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Restoration of *Gavia immer* (Common Loon) in Minnesota—2021 Annual Report

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U.S. Department of the Interior
U.S. Geological Survey

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Conversion Factors

U.S. customary units to International System of Units

Multiply	By	To obtain
mile (mi)	1.609	kilometer (km)
hectare (ha)	2.471	acre
hectare (ha)	0.003861	square mile (mi^2)

Datum

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Abbreviations

ANP	artificial nest platform
DWH	*Deepwater Horizon*
GPS	Global Positioning System
LWS	Minnesota Loon Watcher Survey
MN DNR	Minnesota Department of Natural Resources
MPCA	Minnesota Pollution Control Agency
USGS	U.S. Geological Survey

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Abstract

The *Deepwater Horizon* oil spill caused extensive injury to natural resources in the Gulf of Mexico, and *Gavia immer* (common loon) were negatively affected from the spill. The Open Ocean Trustee Implementation Group funded the project Restoration of Common Loons in Minnesota to restore common loons lost to the spill. In 2020–21, priority lakes in an eight-county region in north-central Minnesota were identified to focus project activities. In 2021, surveys on these lakes were started to monitor common loon territory occupancy, nest success, and chick survival. We surveyed 62 lakes and identified 110 common loon territories that will be included in the project. At least 1 nest attempt was observed in 78 of 110 territories, and a second nest attempt was observed in 23 territories. A third nest attempt was observed in one territory. Successful nesting was observed in 32 of 110 territories. We present no formal data analysis and plan to analyze the data after the collection of all field data in subsequent years.

Introduction

The *Deepwater Horizon* (DWH) mobile drilling unit exploded on April 20, 2010, resulting in a massive release of crude oil into the Gulf of Mexico. The oil spill caused extensive injury to natural resources in the gulf region; *Gavia immer* (common loon) were among the many wildlife species negatively affected as a result of the spill. The DWH Open Ocean Trustee Implementation Group funded the project Restoration of Common Loons in Minnesota to restore common loons lost from the spill. The overall goal of this project is to decrease mortality and increase reproductive success of common loons at breeding, nesting, and migration staging locations in Minnesota. Specifically, the project has three objectives:

1. Acquire and protect critical lakeshore nesting and foraging habitat.
2. Enhance common loon habitat and increase lake stewardship.
3. Reduce lead exposure through advocacy of nontoxic fishing tackle.

The first objective focuses on land acquisition to protect loon nesting habitat through perpetual easements. Lakeshore acquisition will focus on high-priority nesting areas that are currently threatened by human encroachment. The Minnesota Department of Natural Resources (MN DNR) is working with partners to identify candidate parcels for acquisition. The second objective focuses on increasing common loon production at breeding territories through deployment of artificial nest platforms (ANPs). ANPs can increase common loon hatching success and fledgling production (Piper and others, 2002; Desorbo and others, 2007). In addition, the MN DNR may support lake associations to develop management plans focused on loon conservation. The third objective addresses a leading cause of mortality of nesting loons, namely lead toxicosis (Pokras and Chafel, 1992; Grade and others, 2018). The Minnesota Pollution Control Agency (MPCA) is conducting activities under this objective.

The U.S. Geological Survey (USGS) is involved in many aspects of this project, including as lead of field surveys associated with the first component of objective two (enhancing habitat). MN DNR will work with lake associations to deploy and maintain ANPs while the USGS continues to conduct surveys to quantify the impact of ANPs on loon productivity. This report describes USGS activities under the project "Common Loon Restoration in Minnesota" for calendar year 2021, including identification of candidate lakes to target for restoration activities and field surveys. The Monitoring and Adaptive Management Plan (Open Ocean Trustee Implementation Group, 2019) provided a framework for the USGS, MN DNR, and MPCA to implement the project and identified benchmarks to evaluate project progress and completion. Thus, we report progress on monitoring benchmarks defined in the Monitoring and Adaptive Management Plan that directly pertain to surveys. Furthermore, we include no formal data analysis but report summary statistics. We plan to analyze the data after the collection of all field data.

