Keeyask Generation Project

Terrestrial Effects Monitoring Plan

Colonial Waterbird Habitat Effects Monitoring Report

TEMP-2016-03

KEEYASK

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KEEYASK GENERATION PROJECT

TERRESTRIAL EFFECTS MONITORING PLAN

REPORT #TEMP-2016-03

COLONIAL WATERBIRD HABITAT EFFECTS

MONITORING REPORT

Prepared for

Manitoba Hydro

By

Wildlife Resource Consulting Services MB Inc.

June 2016

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SUMMARY

BACKGROUND

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

This report describes the results of colonial waterbird habitat effects monitoring conducted during the summer of 2015, the second summer of Project construction. Monitoring occurred along the shorelines of the Nelson River from the Kelsey Generating Station downstream to the Limestone Generating Station, including Split Lake and Stephens Lake, and at reference waterbodies which are off the Nelson River regulated system.

WHY IS THE STUDY BEING DONE?

Colonial waterbird habitat effects monitoring is being done to evaluate Project effects on the distribution and relative abundance of ring-billed gulls and common terns and their breeding habitats.

WHAT WAS DONE?

Helicopter and unmanned aerial vehicle (UAV), which is commonly referred to as a drone, surveys were conducted to determine abundance, distribution and habitat use of colonial waterbirds in areas expected to be affected by the Project and in areas away from the Project. Helicopter surveys were wide ranging throughout the Keeyask Region, while UAV surveys focused on active construction areas (including dewatered areas), and islands and rocky reefs in the vicinity of Gull Rapids.

WHAT WAS FOUND?

Five species of colonial waterbirds were encountered during the surveys. Ring-billed gull was the most numerous, followed by common tern. A few American white pelicans, Bonaparte's gulls, and herring gulls were also observed. Gulls and terns congregated on rocky reefs and islands throughout the area surveyed. During the helicopter survey the largest congregations of ring-billed gulls and common terns were observed at islands in Gull Rapids. UAV photography

showed that the greatest numbers of colonial waterbirds at Gull Rapids were observed during late July, and mainly consisted of ring-billed gulls. The ring-billed gull population at Gull Rapids increased from 1,210 in early June to 4,978 in July. The common tern population within 2 km of Gull Rapids was 81 birds in June and 230 birds in July. Few nests or young were observed during both the helicopter and UAV surveys.

UAV Photo of A Nesting Island In Gull Rapids

WHAT DOES IT MEAN?

Islands in the north and central channels of Gull Rapids that were formerly used by nesting gulls and terns are no longer available as nesting habitat due to Project construction. Efforts to deter colonial waterbirds from nesting in these areas were successful, causing colonial waterbirds to congregate on islands in the south channel of Gull Rapids and elsewhere in the area studied. The gull and tern subpopulation estimated at Gull Rapids was similar to estimates made in previous years. The population of ring-billed gulls estimated from the helicopter at Gull Rapids increased in July, while the total population of all other areas combined decreased due to potential colony failures from flooding on reefs and islands in areas outside Gull Rapids.

Numbers of fledgling gulls and terns were likely highly underestimated during counts from aerial photographs due to their excellent camouflage.

WHAT WILL BE DONE NEXT?

Additional aerial surveys will be conducted in future years, including spring and summer of 2016, to continue monitoring the distribution and relative abundance of colonial waterbirds and their breeding habitats. Data that describes the type of habitat chosen by colonial waterbirds during this first year of construction monitoring, and in future years, will be incorporated into an expert information model. The model can then be used to predict the amount of habitat disturbance as a result of the Project and its potential impact on colonial waterbird populations. Since the conditions created by the Keeyask reservoir and water regulation may create novel breeding habitat types, the habitat model will be confirmed during operation.

STUDY TEAM

We would like to thank Sherrie Mason and Rachel Boone of Manitoba Hydro for reviewing the report. Caroline Walmsley and Megan Anger of Manitoba Hydro, Ben Hofer of Custom Helicopters, and Ron Bretecher of North/South Consultants Inc. are acknowledged for logistical assistance in the field. We would also like to thank Dr. James Ehnes, ECOSTEM Ltd., for GIS supported study design and cartography and Unmanned Aerial Imaging Solutions for Unmanned Aerial Vehicle (UAV) operations and photography.

Biologists, technicians and other personnel who designed, participated in, and drafted the study results included:

- Robert Berger, M.N.R.M., Design, analysis, and reporting
- Nicholas LaPorte, M.N.R.M., Analysis, reporting
- Gordon MacDonald, B.Sc., Survey personnel
- Kevin Methuen, B.Sc., Survey personnel
- Eugene Spence (TCN), Survey personnel
- Kristian Bernjak, UAV photography, reporting
- Mike Connellan, UAV photography, reporting
- Adam Beverstein, UAV photography

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INTRODUCTION

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

The *Keeyask Generation Project: Response to EIS Guidelines*, completed in June 2012, provides a summary of predicted effects and planned mitigation for the Project. Technical supporting information for the terrestrial environment, including a description of the environmental setting, effects and mitigation, and a summary of proposed monitoring and follow-up programs is provided in the Keeyask Generation Project Environmental Impact Statement: Terrestrial Environment Supporting Volume (TE SV). The Keeyask Hydropower Limited Partnership (KHLP) was required to prepare a plan to monitor the effects of construction and operation of the generating station on the terrestrial environment. The *Terrestrial Effects Monitoring Plan* (TEMP) was developed for the Project. Monitoring activities for various components of the terrestrial environment were described, including the focus of this report, colonial waterbird habitat effects monitoring, for the construction and operation phases of the Project.

The Project has the potential to affect colonial waterbird populations through alteration and loss of habitat, as well as sensory disturbance. Three species of colonial waterbird - ring-billed gull (*Larus delawarensis*), herring gull (*Larus argentatus*), and common tern (*Sterna hirundo*; hereafter referred to as terns) - commonly breed on rocky islands and reefs in the Nelson River near the Project site. Breeding season surveys conducted in 2001,2002, 2003, 2006, and 2011 indicate that upwards of 1,500 pairs of ring-billed gulls and 100 pairs of common terns colonize islands in Gull Rapids (KHLP 2012). Studies in 2013 (Stantec 2014) reported approximately 3,000 pairs of gulls and 50 pairs of terns, while studies in 2014 estimated 6,200 ($^{\pm}$1,000) gulls and 23 terns in Gull Rapids (Stantec 2015). Islands in the Nelson River between Gull Rapids and Birthday Rapids have supported upwards of 1,500 pairs of gulls and 100 pairs of terns (KHLP 2012). Other colonial waterbird species that have been observed to breed in the region include herring gull, Bonaparte's gull (*Chroicocephalus philadelphia*), and Caspian tern (*Sterna caspia*). Colonial waterbirds that occur in the region but for which there is no evidence of breeding include American white pelican (*Pelecanus erythrorhynchos*), black tern (*Chlidonias niger*), and double-crested cormorant (*Phalacrocorax auritus*) (KHLP 2012).

Colonial waterbirds are generally gregarious birds that congregate into conspecific or multi-species groups of nesting birds at colony sites; the congregation of nesting birds is the colony (Kushlan 1986). Waterbird colonies range from a few birds to many thousands, however, two breeding pairs nesting at a site qualify as a colony (Kushlan *et al*. 2002). Conversely, regardless of how many birds are congregated, if nesting is not taking place, the group of birds is not a colony but a congregation or potentially may be a colony. At such sites, if birds are sleeping or resting the site is referred to as a communal roost site. Often confused with roosting, loafing

includes activities involved in comfort behaviour (preening, stretching) and digestion; such sites are referred to as loafing sites (Campbell and Lack 1985).

At Gull Rapids, loss of foraging and breeding habitat, and habitat avoidance due to Project noise disturbances are anticipated construction related effects on the local colonial waterbird population. Colonial waterbirds receive regulatory protection under the *Manitoba Wildlife Act* (2015) and the *federal Migratory Birds Convention Act* (1994). To avoid disturbing breeding colonial waterbirds near Project construction activities, avian control measures, to deter colonial waterbirds, were implemented in areas affected by construction at Gull Rapids. Such permitted measures included active falconry, pyrotechnics, kites, and egg and/or nest removal. All of these measures were permitted by Environment Canada under Damage and Danger Permit 15-MB-D028 and 15-MB-D031. To assess the effectiveness of the avian control measures implemented, and to adapt the measures if required, colonial waterbird distribution and abundance at Gull Rapids were monitored using an Unmanned Aerial Vehicle (UAV). In addition to monitoring colonial waterbirds at Gull Rapids, areas outside of active construction zones within the Keeyask Region Study Zone 5 were also monitored to determine abundance, distribution and habitat use of colonial waterbirds.

The primary goal of the colonial waterbird habitat effects monitoring is to evaluate how ring-billed gull and common tern breeding habitat distribution and abundance changes due to the Project. Secondarily, this study will evaluate how ring-billed gull and common tern habitat effectiveness changes due to Project sensory disturbance, by measuring changes in the distribution and abundance of ring-billed gulls and common terns in the vicinity of Project disturbances. This report communicates the results of the first year (2015) of the Colonial Waterbird Habitat Effects study.

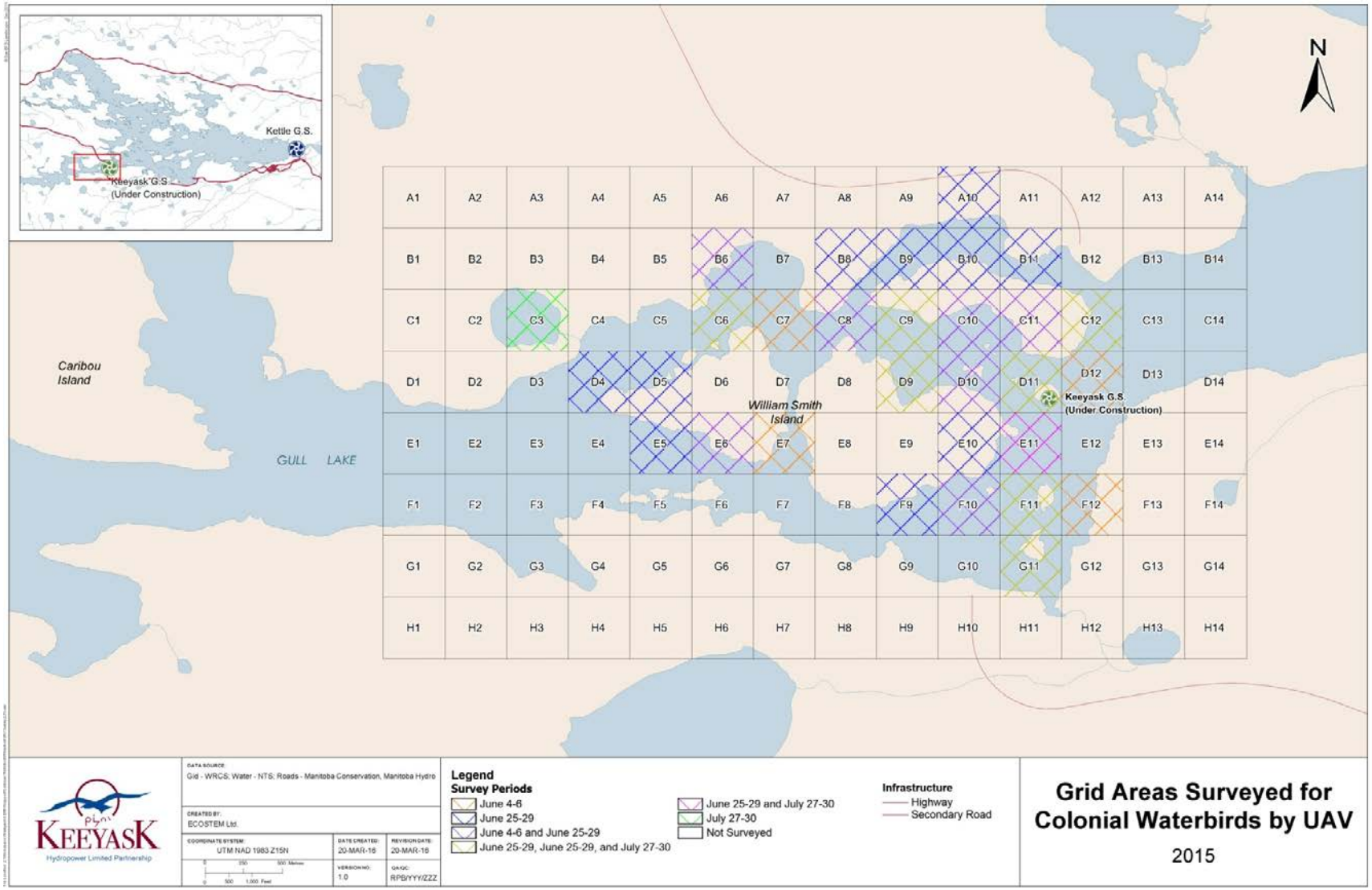
1.0 METHODS

1.1 UNMANNED AERIAL VEHICLE SURVEYS

The distribution and abundance of colonial waterbirds at Gull Rapids was monitored using photographs of nesting areas taken from an Unmanned Aerial Vehicle (UAV). Unmanned Aerial Imaging Solutions (UAIS) was contracted to conduct UAV flights and produce high-resolution images of colonial waterbird colonies and potential nesting areas in the Gull Rapids area.

UAIS deployed a Mini Talon X-UAV; a fixed-wing single propeller UAV with a 130 cm wingspan and equipped with a 12 mega-pixel camera (Photo 2-1). Using the software Mission Planner, camera parameters, flight path, speed, and altitude were programmed into the UAV to guide it during each flight mission. The Gull Rapids area was divided into survey grid squares (Map 2-1). Pre-programmed flights within survey grid squares were conducted at approximately 40 m above ground level (agl) to minimize disturbance to waterbird colonies.

Photo 2-1. Unmanned Aerial Imaging Solutions Launching The Mini Talon X-UAV.



Map 2-1. Grid Squares Surveyed By UAV At Gull Rapids In 2015.

Ten UAV flights totalling 313 minutes were flown from June 4 to 6, ten flights totalling 591 minutes were flown between June 25 and 29, and eight flights totalling 400 minutes were flown from July 27 to 30, 2015. Further information on UAV deployment is available in Appendix A.

Due to UAV survey constraints (*e.g.,* wind, rain, maximum operational range) and mission parameters, all areas in the vicinity of Gull Rapids were not photographed during every UAV survey. Details on which grid squares in the vicinity of Gull Rapids were photographed by UAV are reported in Appendix A, Table 4.

Images were examined in the laboratory to determine the number of colonial waterbirds, nests, and hatch-year birds (chicks) present in the Gull Rapids area. Colonial waterbirds were identified to species where possible. Due to the similar appearance of ring-billed gulls and herring gulls in the UAV photography, observations of these species were grouped together.

1.2 HELICOPTER BASED AERIAL SURVEYS

Helicopter based aerial surveys were conducted to monitor the abundance, distribution, and habitat use of colonial waterbirds in portions of Study Zone 5 during the breeding season. A random, stratified design was used to select waterbodies to be surveyed. Waterbodies were classified broadly as either on-system (influenced by existing or future hydroelectric operations) or off-system (unaffected by hydroelectric operations), grouped into three basic categories (lake, river, or watercourse), and grouped into five different size classes (<0.5, 0.5-1, 1-10, 10-100, 100-1,000, >1,000 ha). Small watercourses (*e.g.*, creeks) were excluded from the design and selection as gulls and terns do not typically use these features as nesting habitat. The total shoreline lengths and distribution of waterbodies are presented in Table 2-1 and Map 2-2. The first survey occurred between June 11-15, 2015 when gull and tern nests are typically initiated and most gulls and terns are incubating eggs, whereas the second survey occurred during the typical chick-rearing period between July 26 and July 30.

Table 2-1. Shoreline Length (km) And Type Of Waterbodies Surveyed In 2015.

