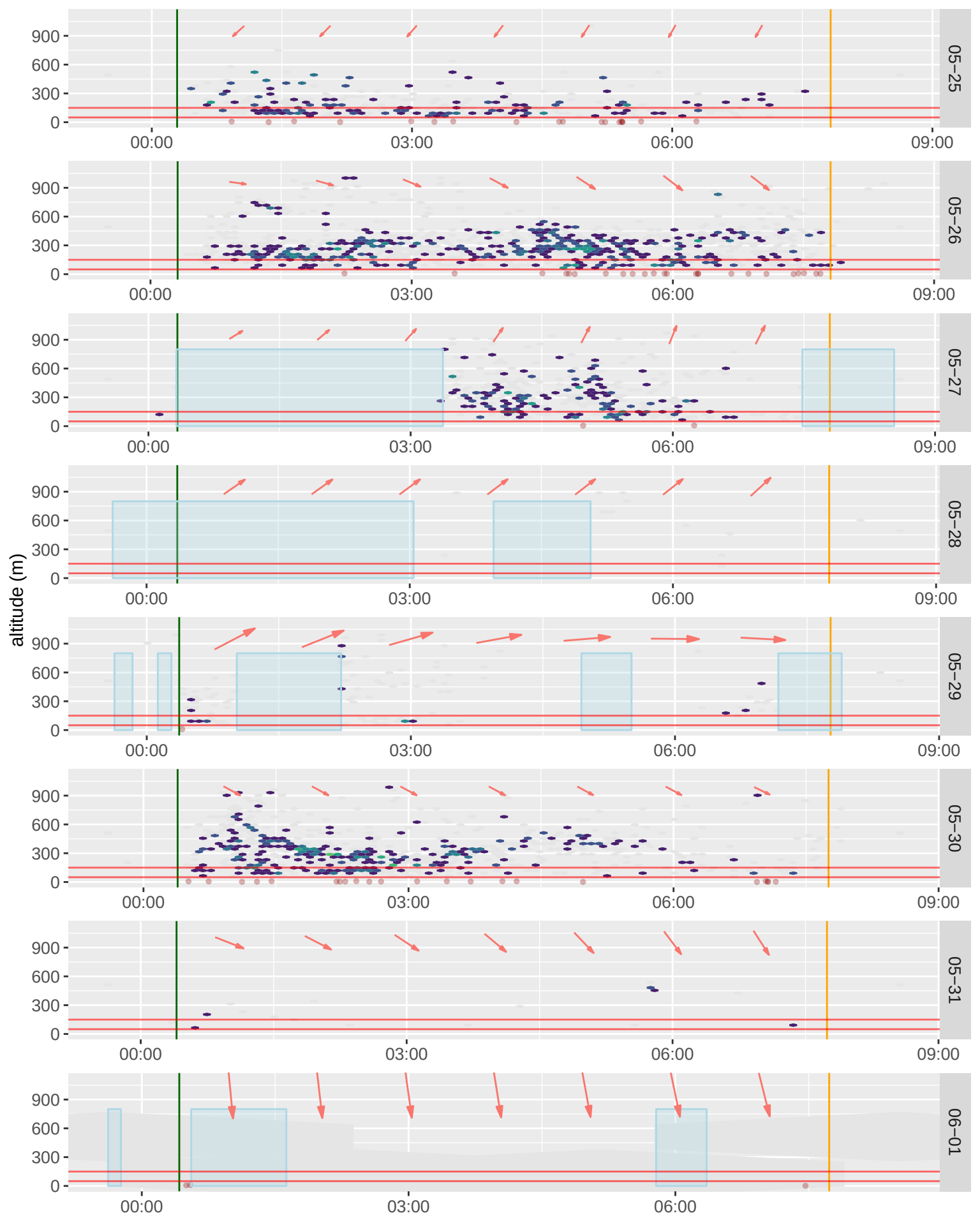
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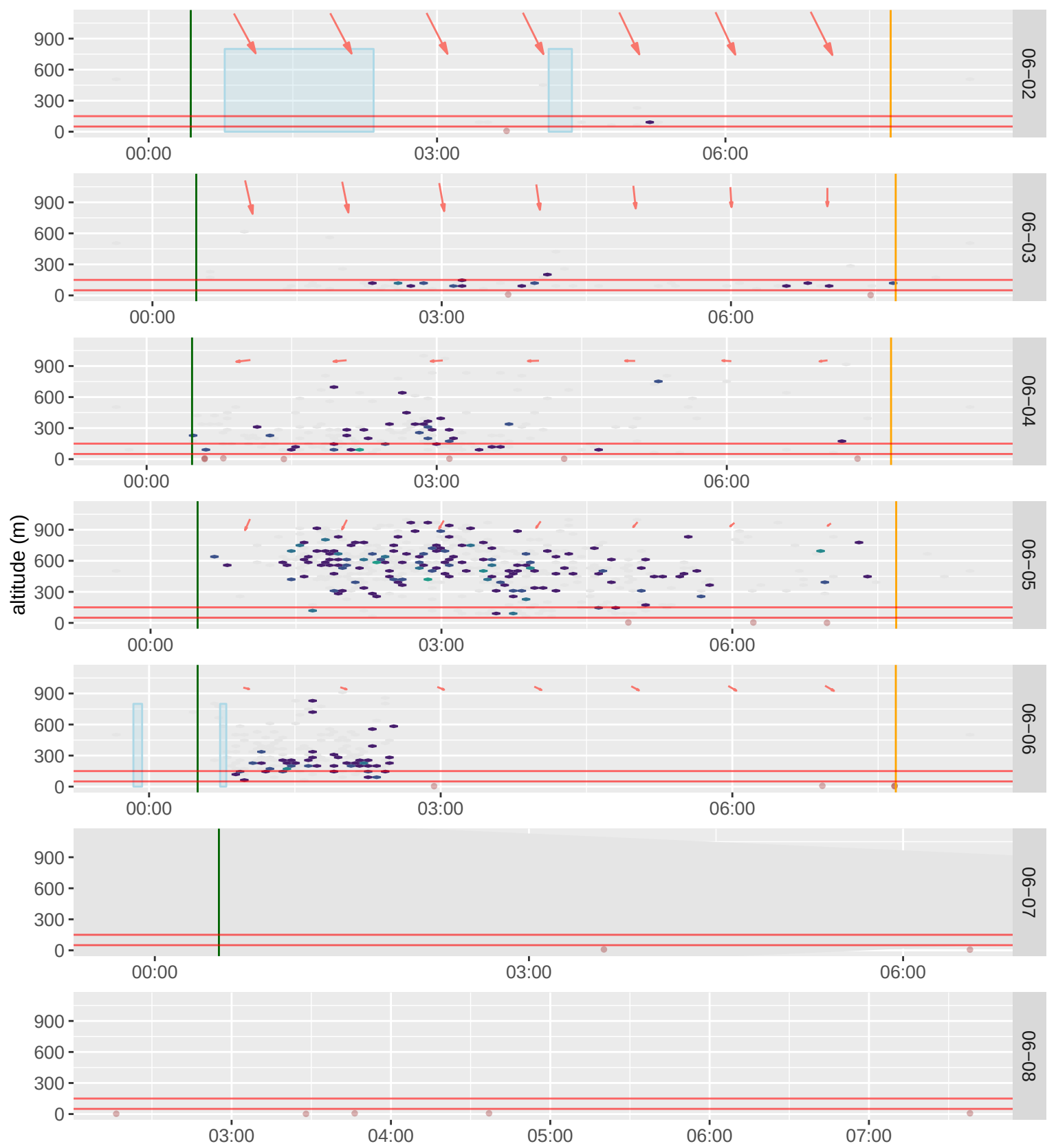
05–31
06–01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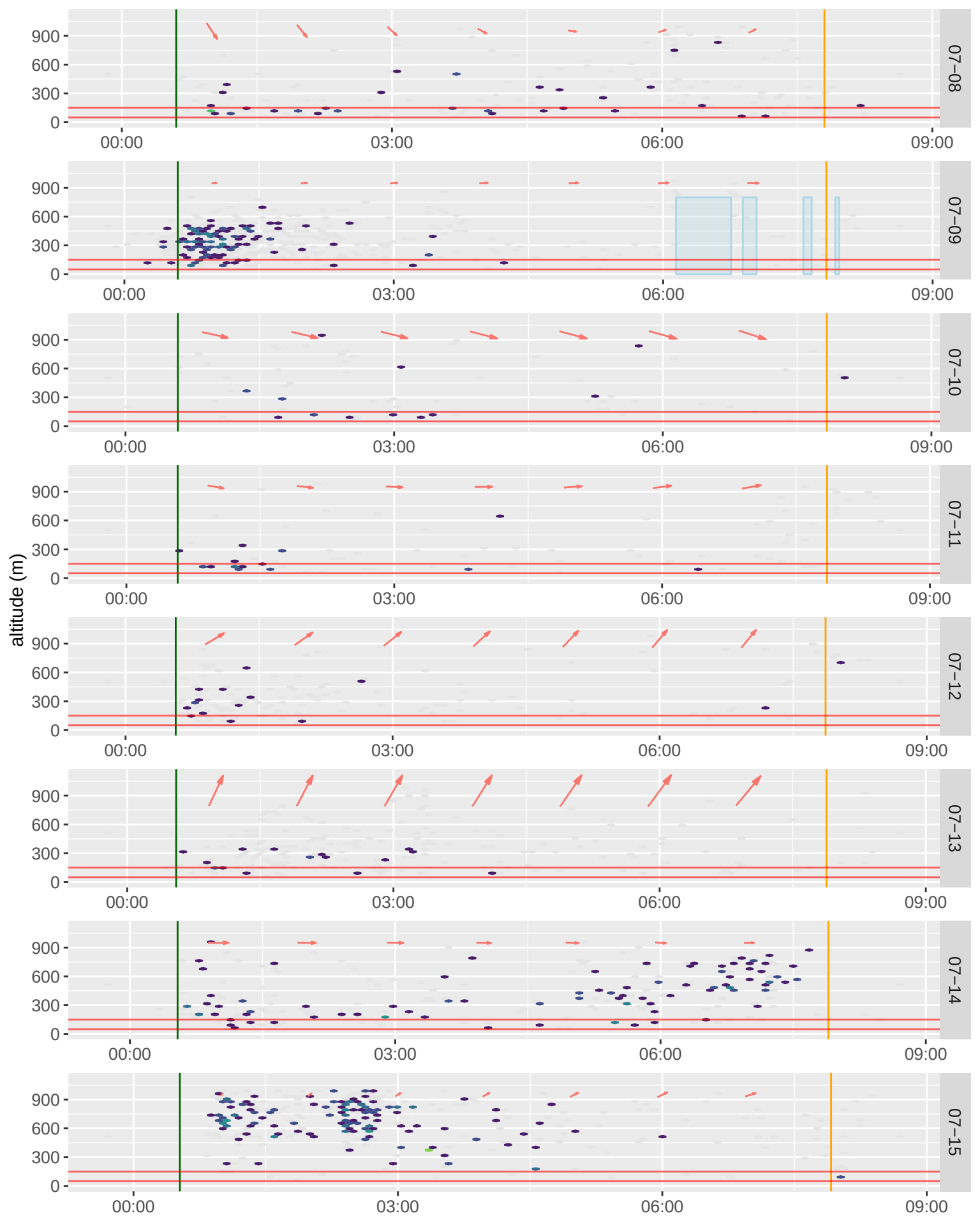
07:00
06–02
06–03
06–04
06–05
06–06
06–07
06–08

Appendix B

Complete Fall Radar Data