Methods

We aim to evaluate the effects of ANPs on common loon reproductive success using a study design that specifies data collection during pretreatment (2021–22) and treatment (2023–24) years with controls. In early spring 2023, the MN DNR intends to deploy ANPs on 45 common loon territories, with another 45 territories serving as control territories. Furthermore, we intend to identify an additional 10 territories as a buffer if any of the aforementioned 90 territories are ultimately deemed unsuitable for the study. Therefore, our target number of candidate territories for the study was 100 (45 control, 45 treatment, 10 as buffer). Common loon territories can be restricted to one lake or can be spread across multiple lakes. Thus, large lakes may support multiple territories, whereas small lakes may support one complete territory or a part of a complete territory. Territories serve as sampling units for the purposes of data analysis.

Identifying Priority Lakes

We identified a candidate set of priority lakes for restoration activities and surveys by analyzing data from the Minnesota Loon Watcher Survey (LWS) program. LWS data were collected by citizen scientists to provide insight into Minnesota loon biology, behavior, and population dynamics. Although record keeping has varied over the years, the LWS generally provides the number of adult loons, total chicks fledged, and number of ANPs for each lake. We inferred the number of territories on each lake on the basis of the number of adult loons. An important feature of the LWS data is that reproductive data from lakes with multiple territories represent annual lake averages. Thus, we did not have territory-specific data for lakes large enough to support multiple breeding loon territories.

The Monitoring and Adaptive Management Plan (Open Ocean Trustee Implementation Group, 2019) prescribes that activities conducted under this project occur on lakes that offer the greatest benefit to loon reproductive success. Therefore, through an interative process, we identified candidate lakes that were reproductively underperforming. First, we identified LWS lakes in an eight-county study area (Aitkin, Becker, Beltrami, Cass, Clearwater, Crow Wing, Hubbard, and Itasca Counties) of north-central Minnesota with mean hatch rate of ≤0.61 chick per pair or, if hatch data were missing, lakes with ≤0.5 chick per pair present in August to provide a preliminary assessment of lakes available for sampling (91 lakes). We specifically used 0.61 chick hatched per pair because this value corresponds to an August chick production of 0.5 chick per pair after accounting for mean estimated chick survival from hatch to 6 weeks of age (that is, 0.82; Meyer, 2006). Furthermore, 0.5 chick per pair in August was used because previous research demonstrated that ≥0.48 fledged chick per pair was required to support a sustained breeding population (Evers and others, 2020). We then eliminated 46 of 91 lakes that were associated with a different long-term loon monitoring program, the Minnesota Loon Monitoring Program, to yield 45 lakes with an estimated 75 territories without ANPs. Second, we iteratively increased our definition of an underperforming lake by 0.1 fledged chick per pair in August (and the equivalent value for chicks hatched per pair after accounting for survival from hatch to August) until our target of 100 candidate territories was achieved. This resulted in the criterion of ≤0.85 chick hatched per pair or ≤0.7 fledged chick in August, which yielded 64 lakes in 7 counties and an estimated 111 potential territories (table 1). No lakes were selected in Clearwater County.

Loon Surveys

We removed two lakes from the 64-lake candidate set before any surveys were conducted (table 1). Specifically, we removed a large candidate multiterritory lake (Gull Lake, Cass and Crow Wing Counties) because the geographic extent of LWS data was unknown for this lake, and the large lake area (4,051 hectares [ha]) precluded us from completely surveying the lake. In addition, we removed a small lake with a single candidate territory because we were unable to obtain access (Unnamed Lake, Aitkin County).

We surveyed lakes from May 3 to August 14, 2021, to collect pretreatment data before ANP deployment in 2023. Observers had a background in waterbird identification through field ornithology coursework or work experience and participated in training sessions provided by an experienced loon biologist, during which loon survey techniques, loon behaviors, nesting habitat, nest physical structure, and determination of nest fate were described. We defined territories through a post hoc evaluation of the field data. We defined a territory as an area with three observations of a pair of loons, of which at least one observation included a territorial behavior (such as territorial interaction with another loon, nest searching, nest building, or copulation), or one or more observations of a subsequent stage in the reproductive process (for example, incubation or chicks). Thus, we refer to areas surveyed with a breeding pair as "candidate territories" and areas that met our post hoc definition of a territory as simply "territories." We divided survey efforts across the loon reproductive season into three time periods: (1) candidate territory occupancy surveys (May 3 to June 18, 2021), (2) nest-monitoring surveys (June 21 to July 16, 2021), and (3) chick survival surveys (August 2 to 13, 2021).