System	Waterbody	Waterbody Size Class (ha)					Total Shoreline Length (km)
		<1	01-10	10-100	100-1,000	>1000	
On-system	Lake	0	0	0	0	668	668
	River	0	0	0	0	740	740
Off-system	Lake	1	2	15	77	420	515
	River	0	0	15	0	104	119
Total		1	2	30	77	1,932	2,042

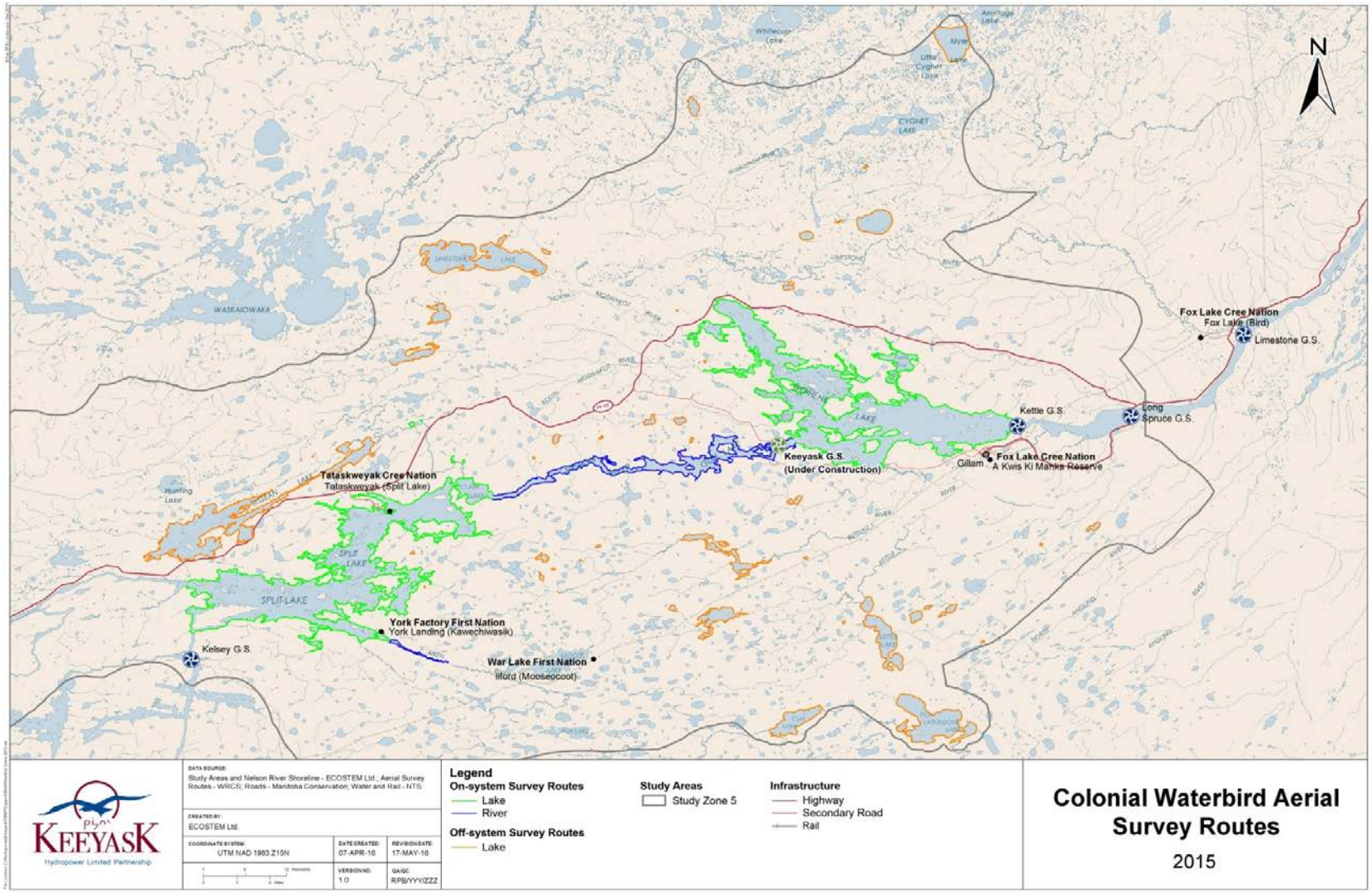
Aerial surveys followed protocols adapted from methods used by the United States Fish and Wildlife Service, US Geological Survey, Missouri Department of Conservation (2006) and Manitoba Conservation and Water Stewardship (Raedeke pers. comm. 2007 *In* Stantec 2012). Daily flights were conducted when wind speeds were below 25 km/h and when rain or fog did

not restrict observers ability to count birds. The survey was flown at approximately 100 km/h and at elevations no less than 150 m agl, and at distances no closer than 300 m to minimize disturbance to waterbird colonies and avoid collisions with flying birds.

The aerial survey crew consisted of three observers and the helicopter pilot. The primary observer was seated in the front left seat and was responsible for preliminary counts of colonial waterbirds observed during the survey. The secondary observer, seated in the rear left seat, was responsible for recording observations and photographing congregations using a Nikon Coolpix Aw130 16.0 megapixel camera. The assistant, seated in the right rear seat, counted all colonial waterbirds and incidental observations inland. The helicopter followed a shoreline transect with open water on the left and terrestrial habitat on the right. When colonial waterbirds were spotted on rocky reefs in open water areas, the helicopter departed from the shoreline transect to investigate.

During the survey, numbers of waterbirds at all colony and loafing sites, and all dispersed waterbirds were recorded along with their locations. Dispersed birds were single birds and flocks of waterbirds in flight. When a congregation of waterbirds was observed, the helicopter slowed and circled the site briefly for survey personnel to photograph and count individuals and nests. Preliminary abundance estimates were made by counting all nests and individuals. In-flight counts and photography were conducted quickly to minimize disturbing birds. All observations were georeferenced with a Garmin GPS 64. Notes on the terrestrial habitat of congregation sites were recorded and size (ha) was estimated from the helicopter. Congregation site sizes were classified as <0.1 ha, 0.1-09 ha, 1.0-1.9 ha, 2.0-2.69 ha and 3.0-3.9 ha.

Small congregations of colonial waterbirds were easily counted by the naked eye though final abundance estimates were determined through interpretation of the in-flight photographs. Photographs were analysed in Microsoft Paint to permit mark-up of the photo to facilitate the counting of adults sitting tight with no nest visible, birds flying, standing or swimming, and occupied and unoccupied nests in the photographs. Evidence of nesting included presence of visible nests, adults sitting tight, or young. Adults sitting tight are likely to be sitting on a nest but may otherwise be loafing. Examples of marked-up photographs are available in Appendix B. On a few occasions the in-flight photographs were of insufficient quality for birds to be counted, thus preliminary counts were included in lieu of photographic data in the final abundance estimates.



Map 2-2. Colonial Waterbird Survey Shoreline Routes.

2.0 RESULTS

2.1 UAV-BASED SURVEYS

Colonial waterbirds were least abundant in early June, with gulls consisting of the majority of observations (Table 3-1). In early June, only a single common tern nest was observed and 38 gull nests were observed. Colonial waterbird numbers were slightly higher during the late-June survey. The majority of observations in late June were of gulls, with relatively few common tern observed. A total of 81 gull nests were observed, as well as 10 fledgling gulls. Gulls and terns were distributed amongst the large islands and small rocky reefs in the Gull Rapids area (Maps 3-1 to 3-3). All nests observed were on islands and reefs in the Gull Rapids area, except for one gull nest observed in a dewatered area. The greatest numbers of colonial waterbirds, mainly consisting of ring-billed/herring gulls, were observed during the late July survey. No colonial waterbird nests were observed during the survey conducted in late July, but 42 hatch-year gulls were observed. Examples of UAV based photography are available in Appendix C.

2.2 HELICOPTER BASED AERIAL SURVEYS

Five species of colonial waterbird, including ring-billed gull, common tern, herring gull, Bonaparte's gull, and American white pelican were observed during the 2015 helicopter aerial survey. During both helicopter surveys, ring-billed gulls were the most abundant colonial waterbird with common terns being the second most abundant. Bonaparte's gull, herring gull, and American white pelican were far less abundant (Table 3-2).

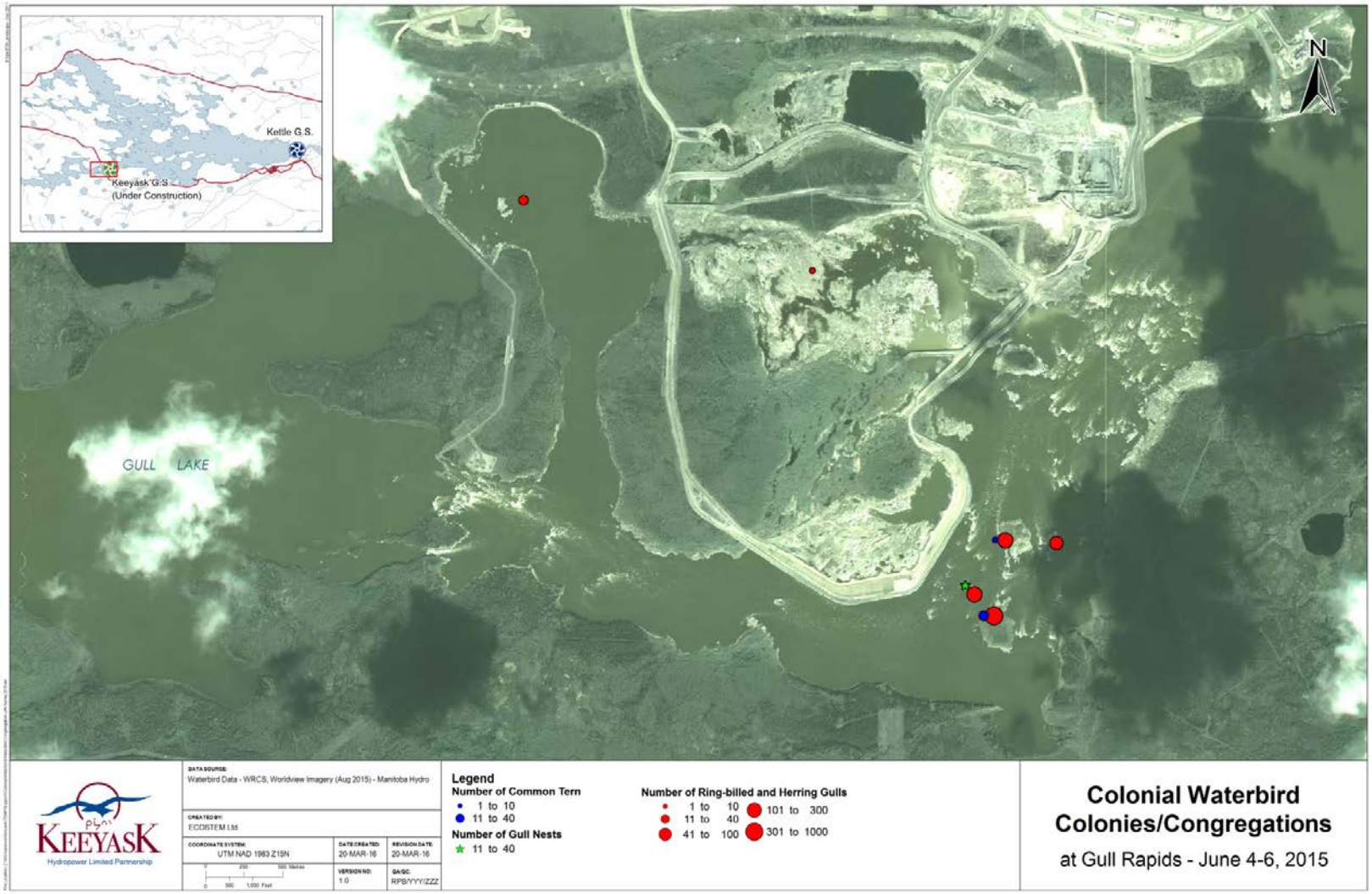
Table 3-1. Colonial Waterbird Abundance During The June And July, 2015 Aerial Surveys.

Species	June			July		
	Dispersed birds	Congregated birds	Total	Dispersed birds	Congregated birds	Total
Ring-billed gull	894	3,026	3,925	302	3,439	3,741
Common tern	173	451	624	461	572	1,033
Bonaparte's gull	137	26	163	56	0	56
Herring gull	4	23	27	8	9	17
American white-pelican	1	0	1	0	228	228

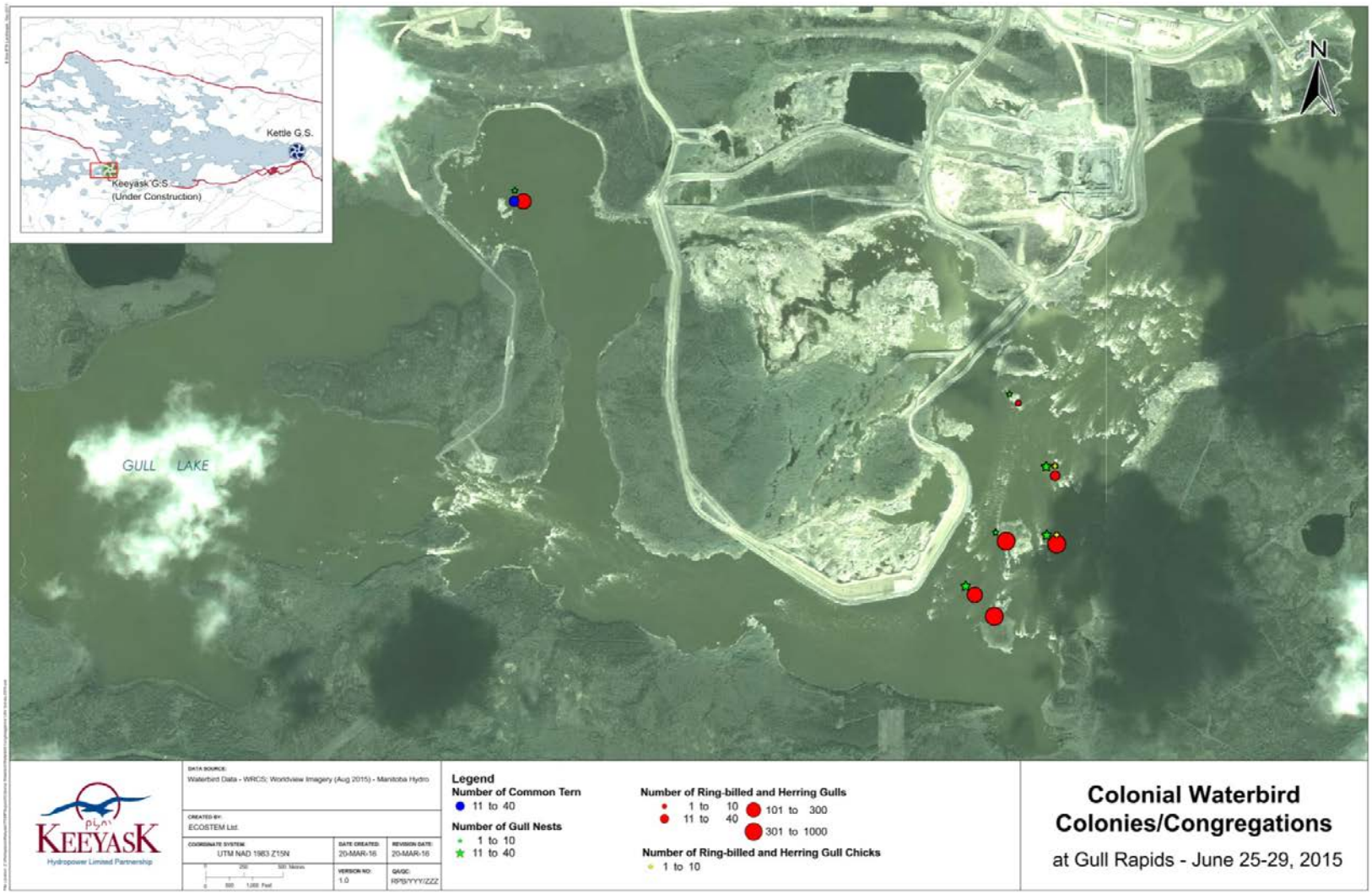
Table 3-2. Gulls And Terns Observed During UAV Surveys In 2015.