Fall Radar Data Overview

The entire radar and acoustic detections for the fall monitoring period are provided below. Each plot is a separate night, with the beginning and end of civil twilight indicated by the vertical green and yellow lines, respectively. Date and time are on the x-axis and altitude is on the y-axis. Hexagonal points are radar detections divided into time and altitude bins and are scaled from light grey (few detections) through dark purple to yellow (many detections). Acoustic detections (a single NFC) are red points along the base of each plot (these have not been processed, and so on some nights may include insects, raindrops, or other noise). Wind direction and strength at approximately 700 m (red arrow) for each hour are displayed at the top of each plot. The blue box represents a period of rain when raindrops could not be distinguished from bird detections. Red lines represent the approximate altitudinal range of the rotor swept area.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300
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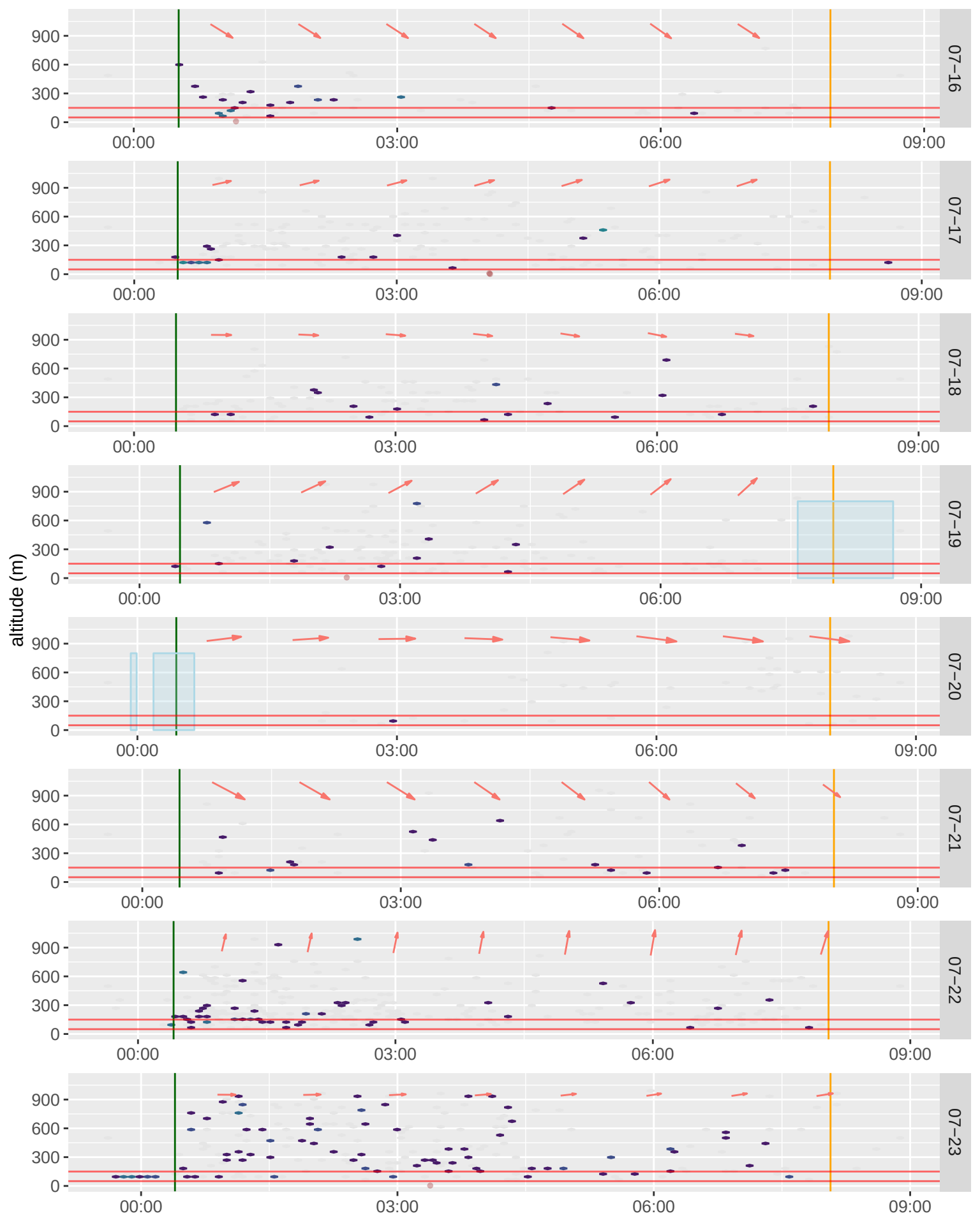
07–15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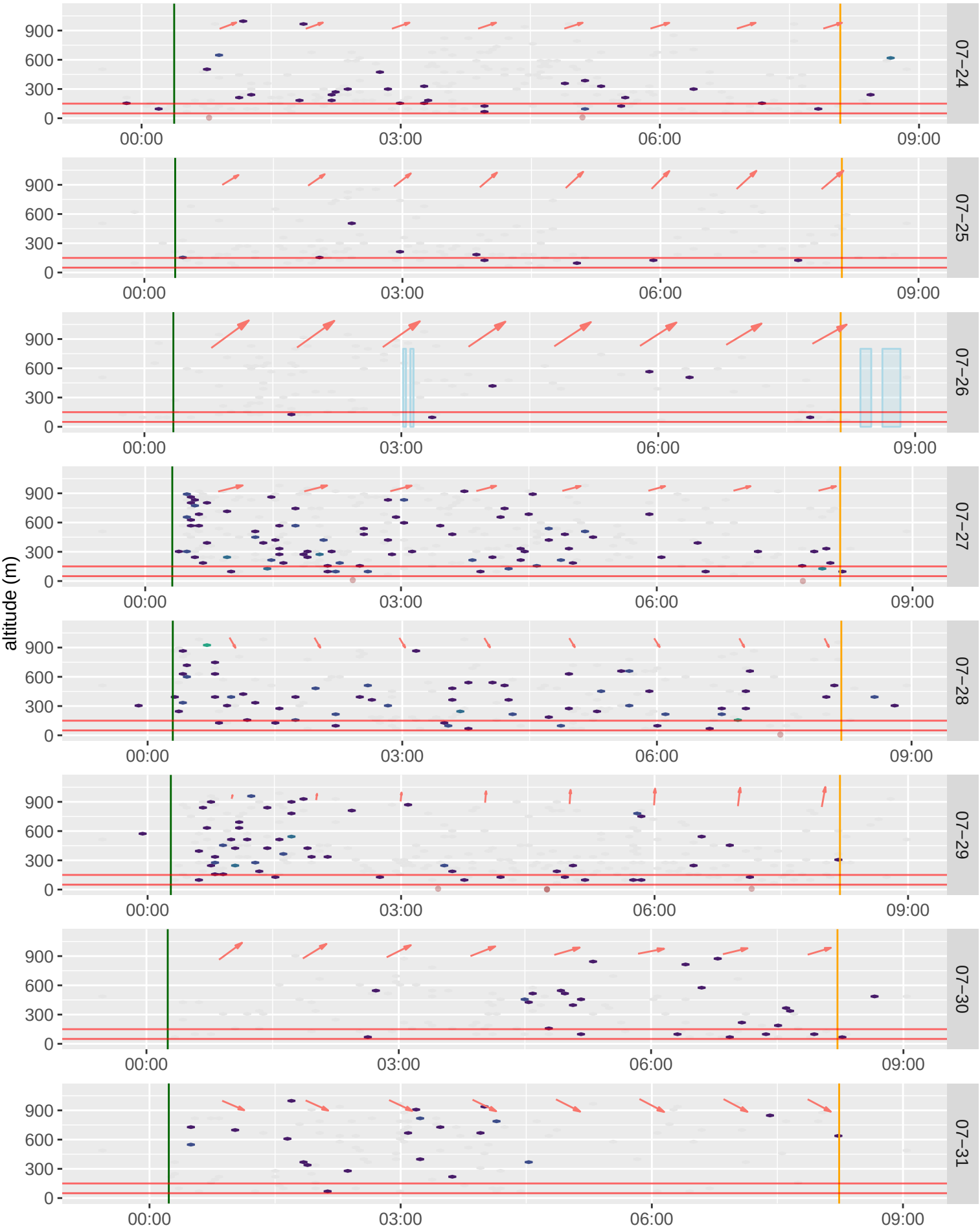