We surveyed selected lakes at least four times to identify loon territories for territory occupancy surveys from May 3 to June 18, 2021. We completely surveyed each lake by motorboat, kayak/canoe, or shoreline observation using public water access. We secured access through private property following USGS private landowner access protocols if a lake did not have public access. Observation time at each lake depended on variables that affected our ability to count loons and determine breeding status (for example, lake area and shape,

Table 1. Lakes in a seven-county region in north-central Minnesota that were initially surveyed to collect baseline information on common loon territory occupancy, nest success, and chick survival.

County	Lake
Aitkin	Big Sandy
Aitkin	Long
Aitkin	Clear
Aitkin	Unnamed[1]
Aitkin	Dam
Aitkin	Gun
Aitkin	Waukenabo
Becker	Knutson
Becker	Blueberry
Becker	Maud
Becker	Nelson
Becker	Unnamed
Beltrami	Stump
Cass	Little Thunder
Cass	Thunder
Cass	Lost
Cass	Long
Cass	Boxell
Cass	Town Line
Cass	Dade
Cass	Spider
Cass	Margaret
Cass	Hattie
Cass	Little Portage[2]
Cass	Island
Cass	Widow
Cass	Gull[1]
Cass	Norway
Cass	Mud
Cass	Horse
Cass	Five Point
Cass	Horseshoe
Cass	Stony[2]
Cass	Birch
Cass	Howard
Crow Wing	Barbour
Crow Wing	Scott
Crow Wing	Little Rabbit
Crow Wing	Dolney
Crow Wing	Goodrich
Crow Wing	Butterfield
Crow Wing	Island
Crow Wing	Pleasant
Crow Wing	Velvet
Crow Wing	Mitchell
Crow Wing	Little Ox
Crow Wing	Cross Lake Reservoir
Crow Wing	Mud
Crow Wing	Mollie
Crow Wing	Moody
Crow Wing	Little Hubert[2]
Crow Wing	Love[2]
Crow Wing	Hartley
Crow Wing	Fish Trap[2]
Hubbard	First Crow Wing[2]
Hubbard	Crooked
Hubbard	Unnamed[2]
Hubbard	Buck
Hubbard	Lord
Hubbard	Daisy
Itasca	Ox Hide
Itasca	Thistledew
Itasca	Alice
Itasca	Deer

[1]Not surveyed in 2021, removed from study.

[2]Surveyed in 2021, removed from study.

environmental conditions, survey method, and loon behaviors). Larger lakes were circumnavigated by boat with frequent stops to scan for loons using binoculars and the naked eye, especially within small inlets and coves, near islands, and over large expanses of open water. Shoreline surveys were conducted on small lakes (<8 ha) that were entirely visible from terrestrial vantage point(s) using binoculars, a spotting scope, and the naked eye. We collected information on environmental variables that could affect loon or nest detection, including visibility and water surface conditions. Behavioral cues (such as parallel swimming, courtship behavior, copulation, and territorial interactions) were used to determine pairing status if more than one loon was located on a lake. Common loon behavioral cues were also used to denote candidate territory boundaries on larger multiterritory lakes.

We recorded all information from all surveys using an ArcGIS Survey123 application. We recorded the following information at each lake for each territory occupancy survey: (a) number of adult loons, (b) adult loon behavior, (c) number of candidate territories, (d) number of nests, and (e) number of subadult loons (in other words, loons in nonbreeding plumage). The location of each adult and subadult loon

was documented by using mapping capabilities of ArcGIS Collector. For each breeding pair identified on a lake, observers noted evidence of nesting activity. If no breeding pairs were identified on a lake following four occupancy survey visits of the candidate territory, the lake was dropped from further consideration. Likewise, candidate territories with an existing ANP were dropped from the study because these candidate territories will likely have an ANP in 2023 and could not be randomly assigned to treatment (ANP) or control (no ANP) categories. Thus, only candidate territories that had documented nests without an ANP were further surveyed to monitor nest status.