Survey Dates	Island Waypoint	Common Tern	Common Tern Nests	Common Tern Chicks	Ring-billed Gull/Herring Gull	Ring-billed Gull/Herring Gull Nests	Ring-billed Gull/Herring Gull Chicks	Unknown Gull/Tern	Unknown Gull/Tern Nests	Unknown Gull/Tern Chicks
June 4-6	83	0	0	0	12	0	0	0	0	0
	224	30	0	0	322	0	0	0	0	0
	225	0	0	0	60	0	0	0	0	0
	226	1	0	0	156	0	0	0	0	0
	227	0	0	0	166	38	0	0	0	0
	484	0	0	0	1	0	0	0	0	0
	NA*	30	0	0	493	0	0	9	0	0
	Total	61	0	0	1,210	38	0	9	0	0
June 25-29	83	23	0	0	214	3	0	0	0	0
	224	0	0	0	341	0	0	0	0	0
	225	0	0	0	549	26	6	0	0	0
	226	0	0	0	504	7	0	0	0	0
	227	0	0	0	119	30	0	0	0	0
	478	0	0	0	14	11	4	0	0	0
	480	0	0	0	10	3	0	0	0	0
	NA*	37	0	0	41	1	0	2	0	0
	Total	60	0	0	1,792	81	10	2	0	0
July 27-30	224	2	0	0	1,200	0	0	0	0	0
	225	0	0	0	930	0	33	0	0	0
	226	0	0	0	2,759	0	5	0	0	0
	227	0	0	0	87	0	4	0	0	0
	NA*	1	0	0	2	0	0	3	0	0
	Total	3	0	0	4,978	0	42	3	0	0

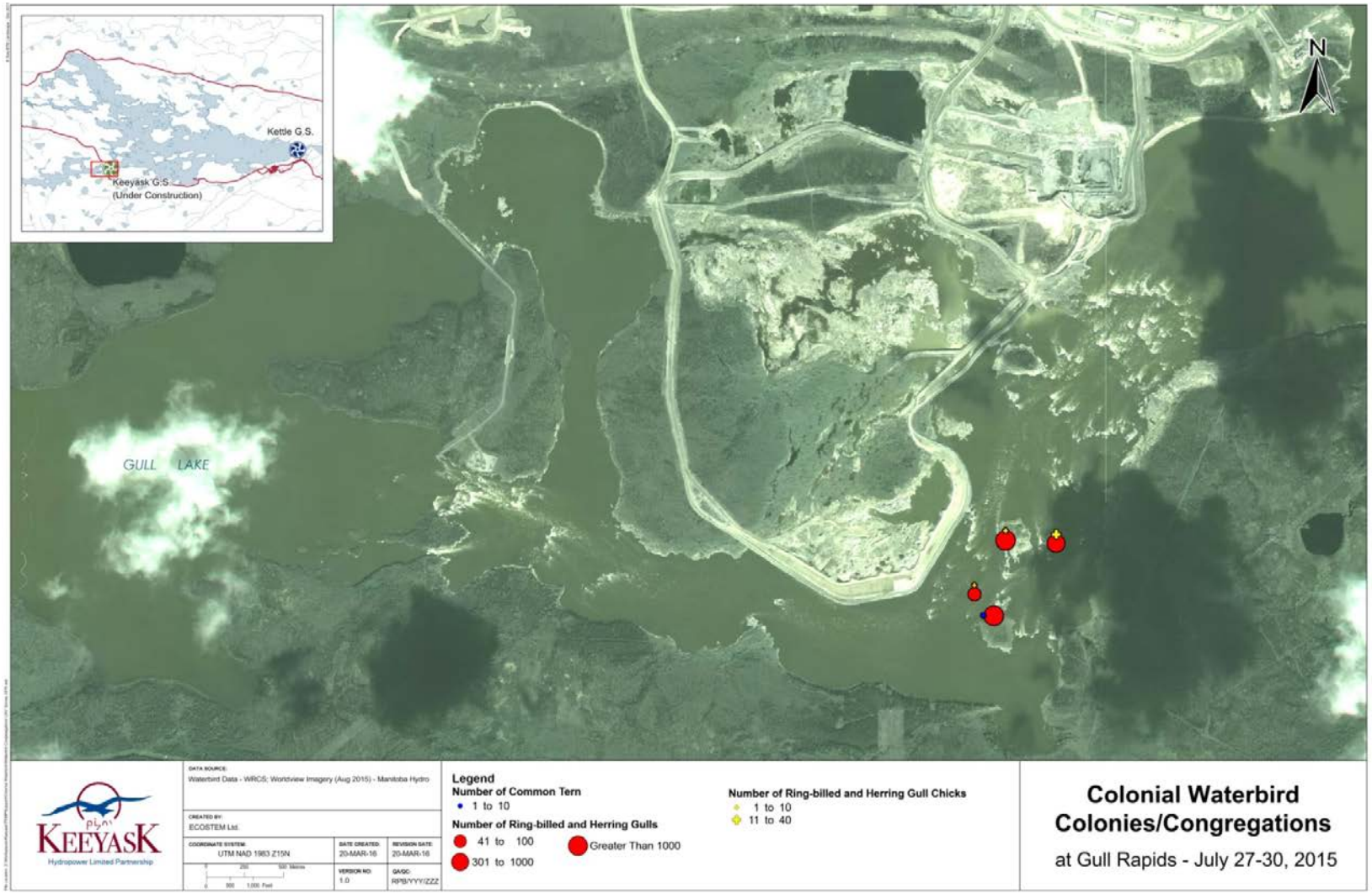
* Not assigned to a specific island.



Map 3-1. Colonial Waterbird Congregations/Colonies Photographed By UAV In The Gull Rapids Area Between June 4-6, 2015.



Map 3-2. Colonial Waterbird Congregations/Colonies Photographed By UAV In The Gull Rapids Area Between June 25-29, 2015.



Map 3-3. Colonial Waterbird Congregations/Colonies Photographed By UAV In The Gull Rapids Area Between July 27-30, 2015.

2.2.1 RING-BILLED GULL

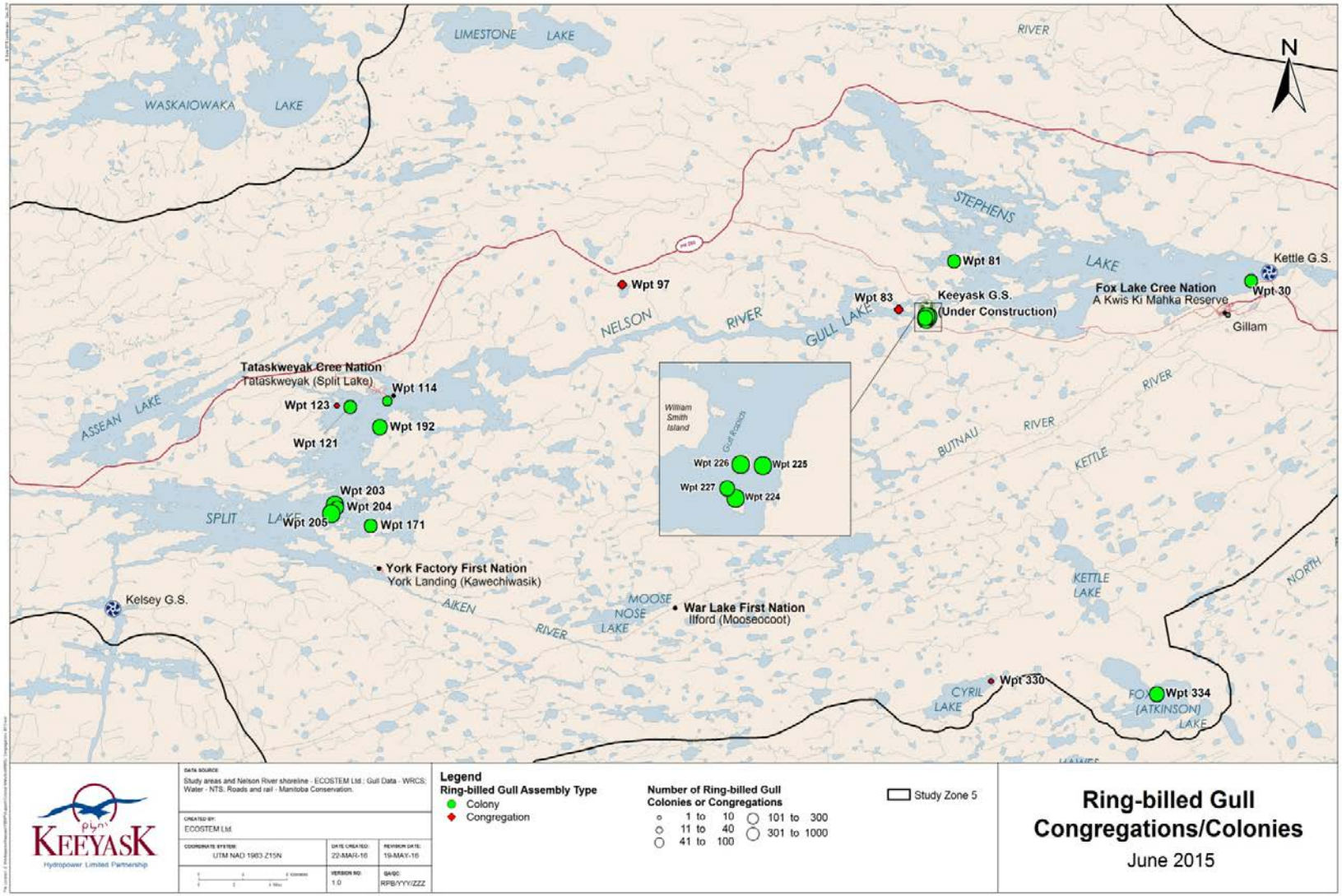
During the 2015 breeding season, the number of ring-billed gulls observed during the helicopter survey (including dispersed gulls) decreased from 3,925 adult ring-billed gulls in June to 3,741 in July (Table 3-2). Ring-billed gulls congregated at 32 sites in the survey area (Maps 3-4 and 3-5), though evidence of nesting was only observed at 19 of these sites (Table 3-3). A total of 3,026 adult ring-billed gulls (not including dispersed gulls) congregated at 17 sites in June, whereas 3,439 ring-billed gulls congregated at 23 sites in July (Table 3-3). In June, the size of ring-billed gull congregations ranged from two to 394 adults, and from two to 1,087 adults in July (Table 3-3). In July, ring-billed gulls were absent at ten of the sites previously occupied in June, and congregated at 15 new sites (Table 3-3). Common terns were observed at 12 sites where ring-billed gulls were also observed (Table 3-3). Hatch-year ring-billed gulls were observed at six colonies (Table 3-3).The largest congregations of ring-billed gulls were observed at islands in Gull Rapids (Table 3-3; Maps 3-4 and 3-5). These four colonies ranged from 131 to 1,087 adult ring-billed gulls, and contained a total of 1,648 adults in June, and 2,625 adults in July, representing 54% of all congregated adults in June and 76% of all congregated adults in July (Table 3-3). Other colonies ranged in size from two to 362 adults (Table 3-3).

All of the sites where ring-billed gulls congregated in 2015 were islands. Generally, these islands were open areas of exposed bedrock, boulders, gravel, or sand, with a small vegetated area. Four sites in Gull Rapids were surrounded by rapids, two sites on islands in the Nelson River were surrounded by flowing water, whereas the remaining sites were in lakes with minimal water currents (Table 3-4). Photographs of islands where ring-billed gulls congregated are available in Appendix D.

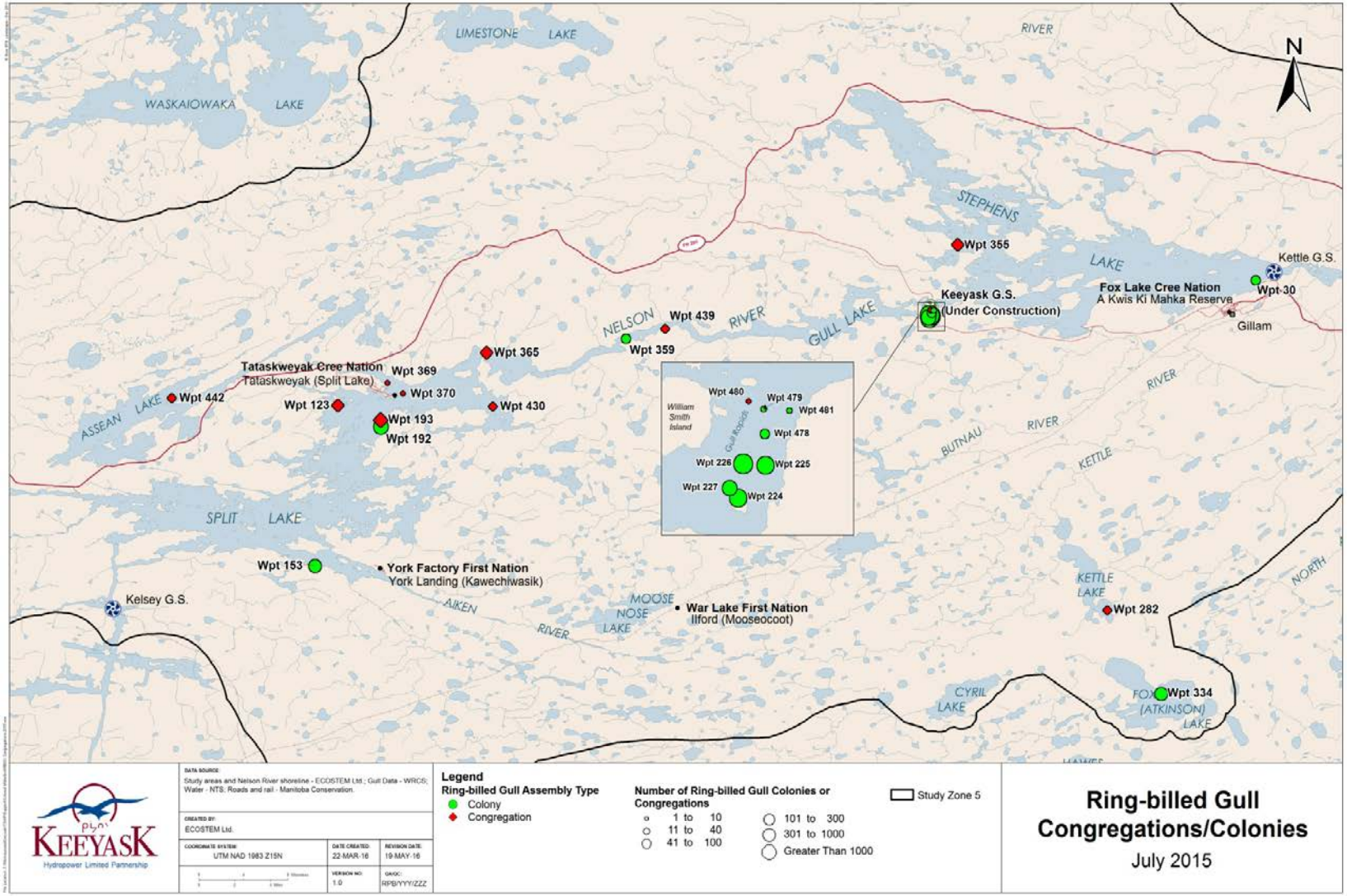
2.2.2 COMMON TERN

During the 2015 breeding season, a total of 624 adult terns (including dispersed terns) were observed during the June helicopter survey and 1,033 were observed during the July helicopter survey (Table 3-2). Terns congregated at 25 sites in the survey area, nesting colonies were established at six of these sites (Table 3-5; Maps 3-6 and 3-7). A total of 45 adult terns (not including the dispersed terns) were congregated at 18 sites in June, whereas 572 terns were congregated at nine sites in July (Table 3-5). The size of tern congregations ranged from four to 78 adults in June, and between two and 230 adults in July (Table 3-5). Hatch-year terns were not observed at any site.

In July, terns were absent from 16 of the sites previously occupied in June, and were congregated at seven new sites (Maps 3-6 and 3-7; Table 3-5). At six of the seven sites occupied by terns and ring-billed gulls in June, no terns were observed in July (Table 3-5). Terns and ring-billed gulls were present together at four sites in July (Table 3-5); evidence of



Map 3-4. Ring-billed Gull Congregations/Colonies In June 2015.



Map 3-5. Ring-billed Gull Congregations/Colonies In July 2015.

Table 3-3. Ring-billed Gull Congregations/Colonies During The 2015 Aerial Surveys.

	June					July					
Waypoint	# Unoccupied nests	# Occupied nests	# Adults sitting tight	# Adults standing, swimming, or flying	Total # Adults	# Unoccupied nests	# Occupied nests	# Adults sitting tight	# Adults standing, swimming, or flying	# Young	Total # Adults
30	0	14	0	36	50	0	0	0	12	0	12
81	0	37	0	53	90	0	0	0	0	0	0
83	0	0	0	25	25†	0	0	0	0	0	0†
114	0	0	7	18	25†	0	0	0	0	0	0
121	0	0	33	28	61	0	0	0	0	0	0
123	0	0	0	6	6	0	0	0	56	0	56
153	-	-	-	-	-†	0	0	20	30	0	50†
171	0	14	30	39	83†	0	0	0	0	0	0
192	0	33	78	58	169	0	14	90	10	10	114
193	-	-	-	-	-	0	0	0	270	0	270†
203	0	8	84	211	303	0	0	0	0	0	0
204	0	14	19	23	56	0	0	0	0	0	0
205	0	34	131	197	362	0	0	0	0	0	0†
224	0	9	145	214	368†	0	0	0	691	0	691
225	0	69	105	546	720†	0	0	0	716	25	716
226	47	9	16	369	394†	0	0	0	1087	0	1087
227	0	79	39	48	166	0	0	29	102	15	131
282	-	-	-	-	-†	0	0	0	11	0	11
330	0	0	0	2	2	0	0	0	0	0	0
334	0	0	0	146	146	4	0	0	75	0	75
355	-	-	-	-	-	0	0	0	57	0	57
359	-	-	-	-	-	0	5	4	7	0	16
365	-	-	-	-	-	0	0	0	45	0	45†
369	-	-	-	-	-	0	0	0	6	0	6

	June					July					
Waypoint	# Unoccupied nests	# Occupied nests	# Adults sitting tight	# Adults standing, swimming, or flying	Total # Adults	# Unoccupied nests	# Occupied nests	# Adults sitting tight	# Adults standing, swimming, or flying	# Young	Total # Adults
370	-	-	-	-	-	0	0	0	9	0	9
430	-	-	-	-	-	0	0	0	30	0	30[†]
439	-	-	-	-	-	0	0	0	26	0	26
442	-	-	-	-	-	0	0	0	15	0	15
478	-	-	-	-	-	8	0	0	11	12	11
479	-	-	-	-	-	1	0	0	2	1	2
480	-	-	-	-	-	0	0	0	7	0	7
481	-	-	-	-	-	1	0	0	4	1	2
Total	47	320	687	2019	3,026	14	19	143	3,279	64	3,439

[†]Common terns present.