07–23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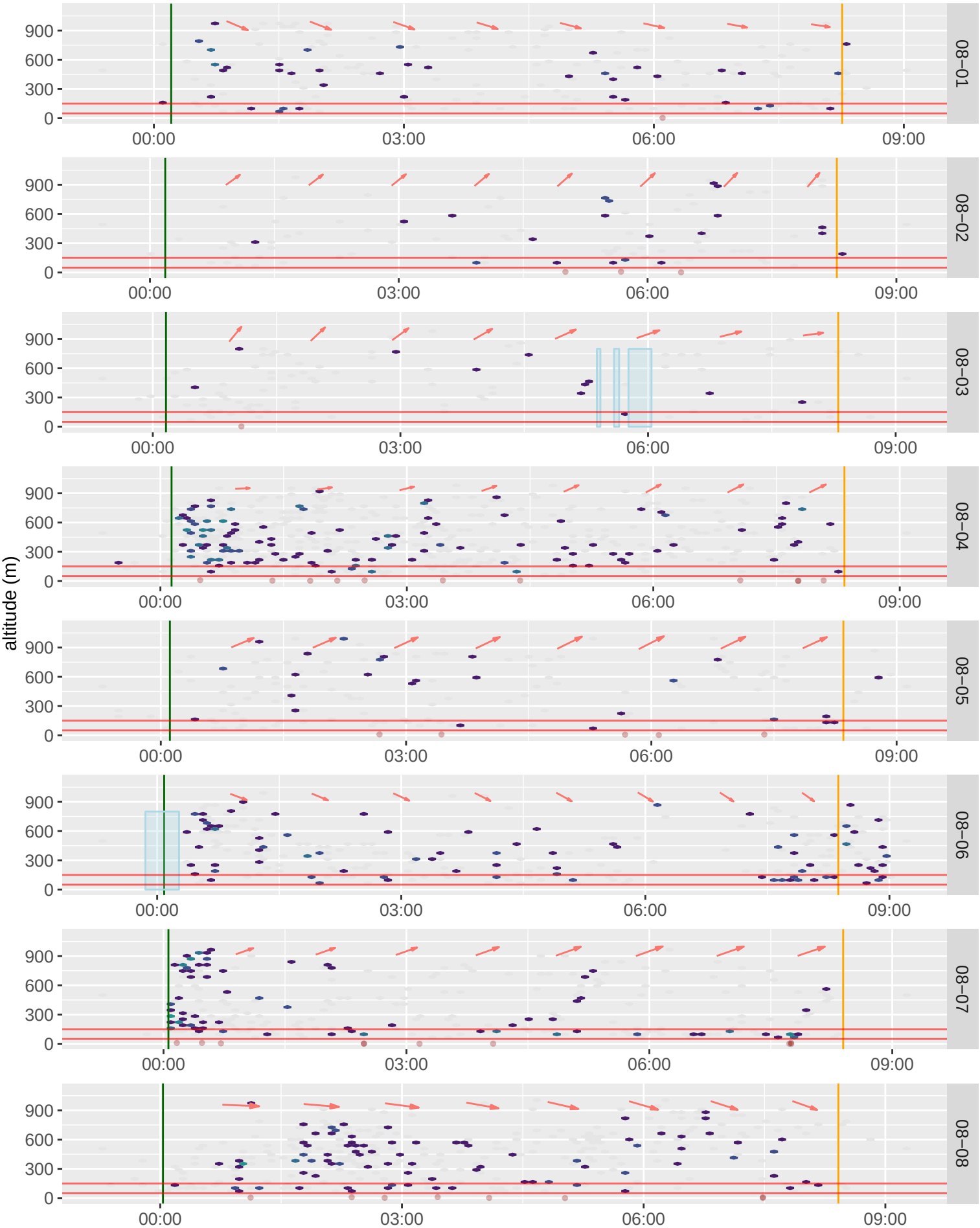
07–31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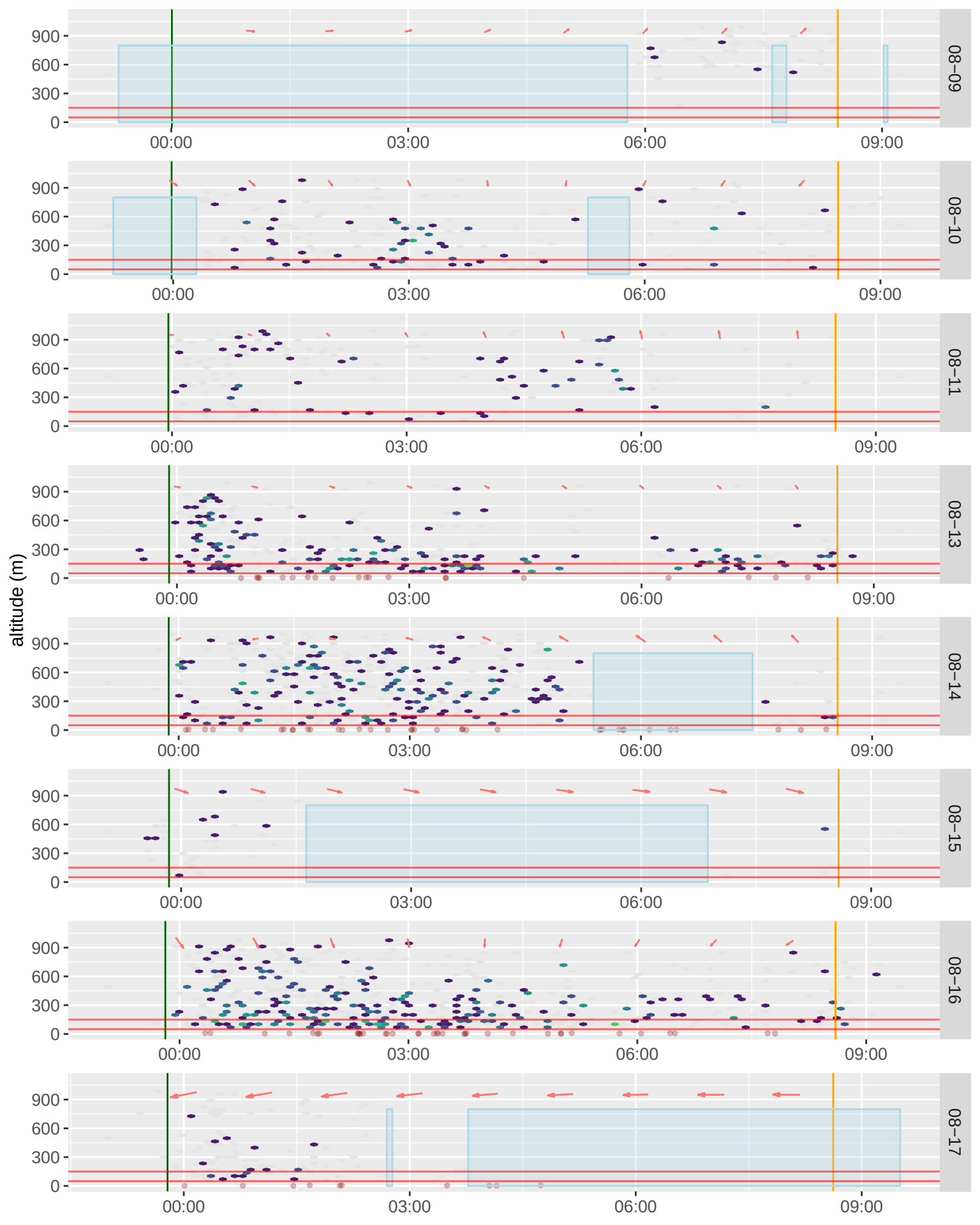
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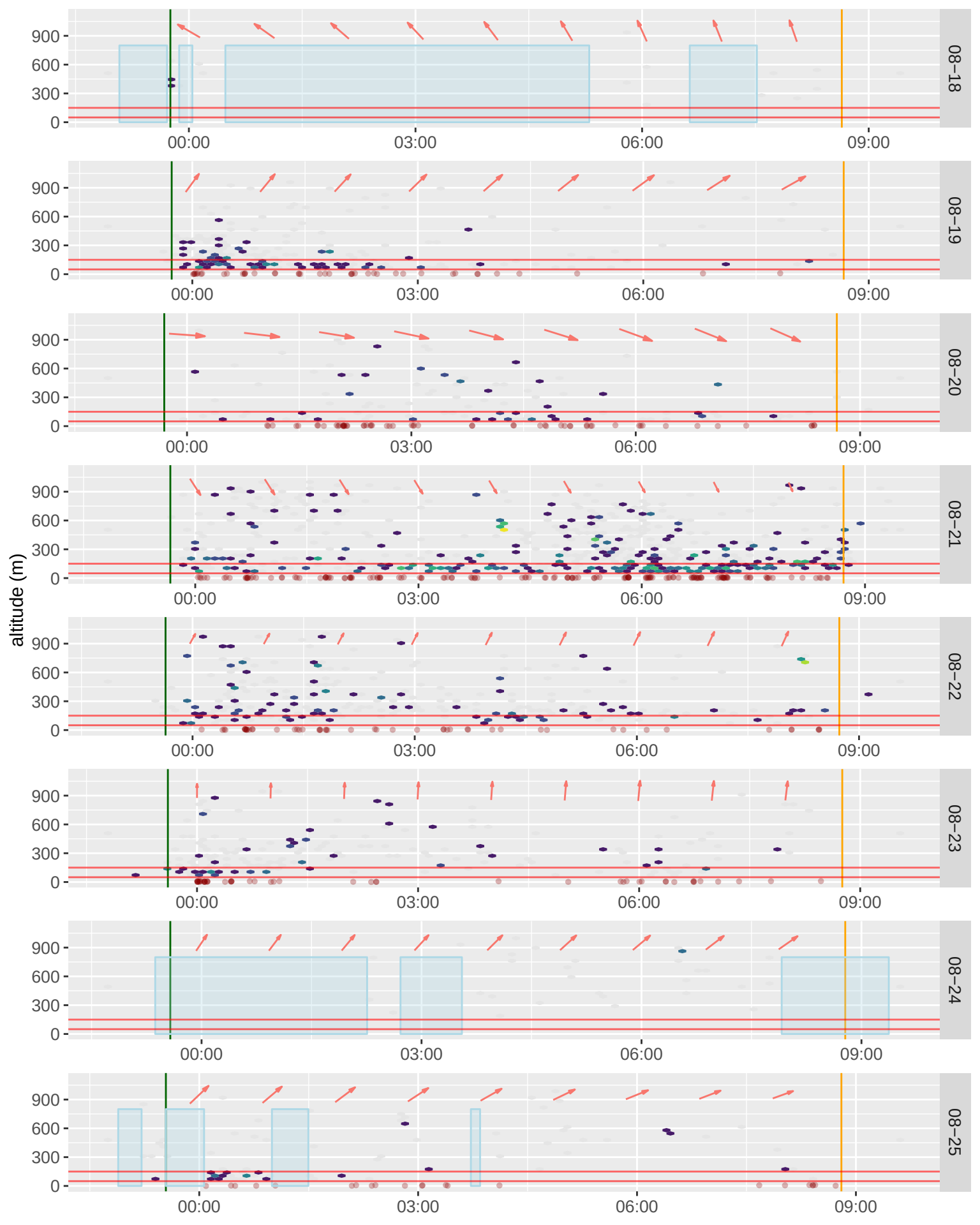
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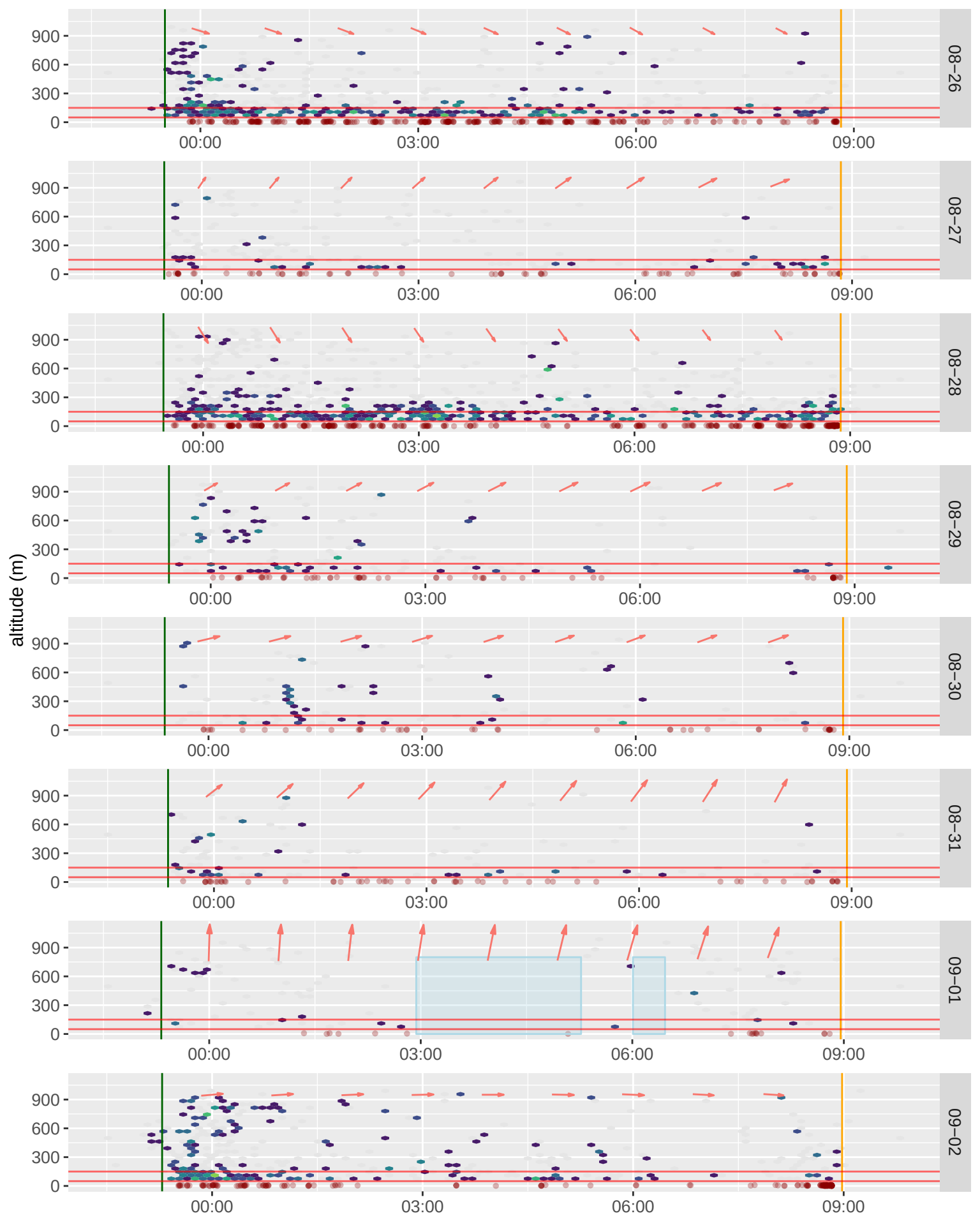