We conducted nest-monitoring surveys every 3–14 days on candidate territories where nests were documented with a breeding pair. The goals of nest-monitoring surveys were to document nest survival and failure, hatch rates, and renest attempts through mid-July. Nest-monitoring surveys were conducted to minimally interrupt a nesting attempt. Observation time near each nest was situation dependent, with consideration taken to conduct research efficiently and allow loons to quickly resume normal nesting behavior. We recorded the following information for nest-monitoring surveys: (a) nest status, (b) potential disturbances affecting the nest, (c) loon behavior, (d) presence of *Simulium annulus* (black flies) at the nest, (e) nest type, (f) approximate distance of the nest to shore, (g) vegetative cover surrounding the nest (unobscured, partially obscured, or obscured), and (h) number of eggs in the nest (when possible). Nest status (a) was defined as one of five categories: (1) nest not located, (2) nest building, (3) adult incubating, (4) nest failed, or (5) nest successful. A candidate territory where observers failed to detect a nest during the early occupancy or nest-monitoring periods could represent either a breeding pair that did not nest or a false negative where the breeding pair nested, but observers failed to detect the nest.

A nest was considered successful if one or more eggs hatched. We considered eggs to have hatched if chicks were observed on or around the nest or accompanied by parents away from the nest. Additionally, we considered eggs to have hatched if egg membranes were present in the nest bowl, which was assumed to indicate a successful nest and subsequent chick depredation before the next survey. Loon chicks were observed on the back of adults within the first few days of hatching, beneath adult "tented" wings during inclement weather, and located in emergent vegetation during territorial disputes or clashes with intruder or floater loons. Nest locations were documented using the mapping capabilities of ArcGIS Collector, and more accurate Global Positioning System (GPS) coordinates were obtained for some nests using a hand-held GPS receiver after the nest attempt finished or failed. Eggs were counted when adults flushed from the nest or otherwise were not present. When eggs hatched, the following information was recorded: (a) the number of eggs hatched, (b) the number of unhatched eggs, (c) the number of chicks present, and (d) chick age in weeks.

We identified a nest as failed if eggs were present in the nest without an incubating adult for two consecutive surveys. A nest failure was also identified in cases where intact eggs were misplaced nearby on a shoreline or in shallow water, no intact eggs were present but eggshell fragments were in the nest or nearby prior to the expected hatch date range, or an absence of eggs was accompanied by evidence of predators in the immediate area. We estimated a range for expected hatch date based on the first date on which a nest was considered active with an incubating adult and an incubation period of 28 days (Sjölander and Ågren, 1972) We inspected the immediate area around failed nests for mammalian scat, fur, and tracks for evidence of the cause of nest failure. Environmental conditions (for example, inclement weather events, black fly infestation) and physical human impacts (for example, excessive boat traffic) that may have occurred prior to the current survey were also documented as potential causes of nest failure. Where nest abandonment was suspected, the temperature and odor of intact eggs were evaluated, and eggs were left for inspection during a subsequent survey. Photographs of nest sites and supportive evidence of nest failure were submitted with documentation via Survey123. Where a nest failed, the following information was recorded: (a) whether the nest was flooded, (b) whether the nest was abandoned, (c) whether nest material was disturbed or displaced, (d) the potential cause of disturbed or displaced nest material, (e) the number of intact eggs in the nest, (f) the number of intact eggs nearby, (g) egg odor, (h) whether the intact eggs sink or float, (i) whether the eggs were depredated, (j) whether eggshell fragments were present from the current year, (k) whether predator tracks, fur, or scat were present, (l) whether predator species were observed, and (m) the presence/absence and abundance of black flies at the nest site. We specifically recorded information on black fly abundance because previous research has demonstrated that outbreaks of black flies can increase nest abandonment and reduce reproductive success in years with severe outbreaks (Piper and others, 2018).