Table 3-4. Habitat Classifications Of Ring-billed Gull Congregation/Colony Sites In 2015.

Waypoint	Waterbody Class Size (ha)	System	Waterbody Type	Island Size Class (ha)
30*	>1000	On System	River	1.0 - 1.9
81*	>1000	On System	River	0.1 - 0.9
83	>1000	On System	River	0.1 - 0.9
97	100-1000	Off System	Lake	0.1 - 0.9
114*	>1000	On System	Lake	0.1 - 0.9
121*	>1000	On System	Lake	0.1 - 0.9
171*	>1000	On System	Lake	0.1 - 0.9
192*	>1000	On System	Lake	0.1 - 0.9
203*	>1000	On System	Lake	0.1 - 0.9
204*	>1000	On System	Lake	<0.1
205*	>1000	On System	Lake	0.1 - 0.9
224*	>1000	On System	River	1.0 - 1.9
225*	>1000	On System	River	0.1 - 0.9
226*	>1000	On System	River	1.0 - 1.9
227*	>1000	On System	River	<0.1
282	>1000	Off System	River	0.1 - 0.9
330	>1000	Off System	Lake	0.1 - 0.9
334*	>1000	Off System	Lake	0.1 - 0.9
355	>1000	On System	River	<0.1
359*	>1000	On System	River	3.0 - 3.9
365	>1000	On System	Lake	<0.1
369	>1000	On System	Lake	<0.1
370	>1000	On System	Lake	<0.1
430	>1000	On System	Lake	0.1 - 0.9
439	>1000	On System	River	0.1 - 0.9
442	>1000	Off System	Lake	<0.1
478	>1000	On System	River	<0.1

Waypoint	Waterbody Class Size (ha)	System	Waterbody Type	Island Size Class (ha)
479	>1000	On System	River	<0.1
480	>1000	On System	River	0.1 - 0.9
481	>1000	On System	River	<0.1

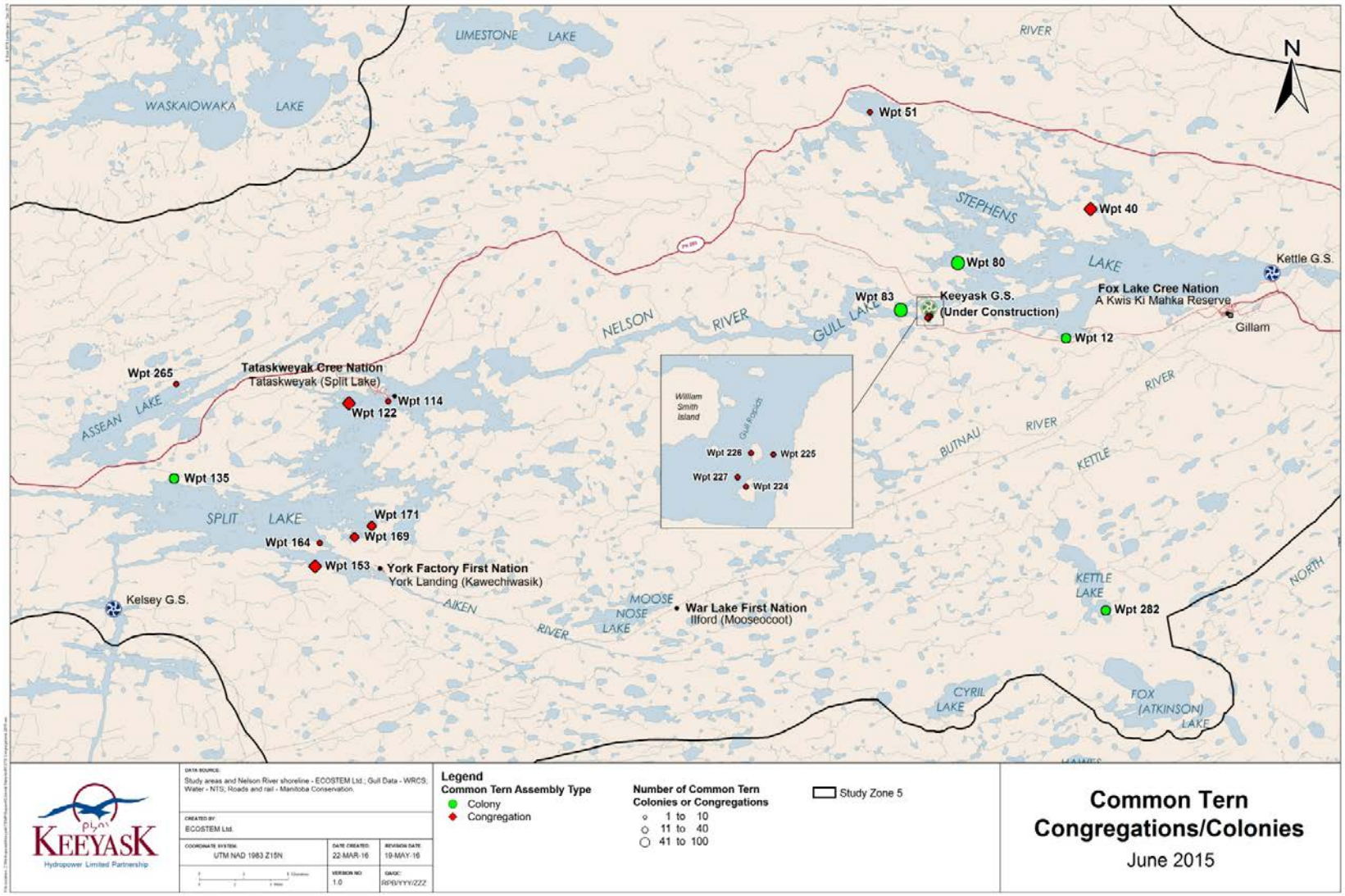
*Colony: Site contained nests or birds sitting tight on a likely nest.

Table 3-5: Common Tern Congregations/Colonies During The 2015 Aerial Surveys.

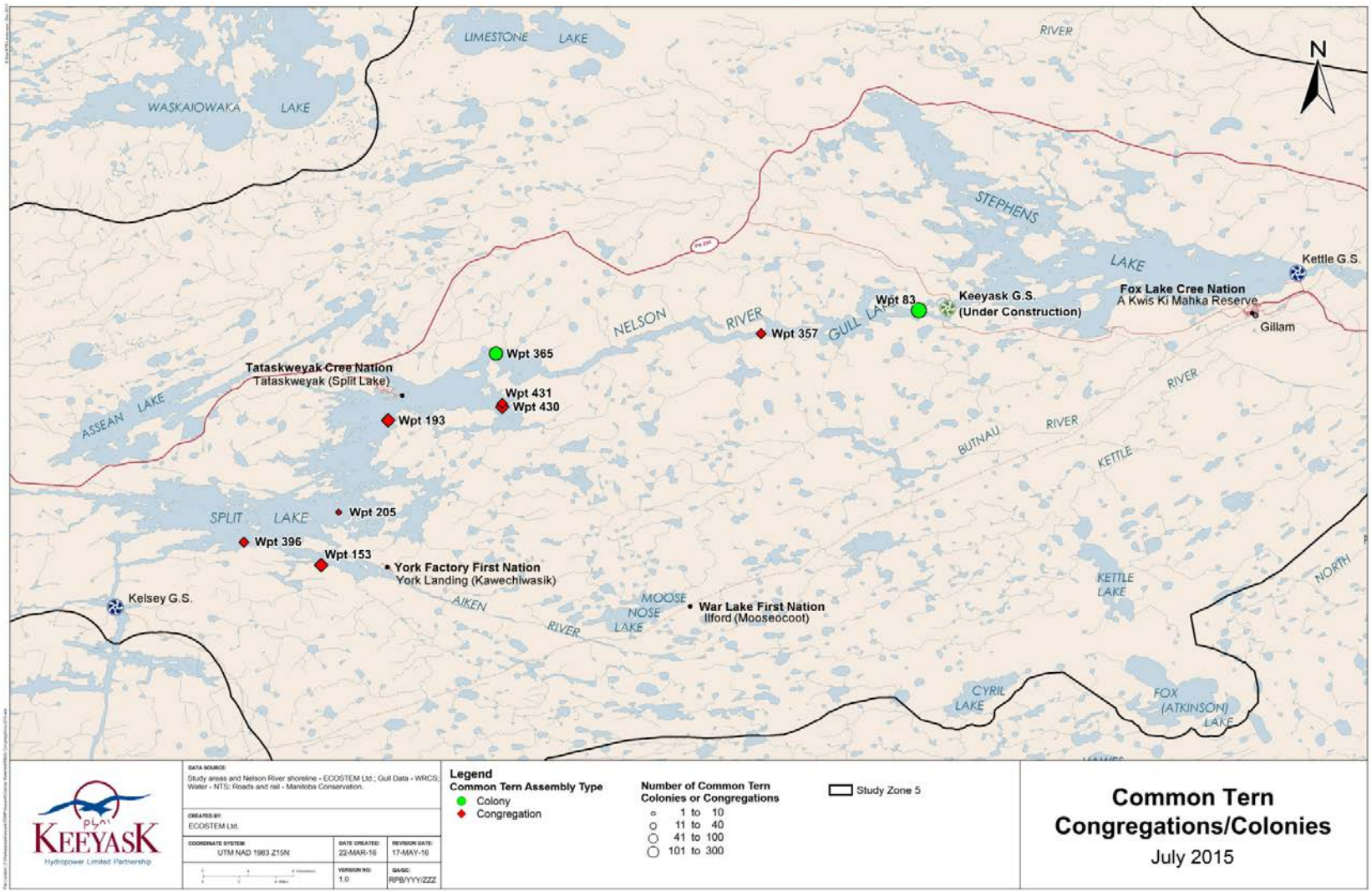
	June					July				
Waypoint	# Unoccupied nests	# Occupied nests	# Adults sitting tight	# Birds standing, swimming, or flying	# Adults	# Unoccupied nests	# Occupied nests	# Adults sitting tight	# Birds standing, swimming, or flying	# Adults
12	0	10	0	10	20	0	0	0	0	0
40	0	0	0	41	41	0	0	0	0	0
51	0	0	0	6	6	0	0	0	0	0
80	0	20	0	23	43	0	0	0	0	0
83	0	24	13	4	41†	0	0	29	201	230
114	0	0	0	4	4†	0	0	0	0	0
122	0	0	0	78	78	0	0	0	0	0
135	0	0	0	38	38	0	0	0	0	0
153	0	0	0	61	61	0	0	20	30	50†
164	0	0	0	4	4	0	0	0	0	0
169	0	0	0	20	20	0	0	0	0	0
171	0	0	0	20	20†	0	0	0	0	0
193	-	-	-	-	-	0	0	0	100	100†
205	-	-	-	-	-†	0	0	0	2	2
224	0	0	0	10	10†	0	0	0	0	0†
225	0	0	0	10	10†	0	0	0	0	0†
226	0	0	0	10	10†	0	0	0	0	0†
227	0	0	0	10	10†	0	0	0	0	0†
265	0	0	0	10	10	0	0	0	0	0
282	0	10	0	15	25	0	0	0	0	0†
357	-	-	-	-	-	0	0	0	14	14
365	-	-	-	-	-	0	0	2	41	43†
396	-	-	-	-	-	0	0	0	40	40
430	-	-	-	-	-	0	0	0	53	53†

	June					July				
Waypoint	# Unoccupied nests	# Occupied nests	# Adults sitting tight	# Birds standing, swimming, or flying	# Adults	# Unoccupied nests	# Occupied nests	# Adults sitting tight	# Birds standing, swimming, or flying	# Adults
431	-	-	-	-	-	0	0	0	40	40
Total	0	64	13	374	451	0	0	51	521	572

†Ring-billed gulls also present.



Map 3-6. Common Tern Congregations/Colonies In June 2015.



Map 3-7. Common Tern Congregations/Colonies In July 2015.

nesting terns was only observed at two of these sites, and evidence of nesting gulls was only observed at one site (Table 3-5).

The largest congregation of terns was observed on a small rocky island at Waypoint (Wpt) 83 in a sheltered bay 2 km upstream of Gull Rapids (Photo 3-1; Maps 3-6 and 3-7). This colony contained 41 adults in June and 230 adults in July comprising 40% of all congregated adults in July (Table 3-5). All other tern nesting colonies ranged in size from 20 to 100 adults (Table 3-5).

Terns congregated on islands with little to no vegetation. Generally, these islands were open areas of exposed bedrock, boulders, gravel, or sand, with a small vegetated area. Three sites where terns congregated in Gull Rapids were surrounded by fast moving water, whereas the remaining sites were in lakes with slow water currents.

Common tern congregations were distributed in lakes (Stephens Lake, Split Lake, Clark Lake, Assean Lake, Kettle Lake, Atkinson Lake) greater than 1000 ha in size and in the Nelson River (Table 3-6; Maps 3-6 and 3-7). Most common tern congregations were on Split Lake and Clark Lake, though two small congregations north of the Nelson River and three south of the Nelson River were observed. Twelve sites where common tern congregated were below 0.1 ha in size, 11 sites were between 0.1-0.9 ha, and two sites had an area greater than 1.0 ha (Table 3-6).

Photo 3-1. Common Tern Colony (Wpt 83) Two km Upstream Of Gull Rapids.

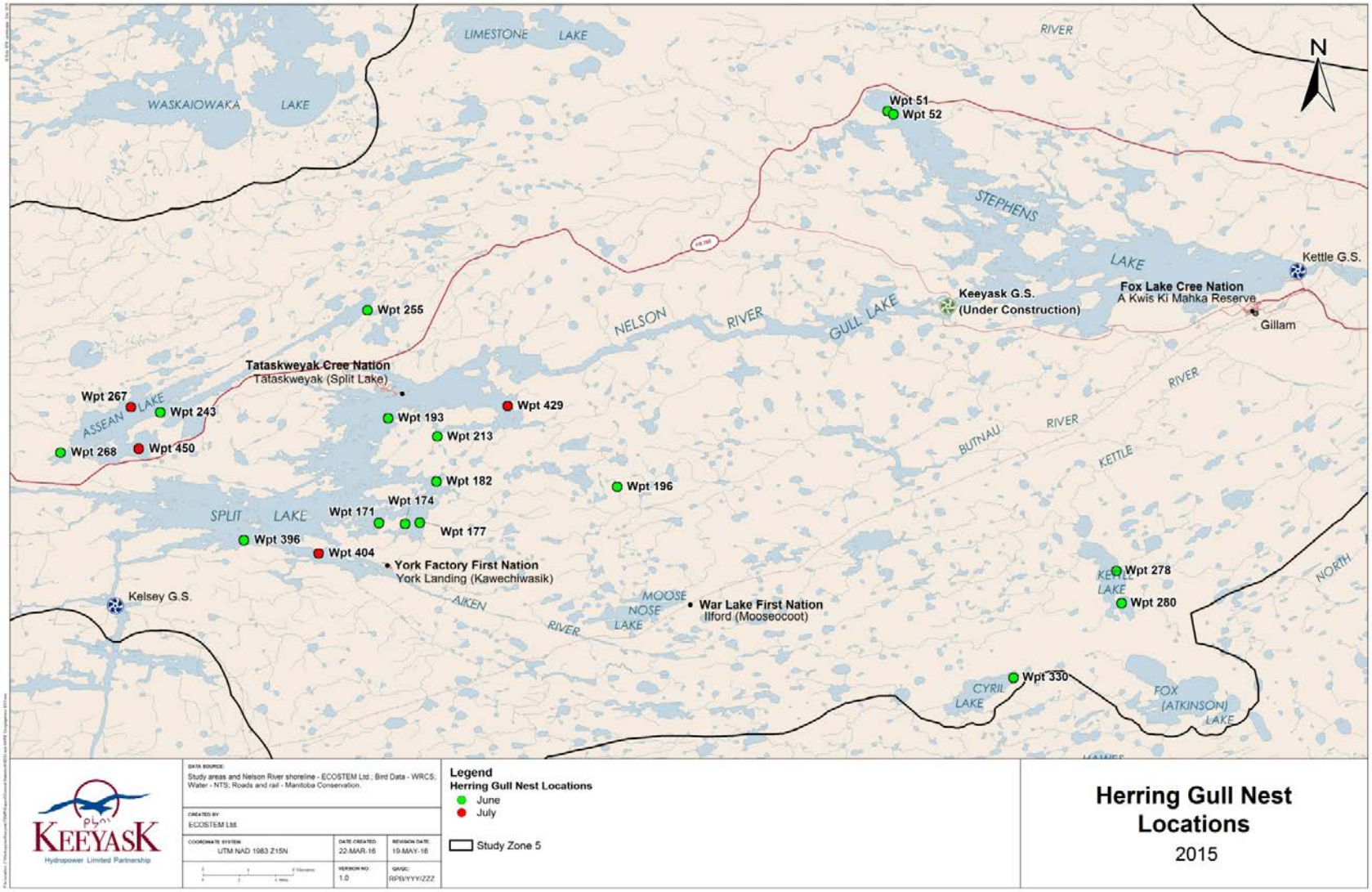
Table 3-6. Habitat Classifications Of Common Tern Congregation/Colony Sites In 2015.