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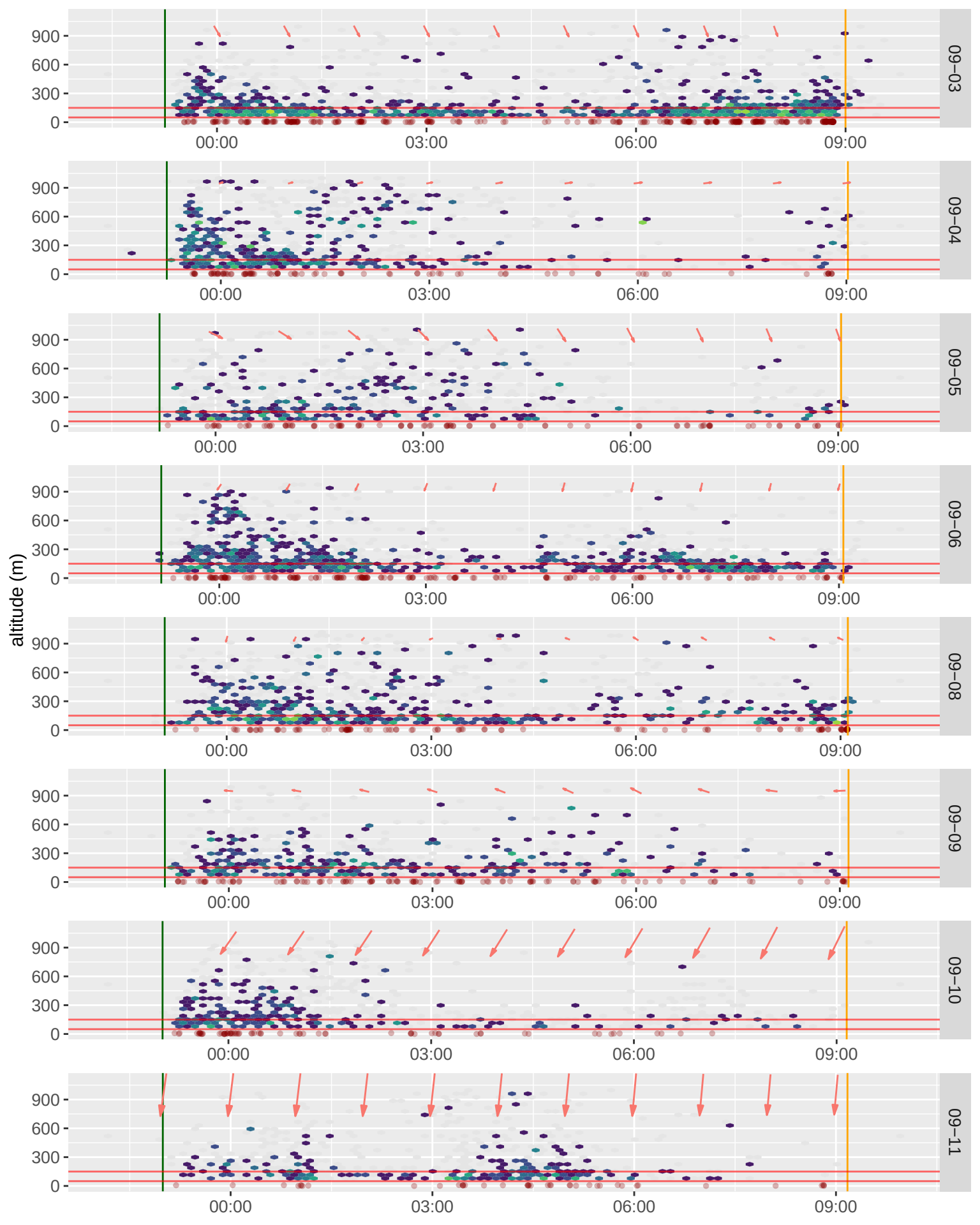
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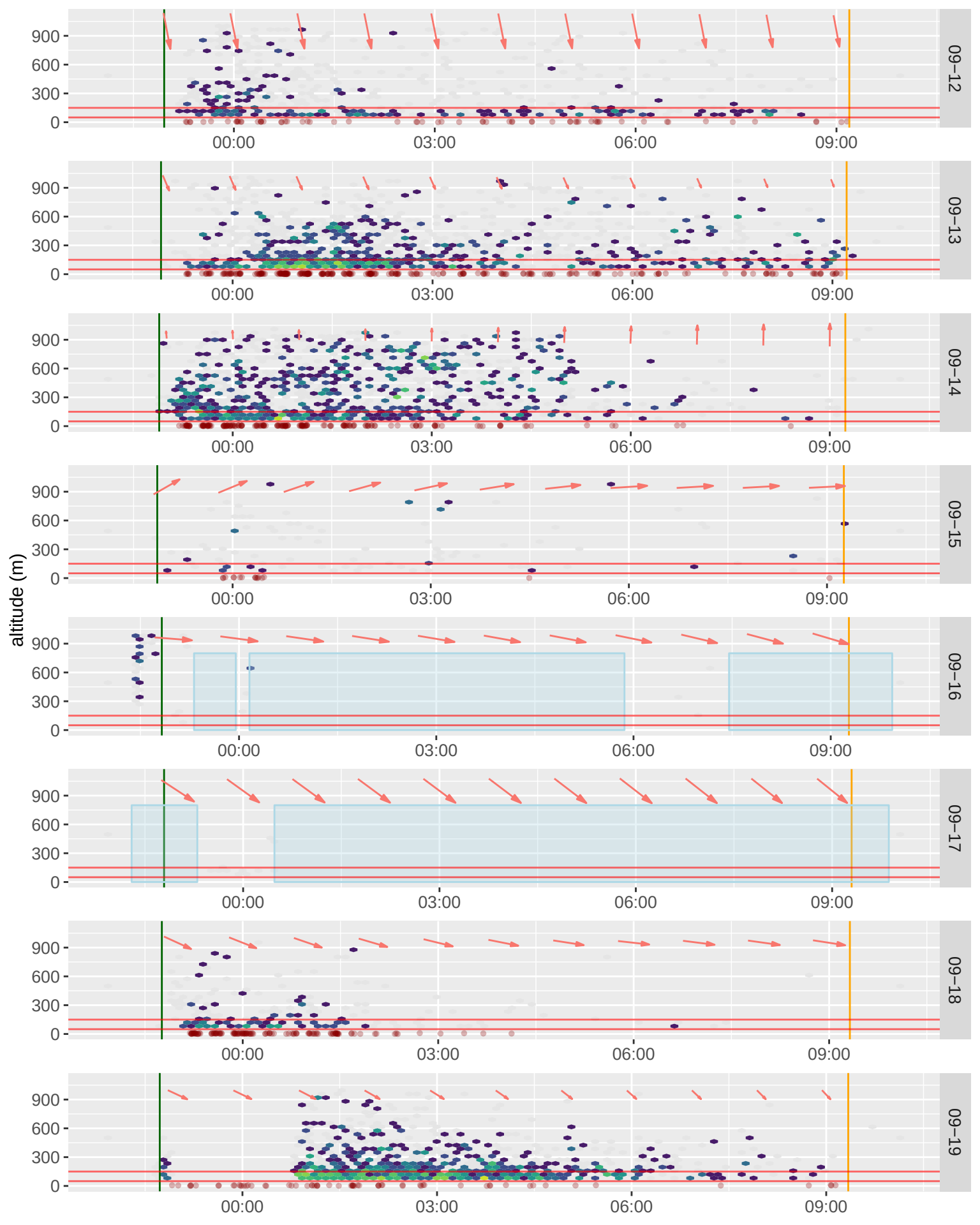
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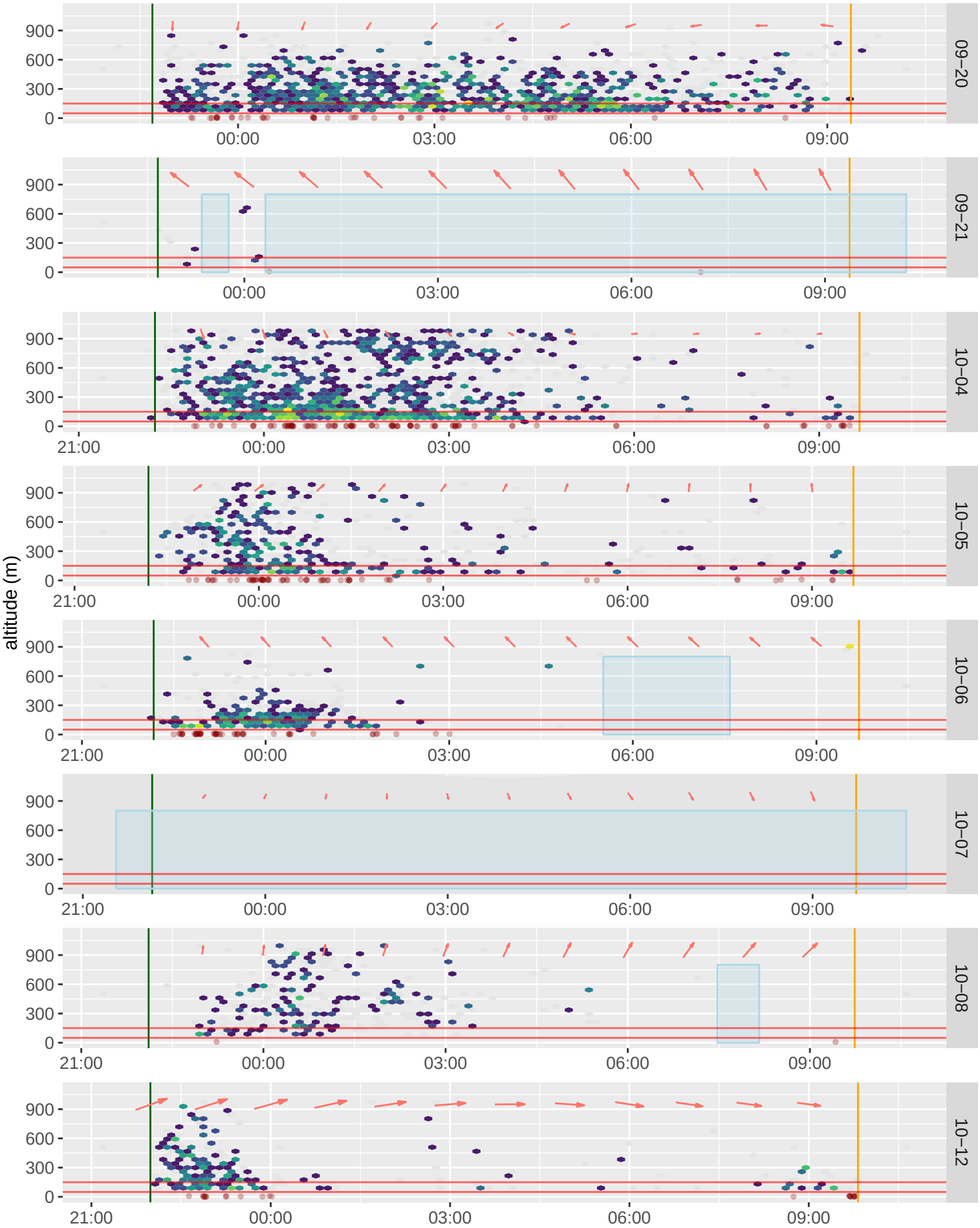