Loon chick survival surveys were conducted twice on all 62 lakes from August 2 to 13, 2021. Loon chick survival surveys served two purposes. First, these surveys provided information on survival of chicks that had been previously detected. If one or more chicks were present during the nest-monitoring period but were not detected during the first chick survival visit, we conducted 1–2 additional surveys. Second, these surveys provided information on survival of chicks that had not been previously detected. Loon chick survival surveys involved locating adult loons tending to chicks in open water. When adult behavior appeared normal in the absence of chicks, the search area was widened to allow for the possibility that older chicks had wandered away from adults.

Areas deemed unoccupied on the basis of occupancy surveys of candidate territories were not systematically surveyed during the nest-monitoring period. However, unoccupied areas were often traversed while we were in transit to survey a candidate territory with an active nest during the nest-monitoring period. Thus, previously unoccupied areas

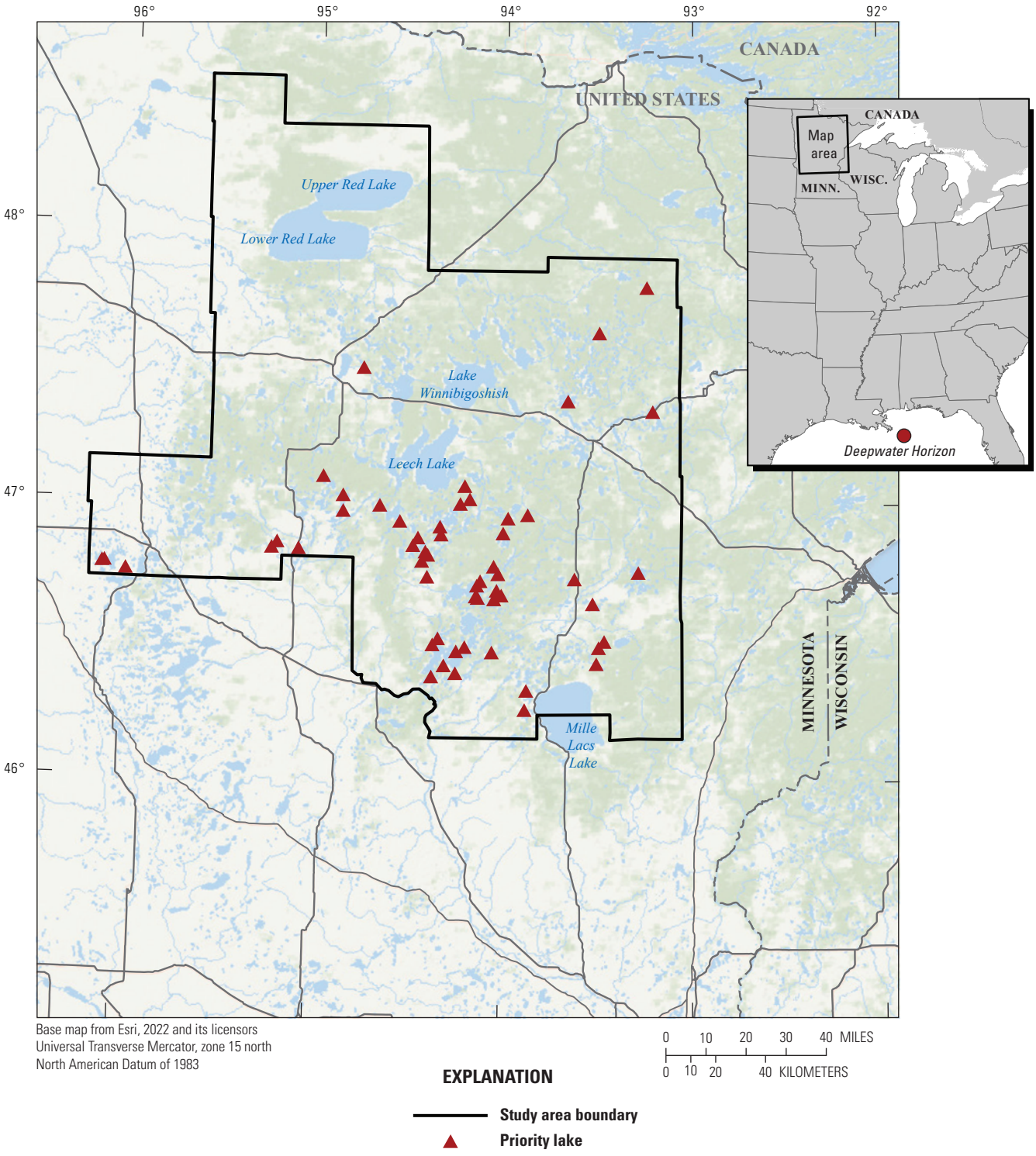

Figure 1. Priority lakes (*n*=55) monitored for *Gavia immer* (common loon) candidate territory occupancy, nesting success, and chick survival in 2021 to evaluate the effect of artificial nest platforms on common loon reproductive success in an eight-county region in north-central Minnesota.

were deemed occupied following chick detections during nest-monitoring or chick survival surveys. Such a newly documented candidate territory likely represented a false negative during occupancy surveys of candidate territories. We included these territories in summary statistics below.

Results

We surveyed 62 lakes every 5–14 days from May 3 to June 18, 2021. A subset of territories, based on pair status (for example, incubating nest or successful nest), were regularly surveyed from June 21 to July 16, 2021. In addition, all 62 lakes were surveyed at least twice from August 2 to 13, 2021, except for lakes with a single candidate territory and an ANP, which were not surveyed during the August period.

We identified 145 loon territories from 62 lakes on the basis of the field surveys. However, a subset of these territories already had an ANP, and we removed these 24 potential territories from the study. We then conducted a post hoc evaluation of the remaining 121 territories to determine whether each territory met our post hoc definition of a territory (see the section "Loon Surveys"). Thus, we identified 110 territories across 55 lakes (table 1) for this study after removing candidate territories that that did not meet our definition of a territory or already had an ANP (fig. 1).