Waypoint	Waterbody Class Size (ha)	System	Waterbody Type	Island Size Class (ha)
12*	>1000	On System	River	<0.1
40	>1000	On System	River	<0.1
51	>1000	On System	River	0.1 - 0.9
80*	>1000	On System	River	0.1 - 0.9
83*	>1000	On System	River	0.1 - 0.9
114	>1000	On System	River	0.1 - 0.9
122	>1000	On System	Lake	<0.1
135	>1000	On System	Lake	<0.1
153*	100-1000	Off System	Lake	<0.1
164	>1000	On System	Lake	<0.1
169	>1000	On System	Lake	<0.1
171	>1000	On System	Lake	0.1 - 0.9
193	>1000	On System	Lake	0.1 - 0.9
205	>1000	On System	Lake	0.1 - 0.9
224	>1000	On System	Lake	0.1 - 0.9
225	>1000	On System	Lake	0.1 - 0.9
226	>1000	On System	Lake	1.0 - 1.9
227	>1000	On System	River	<0.1
265	>1000	Off System	Lake	<0.1
282	>1000	Off System	Lake	0.1 - 0.9
357	>1000	Off System	Lake	<0.1
365*	>1000	Off System	Lake	<0.1
396	>1000	On System	River	0.1 - 0.9
430	>1000	On System	River	0.1 - 0.9
431	>1000	On System	River	<0.1

*Colony: Site contained nests or birds sitting tight on a likely nest.

2.2.3 HERRING GULL

During the 2015 breeding season, a total of 28 adult herring gulls (including dispersed gulls) were observed during the June helicopter survey whereas 22 were observed during the July helicopter survey (Table 3-2). Herring gulls were observed nesting at 20 sites in the survey area (Map 3-8; Table 3-7). A total of 24 adult herring gulls (not including dispersed gulls) were observed at 16 nest sites in June, and 14 herring gulls were observed at 11 nest sites in July (Table 3-7). In July, herring gulls were absent at nine of the sites previously occupied in June, and nests were established at three new sites (Table 3-7).



Map 3-8. Herring Gull Nest Observations In 2015.

Table 3-7. Herring Gull Nest Sites During The 2015 Aerial Surveys.

	June					July					
Waypoint	# Unoccupied nests	# Occupied nests	# Birds sitting tight (likely nest)	# Birds standing, swimming, or flying	# Adults	# Unoccupied nests	# Occupied nests	# Birds sitting tight (likely nest)	# Birds standing, swimming, or flying	# Adults	# Young
51*	0	1	0	0	1	1	0	0	0	1	0
52	0	1	0	0	1	0	0	0	0	0	0
171‡	0	1	0	0	1	0	0	0	0	0	0
174	0	1	0	1	2	0	0	0	0	0	0
177	0	2	0	2	4	0	0	0	0	0	0
182	0	1	0	0	1	0	0	0	0	2	0
193*	0	1	0	0	1	0	0	0	0	0	0
196	0	1	0	0	1	0	0	0	0	0	0
213	1	1	0	1	2	0	0	0	0	0	0
243	0	1	0	0	1	0	0	0	0	0	0
255	0	1	0	0	1	1	0	0	1	1	0
267	0	0	0	0	0	0	1	0	0	2	0
268†	0	1	0	1	2	0	0	0	0	0	0
278	0	1	0	1	2	0	1	0	0	1	0
280	0	1	0	2	3	0	1	0	0	1	0
330†	0	1	0	0	1	0	0	0	1	1	0
396*	-	-	-	-	-	0	0	0	2	2	2
404	-	-	-	-	-	1	0	0	1	1	0
429	-	-	-	-	-	0	0	0	1	1	1
450	-	-	-	-	-	1	0	0	1	1	2
Totals	1	16	0	8	24	4	3	0	7	14	5

*Site also contained common terns; †Site also contained ring-billed gulls; ‡Site also contained common terns and ring-billed gulls.

All sites where herring gulls nested contained a single nest except for one colony (Wpt 177) containing two active nests (Table 3-7). In one nest (Wpt 52), three eggs were visible (Appendix D; Photo D-25) though no young or adults were observed at this location in July. In July, two hatch-year herring gulls (Appendix D; Photo D-26) were observed at two sites and one hatch-year herring gull was observed at a third site (Table 3-7).

Herring gulls nested at one site with ring-billed gulls, two sites with terns, and one site with ring-billed gulls and terns (Table 3-8). Other colonial waterbird species were absent from the remaining 14 herring gull nest sites (Table 3-8). Evidence of other waterbird species nesting at the same sites as herring gulls was only observed at one of the colonies where 83 ring-billed gulls and 20 terns were observed (Table 3-8). Additional photographs of herring gull nest sites are available in Appendix D (Appendix D; Photos D-21 to D27).

In 2015, herring gull nest sites were positioned at the highest point of rocky islands or at the top of the largest boulder (Appendix D; Photo D-27). Herring gull nest sites were distributed in lakes (Stephens Lake, Split Lake, Assean Lake, Kettle Lake, and Cyril Lake) greater than 1,000 ha in size (Table 3-8; Map 3-8). Thirteen herring gull nest sites were on the Nelson River system whereas seven were off-system (Table 3-8). Eleven sites where herring gull nested were below 0.1 ha in size, and the remaining nine sites were between 0.1 and 0.9 ha in size (Table 3-8).

2.2.4 BONAPARTE'S GULL

During the 2015 breeding season, a total of 163 adult Bonaparte's gulls were observed during the June survey whereas 56 were observed in July (Table 3-2). Bonaparte's gulls were observed nesting at two colony sites in the survey area (Maps 3-9 and 3-10). One colony was comprised of four active nests, whereas two nests composed the second colony (Table 3-9). No hatch-year Bonaparte's gulls were observed during the surveys.

The Bonaparte's gull colony of four nests was located at a small unnamed lake 3.5 km northwest of Birthday Rapids while the colony comprised of two nests was located at Limestone Lake 43 km northwest of Gull Rapids (Maps 3-9 and 3-10).

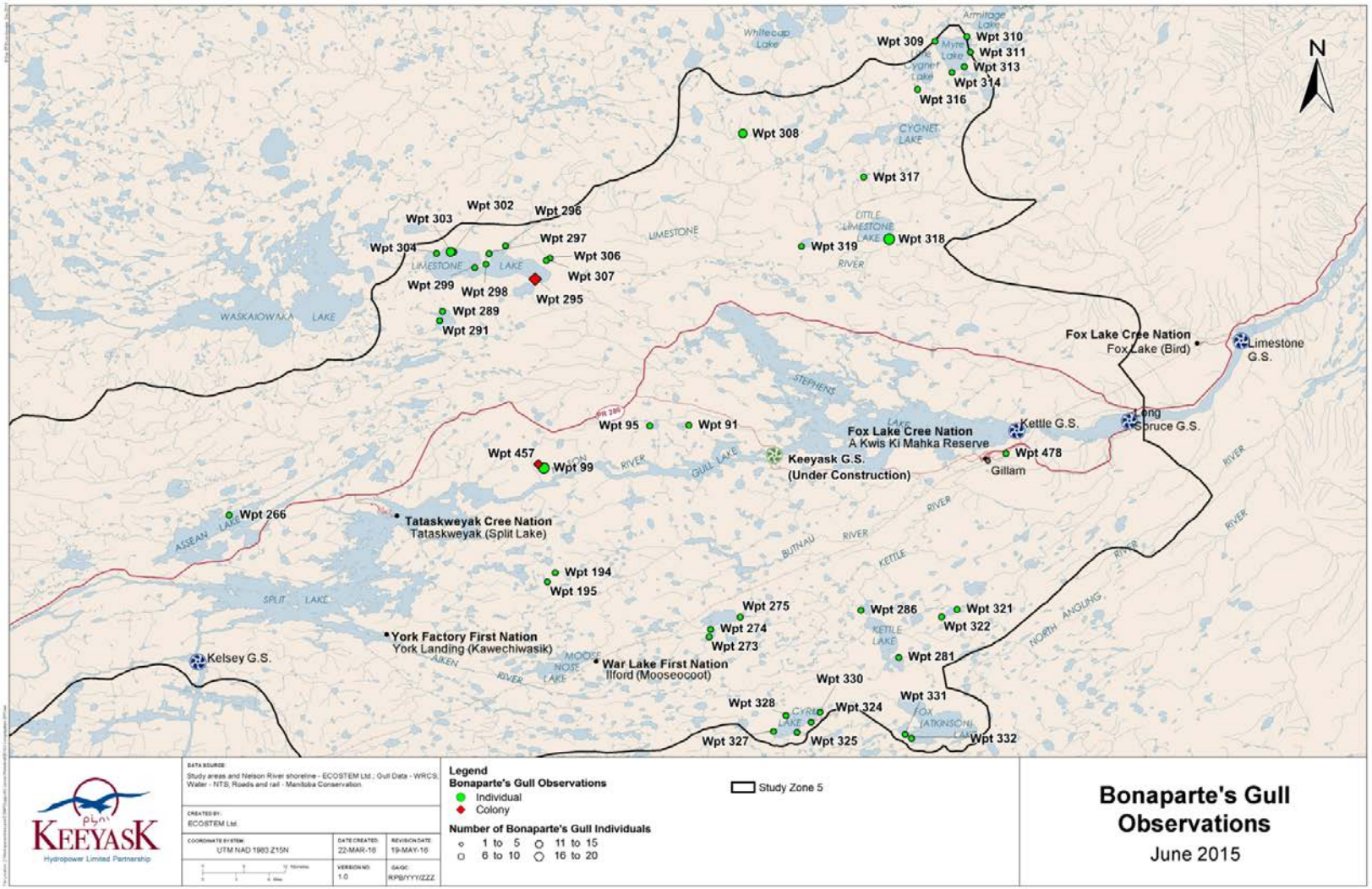
Although only two colonies were found, Bonaparte's gulls were observed at several locations in the survey area. However, this species was absent from the shorelines of Stephens Lake, Split Lake, Clark Lake, and at surveyed rivers and creeks (Maps 3-9 and 3-10). In June, a total of 39 Bonaparte's gulls were observed at Limestone lake, 14 were observed at Myre Lake, 15 at Little Limestone Lake, and nine at Cyril Lake (Table 3-9) suggesting a colony site may have been active earlier in the breeding season at these lakes. Smaller colonies may be located at Atkinson Lake, Kettle Lake, Little Kettle Lake, and some small unnamed lakes (Table 3-9).

All Bonaparte's gull nests observed during the survey were positioned at the top of spruce trees within a few metres of waterbodies (Photo 3-3).

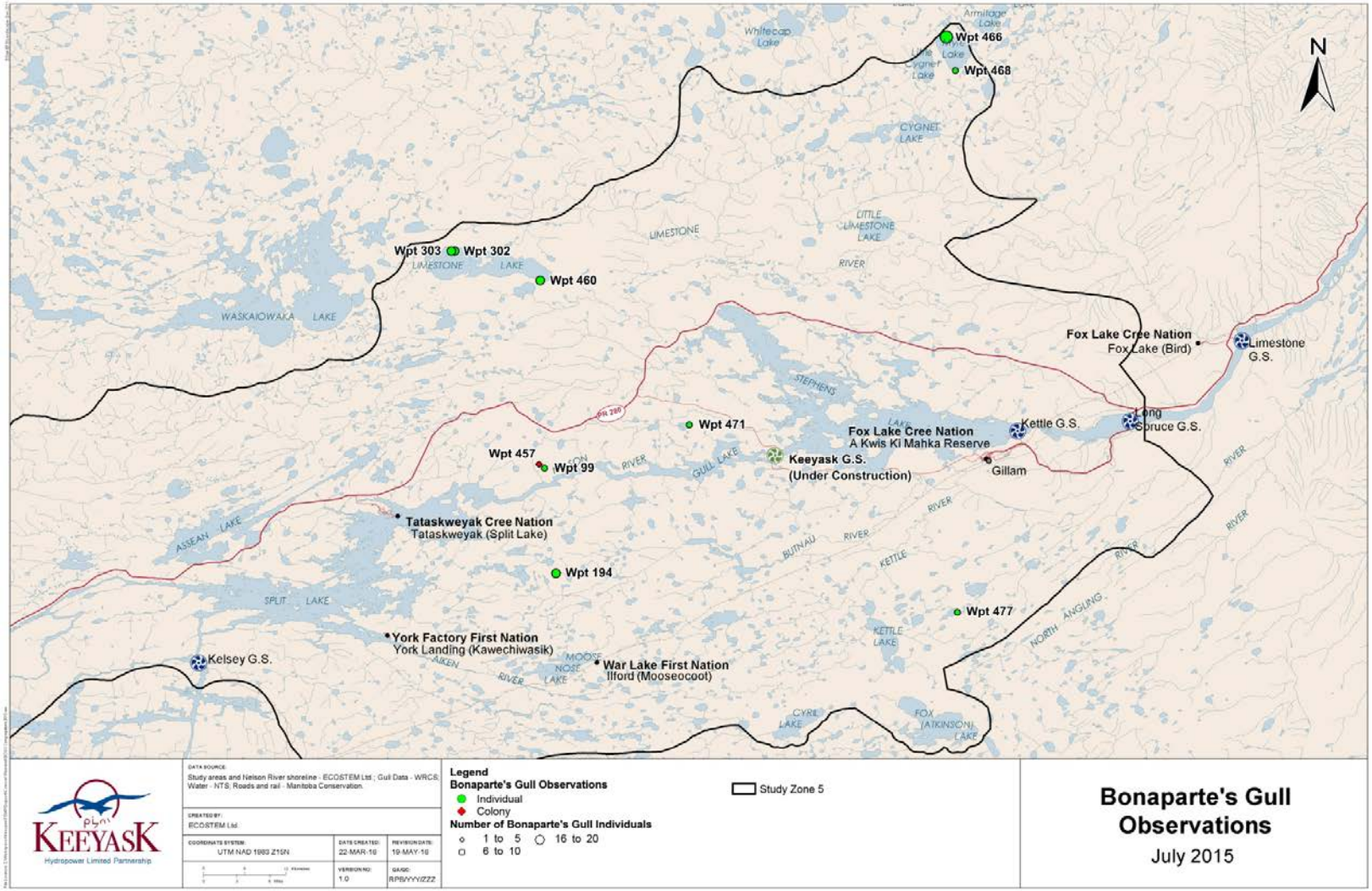
Table 3-8. Habitat Classifications Of Herring Gull Nest Sites In 2015.

Waypoint	Waterbody Class Size (ha)	System	Waterbody Type	Island Size Class (ha)
51*	>1000	On System	River	0.1 - 0.9
52	>1000	On System	River	<0.1
171‡	>1000	On System	Lake	0.1 - 0.9
174	>1000	On System	Lake	<0.1
177	>1000	On System	Lake	0.1 - 0.9
182	>1000	On System	Lake	<0.1
193*	>1000	On System	Lake	0.1 - 0.9
196	>1000	On System	Lake	<0.1
213	10-100	Off System	Lake	<0.1
243	>1000	On System	River	0.1 - 0.9
255	>1000	On System	Lake	<0.1
267	>1000	Off System	Lake	<0.1
268†	>1000	Off System	Lake	<0.1
278	>1000	Off System	Lake	<0.1
280	>1000	Off System	Lake	<0.1
330†	>1000	Off System	Lake	0.1 - 0.9
396*	>1000	On System	River	0.1 - 0.9
404	>1000	Off System	River	<0.1
429	>1000	On System	River	0.1-0.9
450	>1000	On System	Lake	0.1-0.9

* Site contained common terns; † Site contained ring-billed gulls; ‡ Site contained common terns and ring-billed gulls.



Map 3-9. Bonaparte's Gull Observations In June 2015.



Map 3-10. Bonaparte's Gull Observations In July 2015.

Table 3-9. Bonaparte's Gull Observations During The 2015 Aerial Surveys.