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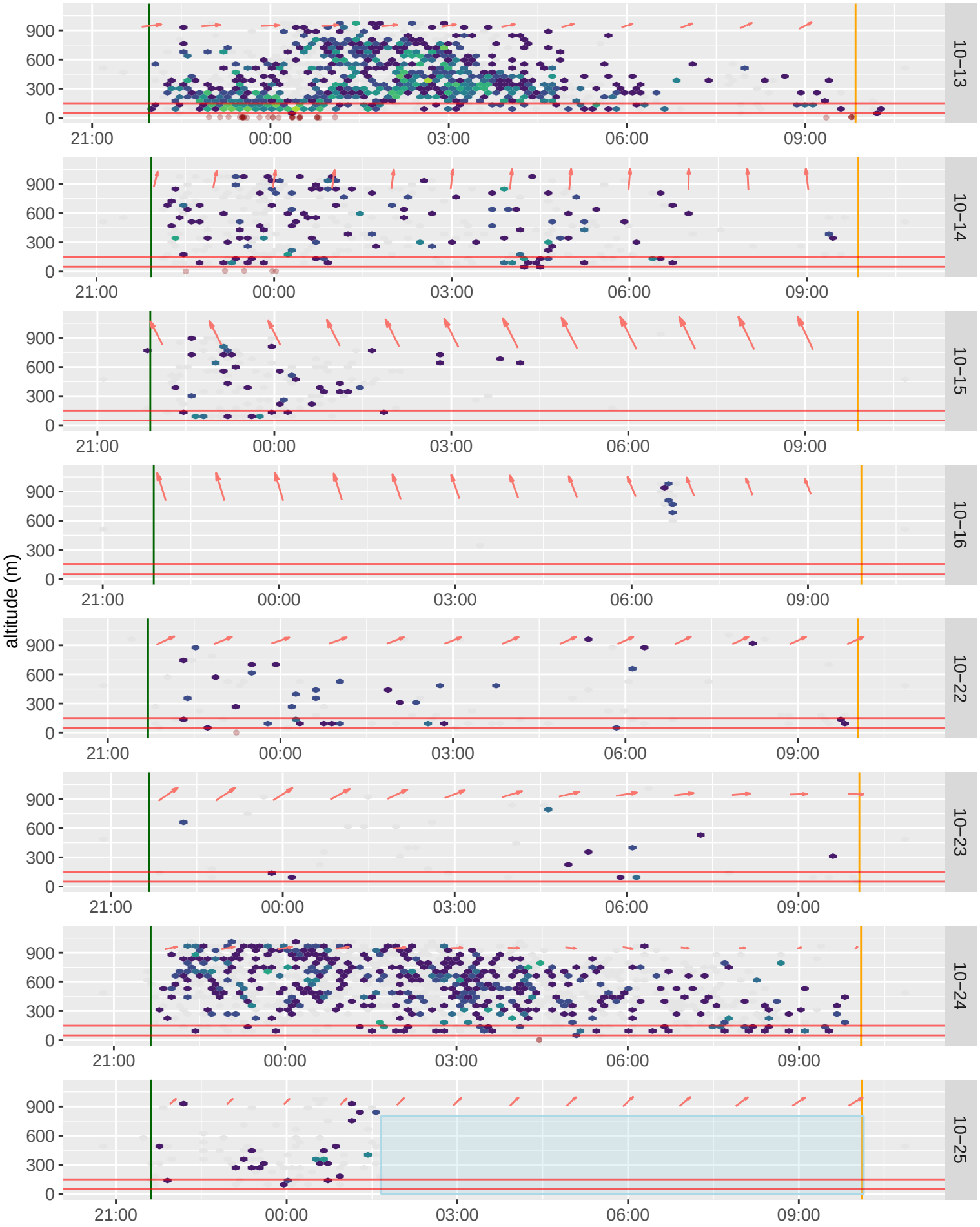
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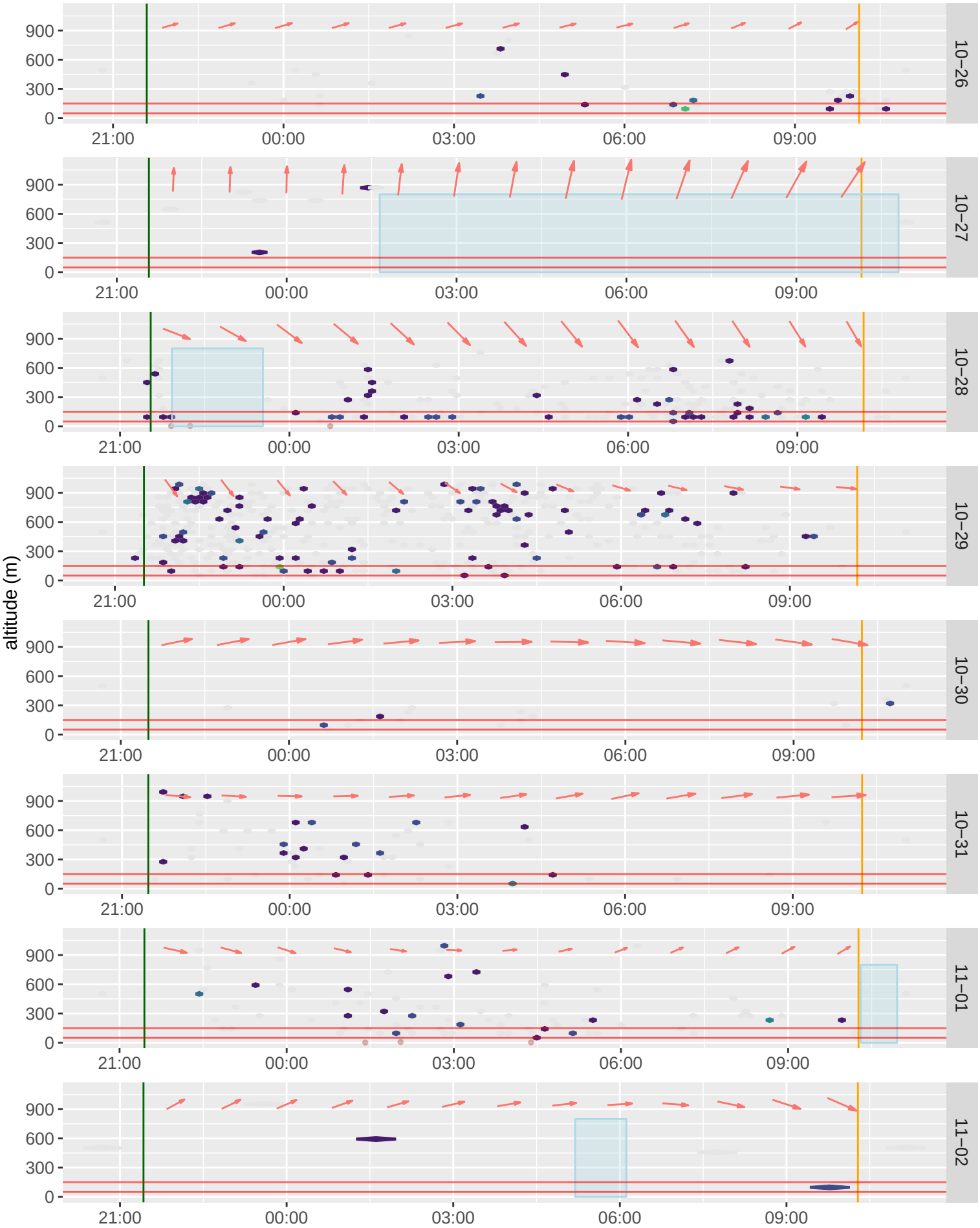
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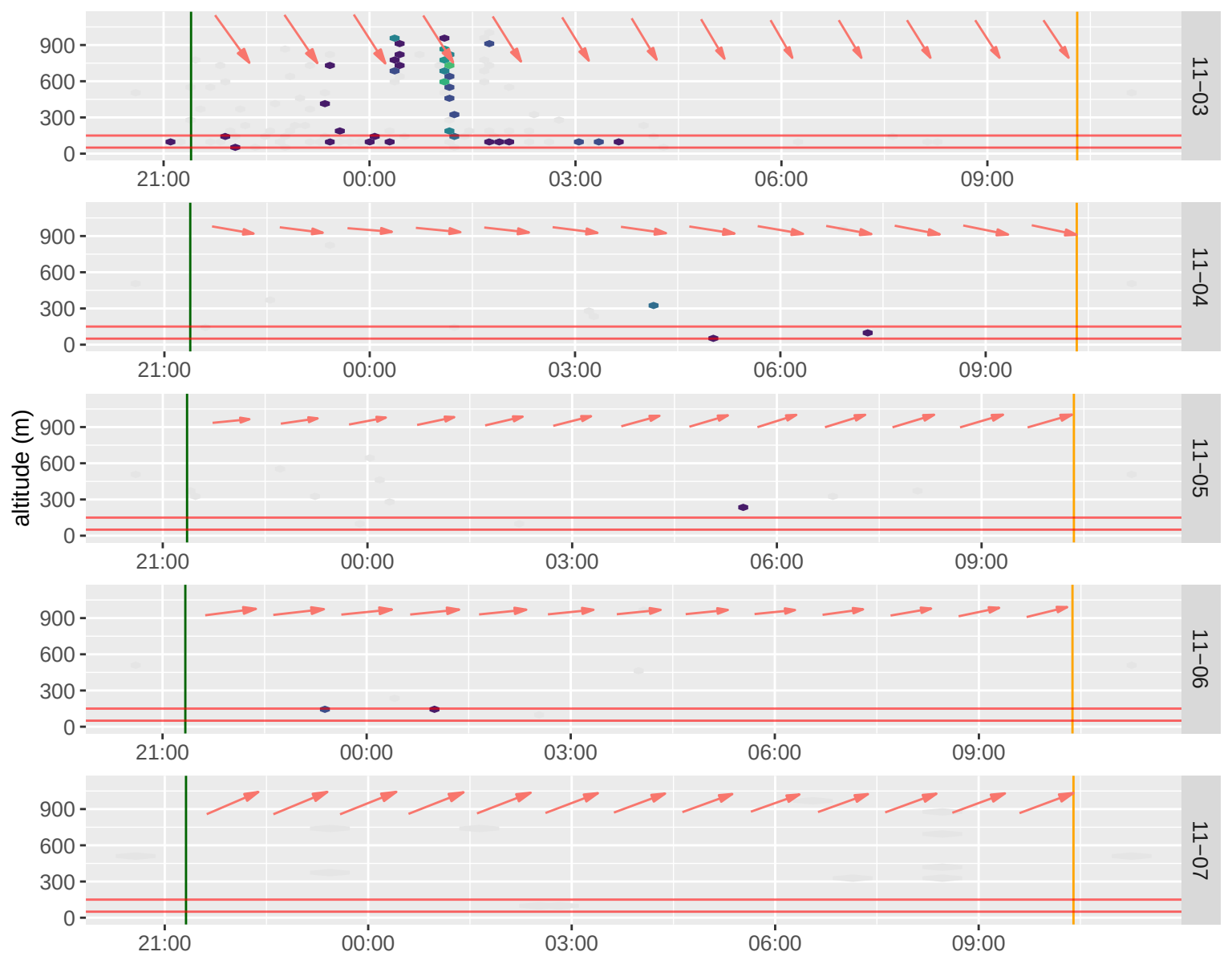
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