An initial nest attempt was observed in 78 of 110 territories, whereas nesting was not observed in 32 of those territories. However, six territories where a nest was not observed were subsequently determined to have a successful nest by the observation of chicks. A second nest attempt was observed within 23 territories, and a third nest attempt was observed in one territory, resulting in a total of 108 observed nest attempts. Territories were considered as yielding a successful nest (in other words, at least 1 chick was observed, or other evidence at the nest site indicated a successful nest) in 32 of 110 territories (29 percent of territories).

Benchmarks To Evaluate Project Progress

The Monitoring and Adaptive Management Plan (Open Ocean Trustee Implementation Group, 2019) provides parameters for monitoring project implementation and progress. We report progress on monitoring defined in the plan's parameters that directly pertain to surveys (parameters 1, 3, 4, and 7).

Parameter 1, Baseline status of lakes.—We analyzed existing data to identify a candidate list of priority lakes where restoration activities may occur (table 1). In spring 2021, we identified 64 lakes to survey in summer 2021 to collect baseline data. In the Monitoring and Adaptive Management Plan, the performance criteria for parameter 1 are completion of data evaluation and identification of priority lakes for restoration. After the surveys, we identified 55 lakes, comprising 110 territories, to be the focus of restoration activities (table 1). Thus, we completed parameter 1.

Parameter 3, Number and placement of ANPs deployed.—We identified 55 lakes and 110 territories intended to serve as future sampling units to deploy 45 ANPs. The MN DNR is currently (2022) in the process of identifying lake associations to support ANPs and anticipates ANPs will not be deployed until 2023. Thus, 0 of 45 ANPs (0 percent) have been deployed, and information from surveys in 2021 and 2022 can inform placement of ANPs in 2023.

Parameter 4, Number of ANPs occupied by nesting loons.—As stated previously, the MN DNR is currently (2022) working with lake associations to deploy and support ANPs. We anticipate ANPs will be deployed in 2023. Thus, we have no values to report for parameter 4.

Parameter 7, Presence/absence, territory occupancy, and nest productivity.—We identified 110 breeding pairs on 55 lakes in 2021. We defined a loon territory conditional on loon presence in the first year, which means that loon territory occupancy was 100 percent in the first year of the study. In 2021, at least one chick was successfully hatched in 32 of 110 territories (29 percent). We completed 100 percent of the survey plan in 2021.

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