		June		July	
Waypoint	**Waterbody**	**# Nests**	**# Adults**	**# Nests**	**# Adults**
266	Assean Lake	0	1	0	0
331	Atkinson Lake	0	3	0	0
332	Atkinson Lake	0	4	0	2
324	Cyril Lake	0	2	0	8
325	Cyril Lake	0	1	0	0
327	Cyril Lake	0	2	0	0
328	Cyril Lake	0	2	0	0
330	Cyril Lake	0	2	0	0
281	Kettle Lake	0	2	0	0
286	Kettle Lake	0	4	0	0
478	Landing Lake	0	4	0	0
295	Limestone Lake	2	18	0	0
296	Limestone Lake	0	3	0	0
297	Limestone Lake	0	3	0	0
298	Limestone Lake	0	1	0	0
299	Limestone Lake	0	1	0	0
300	Limestone Lake	0	0	0	0
302	Limestone Lake	0	5	0	0
303	Limestone Lake	0	7	0	0
304	Limestone Lake	0	1	0	8
460	Limestone Lake	-	-	0	7
273	Little Kettle Lake	0	3	0	0
274	Little Kettle Lake	0	3	0	0
275	Little Kettle Lake	0	2	0	0
318	Little Limestone Lake	0	15	0	0
309	Myre Lake	0	1	0	0
310	Myre Lake	0	1	0	0
311	Myre Lake	0	2	0	0
313	Myre Lake	0	5	0	0
314	Myre Lake	0	5	0	0
466	Myre Lake	-	-	0	0
467	Myre Lake	-	-	0	0
468	Myre Lake	-	-	0	0
308	Small unnamed pond	0	6	0	0
316	Small unnamed pond	0	5	0	0
99	Small unnamed lake	0	11	0	0
194	Small unnamed lake	0	4	0	0
195	Small unnamed lake	0	2	0	0

		June		July	
Waypoint	**Waterbody**	**# Nests**	**# Adults**	**# Nests**	**# Adults**
289	Small unnamed lake	0	2	0	0
291	Small unnamed lake	0	2	0	0
306	Small unnamed lake	0	2	0	0
307	Small unnamed lake	0	2	0	0
317	Small unnamed lake	0	3	0	0
319	Small unnamed lake	0	4	0	2
321	Small unnamed lake	0	2	0	6
322	Small unnamed lake	0	3	0	19
457	Small unnamed lake	4	8	0	0
471	Small unnamed lake	-	-	0	2
477	Small unnamed lake	-	-	0	1
91	Stephens Lake	0	1	0	1
95	Stephens Lake	0	3	0	0
Total		6	163	0	56

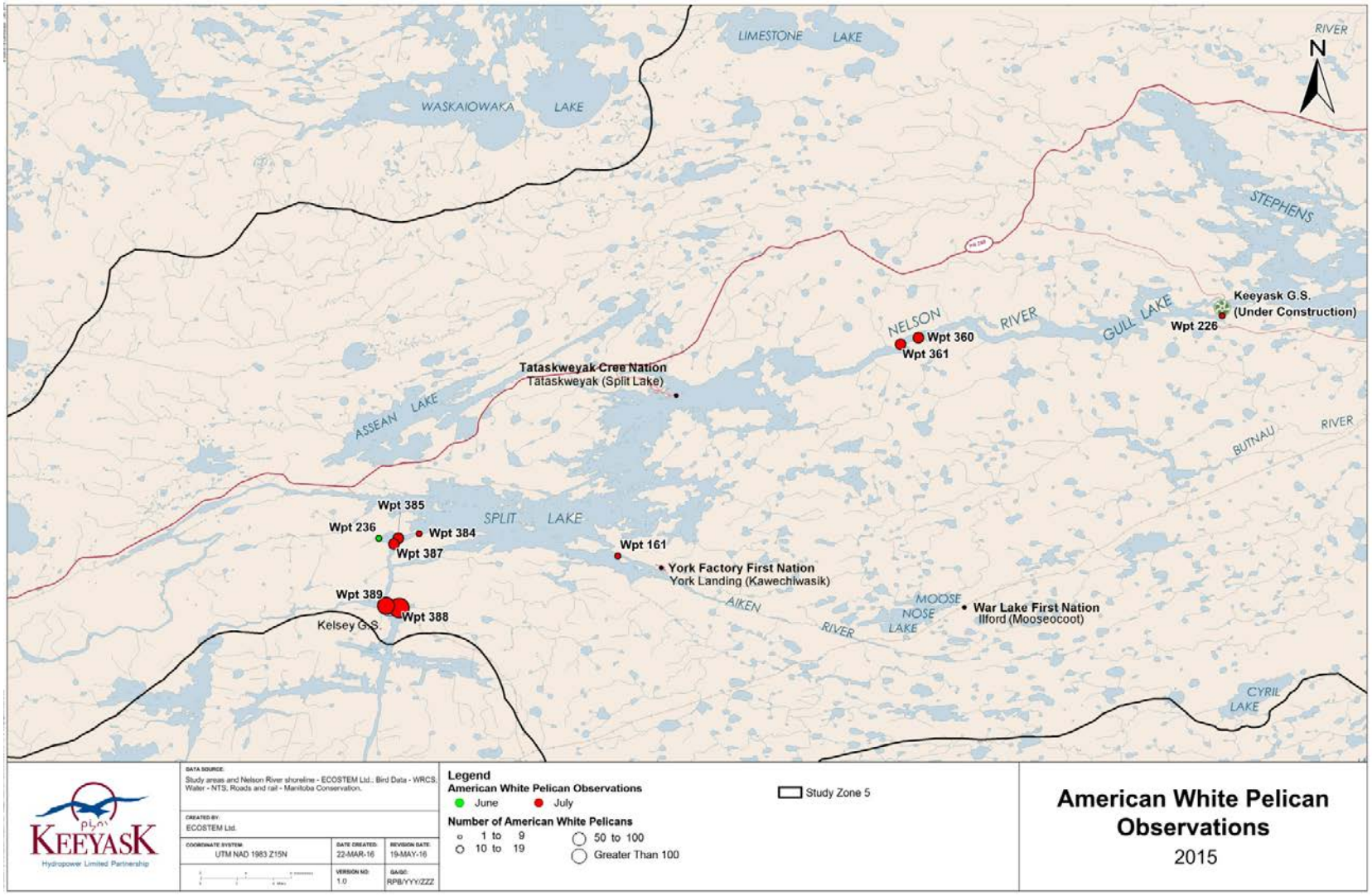
Photo 3-2. Inactive Bonaparte's Gull Nest On Top Of A Black Spruce Tree.

2.2.5 AMERICAN WHITE PELICAN

During the 2015 aerial surveys, one American white pelican was observed in June and 228 were observed in July (Tables 3-2 and 3-10). No evidence of pelicans breeding in the study area was observed. All pelicans observed in July were floating on the water surface in flocks of two to 120 individuals. The largest flocks of pelicans were observed incidentally scavenging at the tailrace of the Kelsey Generating Station (GS) (Map 3-11). Along the survey route, two flocks of 11 pelicans were observed foraging at Birthday Rapids, one flock of six was observed near York Landing, 28 pelicans in four flocks were observed 8 km north of the Kelsey GS on Split Lake, and two pelicans were observed swimming near ring-billed gull colonies in Gull Rapids (Map 3-11).

Table 3-10. American White Pelican Observations During The 2015 Aerial Surveys.

		June	July
Wpt	**Location**	**# Adults**	**# Adults**
236	8 km north of Kelsey GS	1	-
384	8 km north of Kelsey GS	-	3
385	8 km north of Kelsey GS	-	14
387	8 km north of Kelsey GS	-	11
388	Kelsey GS Tailrace	-	120
389	Kelsey GS Tailrace	-	50
226	Gull Rapids	-	2
360	Birthday Rapids	-	11
361	Birthday Rapids	-	11
161	York Landing	-	6
Total		1	228



Map 3-11. American White Pelican Observations In 2015.

3.0 SUMMARY AND CONCLUSIONS

Monitoring activities conducted during the 2015 breeding season provide important information regarding colonial waterbird abundance, distribution and breeding habitats in the Keeyask Region (Study Zone 5). This baseline information was collected to evaluate the effects of Project construction and outcomes of future mitigation measures applied to colonial waterbirds, and specifically, to ring-billed gulls and common terns.

Islands in the north and central channels of Gull Rapids that were formerly used by nesting gulls and terns (Stantec 2014) are no longer available as nesting habitat due to Project construction. In order to keep gulls and terns out of active construction areas, bird control including the use of falconry, kites, drones, pyrotechnics and egg/nest removal was undertaken. The bird control work was permitted under the Environment Canada Damage or Danger Permits 15-MB-28 and 15-MB-31. Helicopter-based surveys, UAV photography, and site observations confirmed that most colonial waterbirds did not nest within the active construction area, but rather congregated on islands in the south channel of Gull Rapids, and potentially, elsewhere in Study Zone 5. Bird control measures and construction noise, likely encouraged some gulls and terns to avoid the area (Thiériot *et al*. 2015; Barber *et al*. 2010) and find suitable alternate habitats elsewhere in the region (Cuthbert *et al.* 2003).

Gulls and terns were observed congregating at and/or colonising several islands upstream and downstream of Gull Rapids. In some cases, gulls and terns congregated at sites where they have not been observed in previous years. However, large numbers of ring-billed gulls congregating on islands in Split Lake suggests that ring-billed gulls attempted to colonise other sites after being discouraged from nesting on historically used islands and reefs. Ring-billed gulls congregated at several islands in the Nelson River and in Split Lake upstream of Gull Rapids and at off-system lakes south of the Nelson River. Islands where ring-billed gulls congregated in Split Lake appeared to provide similar rocky habitats as islands in Gull Rapids. However, many of these islands appeared to have low elevation profiles and may have been subjected to wave action and water inundation during storms, which increases the risk of nest failure. Potential colony failures due to flooding on reefs and islands in areas outside Gull Rapids, possibly explains why sites occupied in June were not occupied in July, and subsequently, a possible reason why the ring-billed gull and tern population at Gull Rapids increased. The assembly of gulls at previously established large colonies in Gull Rapids observed in July was likely facilitated by social attraction (Evans and Welham 1985; Burger and Gochfield 1991). The presence of many gulls and terns at Gull Rapids indicated to other gulls and terns that the area provides suitable habitat and ample food resources, thus increasing the population at this location at the end of the nesting season in July.

The ring-billed gull and common tern population at Gull Rapids remained within the range of populations estimated in previous years. Gull Rapids also continued to be the area where gulls were most abundant with 54% and 77% of all congregated adult ring-billed gulls along the survey route observed during the June and July helicopter surveys, respectively. During the

June helicopter survey, the peak incubation period when gulls and terns are concentrated in nesting areas (Pollet *et al.* 2012; Nisbet 2002), 1,673 ring-billed gulls were counted at Gull Rapids. For gulls, the population estimated from the helicopter in June 2015 was lower than the 6,200 ($^{\pm}$1000) gulls (ring-billed and herring gulls combined) estimated at Gull Rapids in June 2014 (Stantec 2015) but was within the range of 1,600-3,000 gulls estimated in previous years (2001-2013; KHLP 2012). The population of ring-billed gulls estimated from the helicopter at Gull Rapids increased to 2,647 in July while the total population of all other areas combined decreased.

Gull populations estimated from UAV photography produced similar estimates of 1,210 gulls at Gull Rapids in early June and 1,792 in late June 2015. In late July, however, the number of gulls estimated from UAV photography increased to 4,987. This is most likely indicative of the natural variability in the number of gulls present at a congregation site at any given time. Aerial photographs taken at midday are expected to underestimate ring-billed gull populations as numbers of ring-billed gulls at colonies fluctuate daily with peak numbers in early morning and late afternoon, with a low at midday (Conover and Miller 1980). As the helicopter survey was conducted before noon and the UAV survey was conducted in the afternoon, differences in the number of gulls could have been related to the time of day that the two respective methods were employed. More gulls were likely present in the afternoon causing elevated population estimates in UAV photography based estimates. Because the islands were photographed in a short time frame in one afternoon, it is unlikely that gulls moved among islands. As such, the best subpopulation estimate for the gull colonies at Gull Rapids is 4,987 individuals, which is similar to the Stantec (2015) estimate of 6,200 ($^{\pm}$1000) gulls (ring-billed and herring gulls combined) in June 2014.

The common tern population at Gull Rapids during the June helicopter survey was similar to the range of population estimates from helicopter based photography in previous years. The number of terns at Gull Rapids estimated during helicopter surveys increased from 23 in 2014 (Stantec 2015) to 81 in June 2015, and approached the range of 100-200 terns estimated in previous years (2001-2013; KHLP 2012). Populations estimated from UAV photography produced a similar estimate of 61 terns at Gull Rapids in early June and 60 in Late June 2015. Unlike previous years, Gull Rapids was not the area with the highest abundance of terns with 18% and 40% of all congregated terns estimated along the survey route during the June and July helicopter surveys, respectively.

Although the helicopter-based tern population estimate in the south channel of Gull Rapids declined from 40 in June to none in July, a small rocky island (Wpt. 83) nearby experienced an increase from 41 terns in June to 230 in July. Terns attempting to inhabit islands in the south channel of Gull Rapids would have faced intense competition from the many ring-billed gulls that had already established colonies on these islands (Cuthbert and Timmerman 2001), thus may have caused these birds to join the nearest tern colony at the nearby island. Although 25 ring-billed gulls were observed at this island in June they appear to have moved to other areas leaving 29 terns sitting tight on a likely nest along with 201 terns that were observed standing or flying at this island in July.

Few nests or young were observed during both the helicopter and UAV surveys. From helicopter based photographs, over 500 gull nests (unoccupied nests + occupied nests + adults sitting tight on a likely nest) were counted on islands within two km of Gull Rapids in June. This number declined on islands in Gull Rapids to 29 gull nests (adults sitting tight on a likely nest) in July when 40 hatch-year gulls were counted. However, adults sitting tight may not have been sitting on a nest. If correct, and the number of birds sitting tight did not represent actual nesting birds, then the total number of nests (unoccupied nests + occupied nests) in Gull Rapids would be 213 in June and none in July. Similarly, 81 gull nests and 10 hatch-year gulls were counted in UAV photographs of islands in Gull Rapids in June and 42 hatch-year gulls were counted in July. No tern nests or hatch-year gulls were observed in photographs of islands in Gull Rapids from either survey method. Cryptic gull and tern fledglings are smaller than adults and have mottled brown plumage that provides excellent camouflage from predators. Because they are well camouflaged and seek out cover if disturbed, their numbers are may be underestimated in aerial and UAV photographs.

Recommendations to improve colonial waterbird population and nest counts in 2016 include:

- Survey islands at Gull Rapids twice in one day, including mid-day and in the evening;
- Switch UAV photography to oblique angles rather than vertical to improve sightability of nests and young; and
- Employ a slower moving UAV (*i.e.,* quad helicopter UAV) to improve sightability of nests and young.

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APPENDIX A: Gull Rapids UAV Mission Breakdown

Unmanned Aerial Imaging Solutions (UAIS) uses unmanned aerial vehicles (UAV's) which are controlled by remote control, computer software, or a combination of both. The type of UAV that UAIS uses is a Mini Talon X-UAV foam body and all other electrical components are either custom made or custom selected by UAIS. Using computer software (Mission Planner), the UAV operator creates a grid over a predetermined area and defines the speeds at which the UAV will fly, the altitude the UAV will fly, and boundaries that the UAV is not to penetrate (both horizontally and vertically). Once the flight plan is created, camera parameters specific to the onboard camera, are entered into the computer software and a grid pattern is created based on camera capability and desired image overlap and side-lap.

Launching of the UAV is accomplished using a "hand launch" technique. The UAV operator will hold the UAV in one hand, and the UAV remote control in the other hand. The UAV operator will then apply full power on the remote control and launch the UAV into the air. Due to the auto stabilize function of the UAV, the UAV will maintain level flight until the UAV operator takes control using either the computer software or the remote control. Launch of the UAV is done in a relatively clear area for this purpose. Once the UAV operator takes control of the UAV, the flight plan is then initiated and the UAV is monitored using line of sight with secondary reference to UAV telemetry displayed on the computer screen. If at any time the UAV operator need to terminate the flight plan, a "Return to Home" function immediate brings the UAV back to the mission launch location with no other required input from the UAV operator.

The landing site for the UAV requires a relatively clear, flat, and open area. The UAV operator will fly the UAV using the remote control into the approach phase, slowing the UAV down to landing speed and reducing the UAV's altitude in a controlled manner. The UAV is landed on its foam belly and requires approximately 15-30 feet of landing distance to come to a complete stop. The data is then downloaded from the UAV's onboard memory and the camera memory card on to a computer and the data is then processed.

Data processing involves using the Mission Planner software to take the images and place "geo-referencing" meta data into the images. Third party software is then used to arrange the images in a sequential order and then another piece of third party software is used to "stitch" the images together into one large image. The final product is then delivered to the client.

Keeyask Mission 1 (June 4th – June 6th)

Flight 1 took place Thursday, June 4th at 1042 local time (Table 1). The proposed mission area was Mission 5. The sky condition was partly cloudy and the winds were light (less than 5 knots or 10 km/hr). The most suitable take-off and landing site was located in the center of E6 (see Photo 1). Total flight time was 28 minutes from take-off to landing. The UAV captured 313 images of the proposed mission area successfully during the 28 minute flight. All phases of flight were uneventful.

Table A-1. Mission 1 (June 4th – June 6th, 2015)

Flight	Mission, area flown	Date/Time	T/O and Landing	Weather	Flight Time	Notes
1	5	Jun 4/1042	Center of E6	Partly Cloudy, Light winds	28 mins	
2	3	Jun 4/1412	North C10	Clear, Light winds	45 mins	
3	2	Jun 4/1540	North C10	Clear, Light winds	32 mins	
4	7	Jun 5/1649	SE Corner of G10	Partly Cloudy, Light winds	30 mins	Heli required
5	6a	Jun 5/1748	SE Corner of G10	Partly Cloudy, Light winds	28 mins	Heli required
6	6b	Jun 5/1830	SE Corner of G10	Partly Cloudy, Light winds	30 mins	Heli required
7	1a	Jun 6/0537	NW Corner of C6	Clear, Light winds	27 mins	
8	1b	Jun 6/0634	NW Corner of C6	Clear, Turbulent	42 mins	
9	1a island	Jun 6/0717	NW Corner of C6	Clear, moderate winds	21 mins	
10	1c	Jun 6/0812	NW Corner of C6	Clear, turbulent	30 mins	Day called due to wind and turbulence

Flight 2 took place Thursday, June 4th at 1412 local time (Table 1). The proposed mission area was Mission 3. The sky condition was clear and the winds were light. The most suitable take-off and landing site was located in the northern section of C10. Total flight time was 45 minutes from take-off to landing. The UAV captured 326 images of the proposed mission area successfully during the 45 minute flight. All phases of flight were uneventful.

Flight 3 took place Thursday, June 4th at 1540 local time (Table 1). The proposed mission area was Mission 2. The sky condition was clear and the winds were light. The most suitable take-off and landing site was located in the northern section of C10. Total flight time was 32 minutes from take-off to landing. The UAV captured 330 images of the proposed mission area successfully during the 32 minute flight. The take-off and enroute portions of the flight were uneventful. The UAV sustained minor damage to the foam belly of the UAV on landing which was repaired in the evening of Thursday June 4th.

Flight 4 took place Friday, June 5th at 1649 local time (Table 1). The proposed mission area was Mission 7. The sky condition was partly cloudy and the winds were light. The most suitable take-off and landing site was located in the south east corner of G10. Use of a manned

helicopter was required to transport the UAV, equipment, and personnel to the mission area. Total flight time was 30 minutes from take-off to landing. The UAV captured 312 images of the proposed mission area successfully during the 30 minute flight. All phases of flight were uneventful.

Flight 5 took place Friday, June 5th at 1748 local time (Table 1). The proposed mission area was Mission 6a. The sky condition was partly cloudy and the winds were light. The most suitable take-off and landing site was located in the southeast corner of G10. Use of a manned helicopter was required to transport the UAV, equipment, and personnel to the mission area. Total flight time was 28 minutes from take-off to landing. The UAV captured 316 images of the proposed mission area successfully during the 28 minute flight. All phases of flight were uneventful.

Flight 6 took place Friday, June 5th at 1830 local time (Table 1). The proposed mission area was Mission 6b. The sky condition was partly cloudy and the winds were light. The most suitable take-off and landing site was located in the southeast corner of G10. Use of a manned helicopter was required to transport the UAV, equipment, and personnel to the mission area. Total flight time was 30 minutes from take-off to landing. The UAV captured 298 images of the proposed mission area successfully during the 28 minute flight. All phases of flight were uneventful.

Flight 7 took place Saturday, June 6th at 0537 local time (Table 1). The proposed mission area was Mission 1a. The sky condition was clear and the winds were light. The most suitable take-off and landing site was located in the northwest corner of C6. Total flight time was 27 minutes from take-off to landing. The UAV captured 295 images of the proposed mission area successfully during the 27 minute flight. All phases of flight were uneventful.

Flight 8 took place Saturday, June 6th at 0634 local time (Table 1). The proposed mission area was Mission 1b. The sky condition was clear and the winds were moderate (5-10 knots or 10-20 kph). The most suitable take-off and landing site was located in the northwest corner of C6. Total flight time was 42 minutes from take-off to landing. The UAV captured 367 images of the proposed mission area successfully during the 42 minute flight. All phases of flight were uneventful.

Flight 9 took place Saturday, June 6th at 0717 local time (Table 1). The proposed mission area was Mission 1a island. The sky condition was clear and the winds were moderate. The most suitable take-off and landing site was located in the northwest corner of C6. Total flight time was 21 minutes from take-off to landing. The UAV captured 266 images of the proposed mission area successfully during the 21 minute flight. All phases of flight were uneventful.

Flight 10 took place Saturday, June 6th at 0812 local time (Table 1). The proposed mission area was Mission 1c. The sky condition was clear and the winds were moderate. The most suitable take-off and landing site was located in the northwest corner of C6. Total flight time was 30 minutes from take-off to landing. The UAV captured 288 images of the proposed mission area successfully during the 30 minute flight. All phases of flight were uneventful.

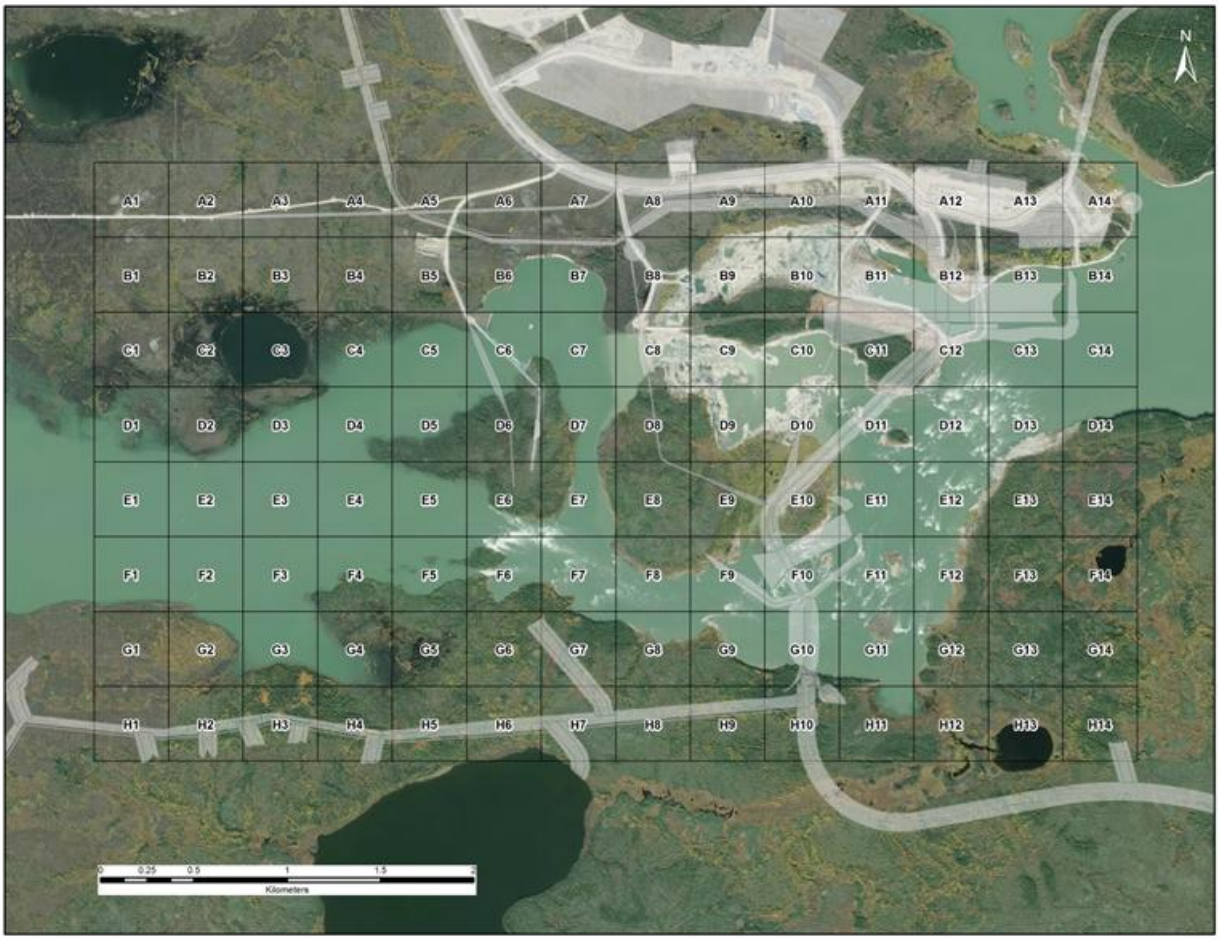

Photo A-1. Gull Rapids UAV Survey Grid, 2015

Keeyask Mission 2 (June 25th – June 28th)

Flight 1 took place Thursday, June 25th at 0850 local time (Table 2). The proposed mission area was Mission 1a. The sky condition was clear and the winds were light. The most suitable take-off and landing site was located in the northwest corner of C6. Total flight time was 31 minutes from take-off to landing. The first attempt at the mission was aborted due to helicopter traffic. A second attempt was made and the UAV captured 272 images of the proposed mission area successfully during the 31 minute flight. All phases of the second attempted flight were uneventful.

Flight 2 took place Thursday, June 25th at 0947 local time (Table 2). The proposed mission area was Mission 5. The sky condition was clear and the winds were light. The most suitable take-off and landing site was located in the center of E6. Total flight time was 41 minutes from take-off to landing. The UAV captured 318 images of the proposed mission area successfully during the 41 minute flight. All phases of flight were uneventful.

Flight 3 took place Thursday, June 25th at 1306 local time (Table 2). The proposed mission area was Mission 5. The sky condition was clear and the winds were light. The most suitable take-off and landing site was located in the center of E6. Total flight time was 41 minutes from take-off to landing. The UAV captured 318 images of the proposed mission area successfully during the 41 minute flight. All phases of flight were uneventful.

Table A-2. Mission 2 (June 25th – June 29th, 2015)

Flight	Mission area flown	Date/Time	T/O and Landing	Weather	Flight Time (mins)	Notes
1	1a	Jun 25/0850	NW Corner of C6	Clear, Light winds	31	First attempt aborted to due helicopter traffic
2	5	Jun 25/0947	Center of E6	Clear, Light winds	41	Long break after flight to take haul road course
3	5b	Jun 25/1306	Center of E6	Clear, Light winds	41	
4	2	Jun 25/1448	North C10	Clear, Light winds	45	
5	3	Jun 25/1537	North C10	Clear, Light winds	46	
6	1bc	Jun 26/0955	NW Corner of C6	Overcast, rain in the early morning, Light winds	60	Rained after flight, no flights until 1700
7	PwrHouse Mid	Jun 26/1702	Center C11	Clear, Light winds	55	Two hour window due to shift change
8	PwrHouse West	Jun 26/1804	Center C11	Clear, Light winds	46	Two hour window due to shift change
9	4b	Jun 27/1405 And 1515	Center D11	Clear, Light winds	42 42	Two flights required, low quality images
10	7	Jun 27/1633	Center D11	Clear, Light winds	58	
11	6aandb	Jun 27/1714	Center D11	Clear, Light winds	55	Two hour window due to shift change
12	7 Extra (Nth of 7)	Jun 27/1820	Center D11	Clear, Light winds	29	

Flight 4 took place Thursday, June 25th at 1448 local time (Table 2). The proposed mission area was Mission 2. The sky condition was clear and the winds were light. The most suitable take-off and landing site was located in the north of C10. Total flight time was 45 minutes from take-off to landing. The UAV captured 326 images of the proposed mission area successfully during the 45 minute flight. All phases of flight were uneventful.

Flight 5 took place Thursday, June 25th at 1537 local time (Table 2). The proposed mission area was Mission 3. The sky condition was clear and the winds were light. The most suitable take-off and landing site was located in the north of C10. Total flight time was 46 minutes from take-off to landing. The UAV captured 334 images of the proposed mission area successfully during the 46 minute flight. All phases of flight were uneventful.

Flight 6 took place Friday, June 26th at 0955 local time (Table 2). The proposed mission area was Mission 1band1c. The sky condition was overcast with rain in the early morning and the winds were light. The most suitable take-off and landing site was located in the northwest corner of C6. Total flight time was 60 minutes from take-off to landing. The UAV captured 371 images of the proposed mission area successfully during the 60 minute flight. All phases of flight were uneventful.

Due to rain, no flights were conducted after flight 6 until roughly 1700 local time. There was a two hour window in which the UAV crew was able to fly the Powerhouse Mid and Powerhouse West missions.

Flight 7 took place Friday, June 26th at 1502 local time (Table 2). The proposed mission area was Powerhouse Mid. The sky condition was clear and the winds were light. The most suitable take-off and landing site was located in the center of C11. Total flight time was 55 minutes from take-off to landing. The UAV captured 352 images of the proposed mission area successfully during the 55 minute flight. All phases of flight were uneventful.

Flight 8 took place Friday, June 26th at 1804 local time (Table 2). The proposed mission area was Powerhouse West. The sky condition was clear and the winds were light. The most suitable take-off and landing site was located in the center of C11. Total flight time was 46 minutes from take-off to landing. The UAV captured 341 images of the proposed mission area successfully during the 46 minute flight. All phases of flight were uneventful.

Due to thunderstorms and rain from 0600 local time Saturday June 27th until 1400 local time, no missions were flown.

Flight 9 took place Saturday June 27th at 1405 local time (Table 2). The proposed mission area was Mission 4b. The sky condition was clear and the winds were light. The most suitable take-off and landing site was located in the center of D11. Total flight time was 42 minutes from take-off to landing. The UAV captured 335 images of the proposed mission area successfully during the 42 minute flight. The images from the flight were deemed to be unacceptable and a second mission was flown for Mission 4b. The same take-off and landing areas were used. The second mission took place at 1515 local time. Total flight time for the second attempt at Mission 4b was

42 minutes. The UAV captured 335 images of the proposed mission area successfully during the 42 minute flight. All phases of flight were uneventful.

Flight 10 took place Saturday June 27th at 1633 local time (Table 2). The proposed mission area was Mission 7. The sky condition was clear and the winds were light. The most suitable take-off and landing site was located in the center of D11. Total flight time was 58 minutes from take-off to landing. The UAV captured 361 images of the proposed mission area successfully during the 58 minute flight. All phases of flight were uneventful.

Flight 11 took place Saturday June 27th at 1714 local time (Table 2). The proposed mission area was Mission 6aand6b. The sky condition was clear and the winds were light. The most suitable take-off and landing site was located in the center of D11. Total flight time was 55 minutes from take-off to landing. The UAV captured 354 images of the proposed mission area successfully during the 55 minute flight. All phases of flight were uneventful.

Flight 12 took place Saturday June 27th at 1820 local time (Table 2). The proposed mission area was Extra Mission 7. The sky condition was clear and the winds were light. The most suitable take-off and landing site was located in the center of D11. Total flight time was 29 minutes from take-off to landing. The UAV captured 292 images of the proposed mission area successfully during the 29 minute flight. All phases of flight were uneventful.

Keeyask Mission 3 (July 27th – July 30th)

Flight 1 took place Monday, July 27th at 1432 local time (Table 3). The proposed mission area was Mission 13 North. The sky condition was partly cloudy and the winds were light. The most suitable take-off and landing site was located in the center of D11. Total flight time was 60 minutes from take-off to landing. The UAV captured 364 images of the proposed mission area successfully during the 60 minute flight. All phases of flight were uneventful.

Flight 2 took place Monday, July 27th at 1620 local time (Table 3). The proposed mission area was Mission 13 South. The sky condition was partly cloudy and the winds were light. The most suitable take-off and landing site was located in the center of D11. Total flight time was 64 minutes from take-off to landing. The UAV captured 377 images of the proposed mission area successfully during the 64 minute flight. All phases of flight were uneventful.

Flight 3 took place Monday, July 27th at 1724 local time (Table 3). The proposed mission area was Mission 17. The sky condition was partly cloudy and the winds were light. The most suitable take-off and landing site was located in the center of D11. Total flight time was 41 minutes from take-off to landing. The UAV captured 322 images of the proposed mission area successfully during the 41 minute flight. All phases of flight were uneventful.

Table A-3. Mission 3 (July 27th – July 30th, 2015)

Flight	Mission, area flown	Date/Time	T/O and Landing	Weather	Flight Time (mins)	Notes
1	13 North	Jul 27/1432	Center D11	Partly cloudy, Light winds	60	
2	13 South	Jul 27/1620	Center D11	Partly cloudy, Light winds	64	
3	17	Jul 27/1724	Center D11	Partly cloudy, Light winds	41	Two Hour window due to shift change
4	16	Jul 27/1814	Center D11	Partly cloudy, Light winds	44	Two Hour window due to shift change
5	15	Jul 27/1919	Center D11	Partly cloudy, Light winds	48	Two Hour window due to shift change
6	14	Jul 27/2019	Center D11	Partly cloudy, Light winds	55	
7	11	Jul 28/0930	Center D11	Partly cloudy, moderate wind	47	

Flight 4 took place Monday, July 27th at 1814 local time (Table 3). The proposed mission area was Mission 16. The sky condition was partly cloudy and the winds were light. The most suitable take-off and landing site was located in the center of D11. Total flight time was 44 minutes from take-off to landing. The UAV captured 330 images of the proposed mission area successfully during the 44 minute flight. All phases of flight were uneventful.

Flight 5 took place Monday, July 27th at 1919 local time (Table 3). The proposed mission area was Mission 15. The sky condition was partly cloudy and the winds were light. The most suitable take-off and landing site was located in the center of D11. Total flight time was 48 minutes from take-off to landing. The UAV captured 340 images of the proposed mission area successfully during the 48 minute flight. All phases of flight were uneventful.

Flight 6 took place Monday, July 27th at 2019 local time (Table 3). The proposed mission area was Mission 14. The sky condition was partly cloudy and the winds were light. The most suitable take-off and landing site was located in the center of D11. Total flight time was 55 minutes from take-off to landing. The UAV captured 35 images of the proposed mission area successfully during the 55 minute flight. All phases of flight were uneventful.

Flight 7 took place Tuesday, July 28th at 0930 local time (Table 3). The proposed mission area was Mission 11. The sky condition was partly cloudy and the winds were moderate. The most suitable take-off and landing site was located in the center of D11. Total flight time was 47 minutes from take-off to landing. The UAV captured 346 images of the proposed mission area successfully during the 47 minute flight. All phases of flight were uneventful.

Flight 8 took place Tuesday, July 28th at 1237 local time (Table 3). The proposed mission area was Mission 5. The sky condition was partly cloudy and the winds were moderate. The most suitable take-off and landing site was located in the center of C11. Total flight time was 41 minutes from take-off to landing. The UAV captured 328 images of the proposed mission area successfully during the 41 minute flight. All phases of flight were uneventful.

Table A-4. UAV Grid Squares Surveyed In 2015.

Grid Square	Surveyed (Yes or No)		
	June 4-6	June 25-29	July 27-30
A10	No	Yes	No
B6	Yes	Yes	No
B8	No	Yes	No
B9	No	Yes	No
B10	No	Yes	No
B11	No	Yes	No
C3	No	No	Yes
C6	Yes	Yes	Yes
C7	Yes	No	No
C8	Yes	Yes	No
C9	Yes	Yes	Yes
C10	Yes	Yes	No
C11	Yes	Yes	No
C12	Yes	Yes	Yes
D4	No	Yes	No
D5	No	Yes	No
D9	Yes	Yes	Yes
D10	Yes	Yes	No
D11	Yes	Yes	Yes
D12	Yes	No	No
E5	No	Yes	No
E6	Yes	Yes	No
E7	Yes	No	No
E10	No	Yes	No
E11	No	Yes	Yes
F9	No	Yes	No
F10	Yes	Yes	No
F11	Yes	Yes	Yes
F12	Yes	No	No
G11	Yes	Yes	Yes

APPENDIX B: Example of Marked-up Helicopter Based Photography

Photo B-1. Marked-up Photograph Of A Ring-billed Gull Colony (Wpt 227) In Gull Rapids In 2015.

APPENDIX C: Examples of UAV Based Photography

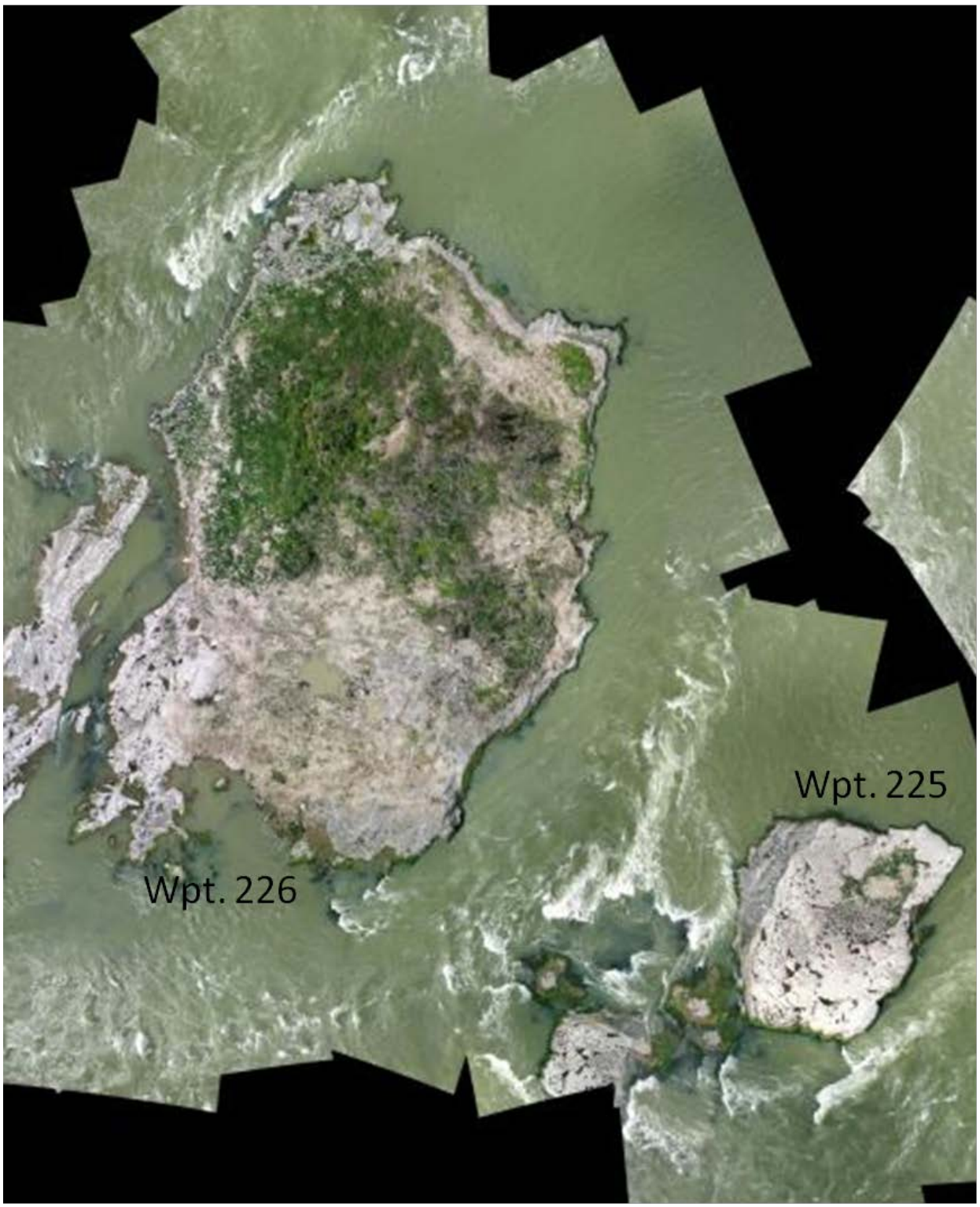

Photo C-1. UAV Based Stitched Images Of Islands (Wpts 225 and 226) In Gull Rapids on July 27, 2015.

Photo C-2. Zoomed-in UAV Based Stitched Images Of An Island (Wpt 225) In Gull Rapids on July 27, 2015.

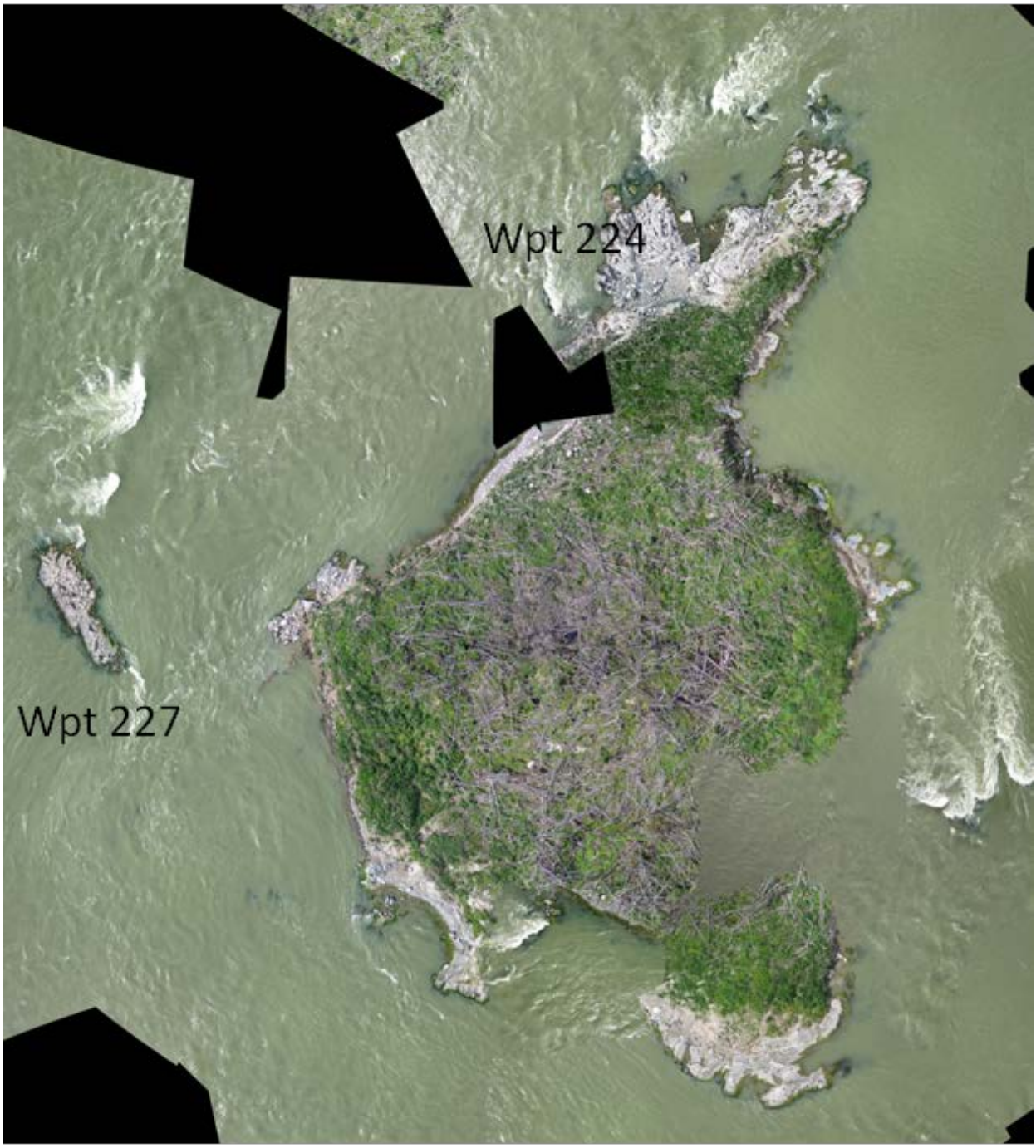

Photo C-3. UAV Based Stitched Images Of Islands (Wpts 224 and 227) In Gull Rapids On July 27, 2015.

Photo C-4. Zoomed-in UAV Based Image Of An Island (Wpt 227) In Gull Rapids on July 27, 2015.

Photo C-5. UAV Based Stitched Images Of Cofferdams And Dewatered Areas At Gull Rapids On July 28, 2015.

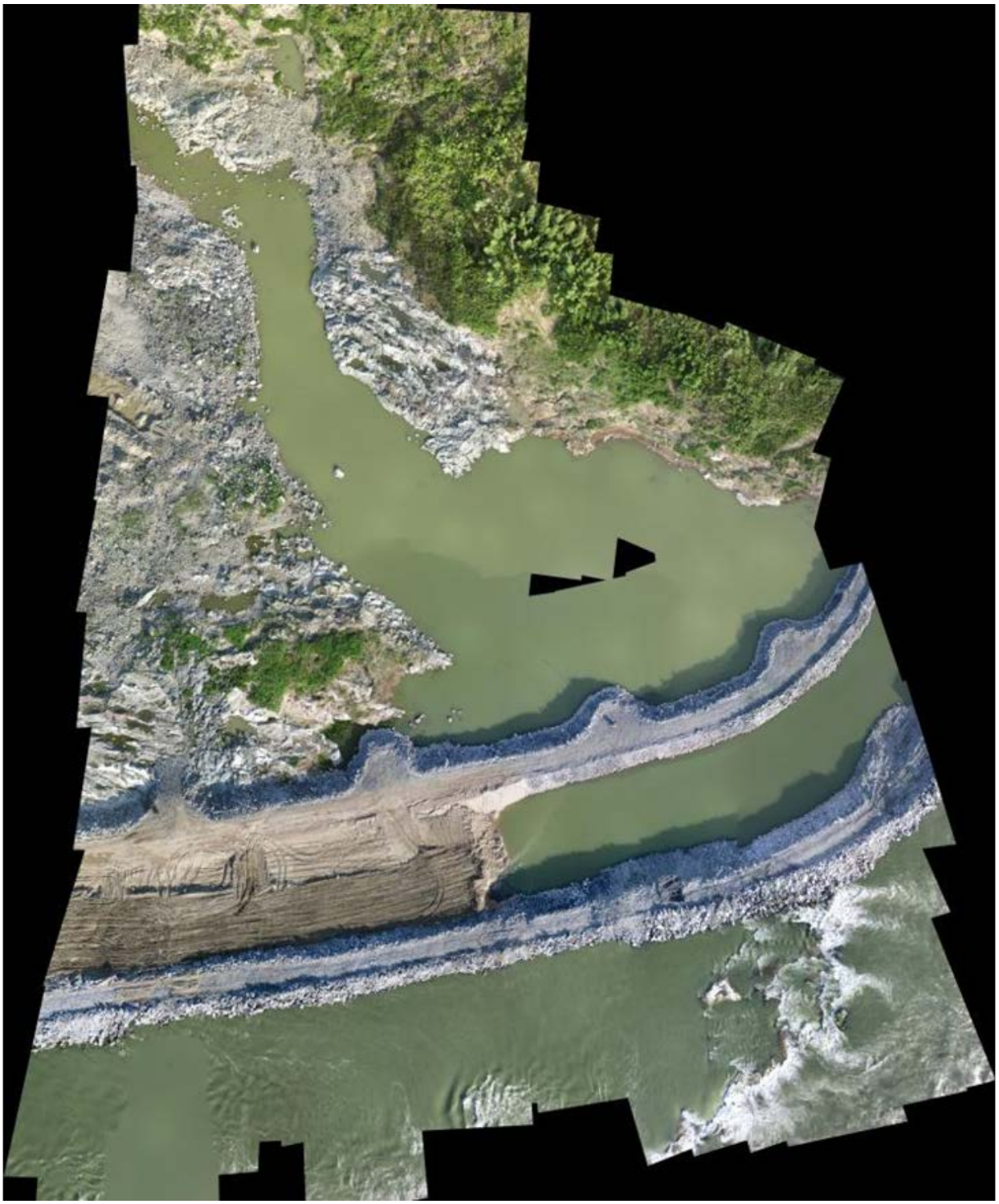

Photo C-6. UAV Based Stitched Images Of Cofferdams And Dewatered Areas At Gull Rapids On July 28, 2015.

Photo C-7. UAV Based Stitched Images Of Cofferdams And Dewatered Areas At Gull Rapids On July 28, 2015.

Photo C-8. UAV Based Stitched Images Of Islands (Wpt 83) Near Gull Rapids On June 25 2015.

Photo C-9. Zoomed-in UAV Based Image Of An Island (Wpt 83) Near Gull Rapids On June 25, 2015.

APPENDIX D: Photographs of Colonial Waterbird Congregation Sites

Photo D-1. Ring-billed Gull Colony Site At Wpt 225 In 2015.

Photo D-2. Ring-billed Gull Colony Site At Wpt 30 Near Kettle GS In 2015.

Photo D-3. Ring-billed Gull Colony Site At Wpt 81 In 2015.

Photo D-4. Common Tern Colony Site At Wpt 83 In 2015.

Photo D-5. Ring-billed Gull Colony Site At Wpt 114 In 2015.

Photo D-6. Ring-billed Gull Colony Site At Wpt 121 In 2015.

Photo D-7. Ring-billed Gull Colony Site At Wpt 171 In 2015.

Photo D-8. Ring-billed Gull Colony Site At Wpt 192 In 2015.

Photo D-9. Ring-billed Gull Colony Site At Wpt 203 In 2015.

Photo D-10. Ring-billed Gull Colony Site At Wpt 205 In 2015.

Photo D-11. Ring-billed Gull Colony Site At Wpt 192 In 2015.

Photo D-12. Ring-billed Gull And Common Tern Congregation Site At Wpt 193 In 2015.

Photo D-13. Ring-billed Gull and Common Tern Congregation/Colony Site At Wpt 205 In 2015. Note The Bald Eagle (*Haliaeetus leucocephalus*) Flying Over The Island.

Photo D-14. Common Tern Congregation Site At Wpt 357 In 2015.

Photo D-15. Common Tern Colony Site At Wpt 365 In 2015.

Photo D-16. Common Tern And Herring Gull Congregation Site At Wpt 396 In 2015.

Photo D-17. Ring-billed Gull Congregation Site At Wpt 439 In 2015.

Photo D-18. Ring-billed Gull Nesting Site At Wpt 479 In 2015.

Photo D-19. Ring-billed Gull Congregation Site At Wpt 480 In 2015.

Photo D-20. Ring-billed Gull Congregation Site At Wpt 481 In 2015.

Photo D-21. Herring Gull and Nest At Wpt 255 In 2015.

Photo D-22. Incubating Herring Gull At Wpt 280 In 2015.

Photo D-23. Incubating Herring Gull At Wpt 255 In 2015.

Photo D-24. Incubating Herring Gull At Wpt 182 In 2015.

Photo D-25. Herring Gull Nest Containing Three Eggs At Wpt 52 In 2015.

Photo D-26. Adult And Two Hatch-year Herring Gulls At Wpt 396 In 2015.

Photo D-27. Incubating Herring Gull With Two Loafing Ring-billed Gulls At Wpt 330.

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