Counts and spatial distribution of harbour seals (*Phoca vitulina*) and grey seals (*Halichoerus grypus*) from an aerial survey of the coast of the Newfoundland Shelf and Sandwich Bay, Labrador during the summer of 2021

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ABSTRACT

Hamilton C.D., Goulet, P.J., Stenson, G.B., and Lang, S.L.C. 2023. Counts and spatial distribution of harbour seals (*Phoca vitulina*) and grey seals (*Halichoerus grypus*) from an aerial survey of the coast of the Newfoundland Shelf and Sandwich Bay, Labrador during the summer of 2021. Can. Tech. Rep. Fish. Aquat. Sci. 3566 : v + 39 p.

Harbour seals reside throughout the year around Newfoundland and Labrador (NL) at unknown abundance levels. The first systematic survey for harbour seals occurred along the NL Shelf during July and August 2021 to obtain haul-out counts and assess distribution. Grey seals were also recorded as these two species can share haul-out locations. Photographic surveys were flown along the coastline with a Bell 429 helicopter. 3,341 seals were seen hauled out and identified as harbour, grey or unknown seals. After the unknown seals were assigned to species, 2,961 harbour and 380 grey seals were estimated to be seen. The largest numbers of harbour seals were found in the Grey Islands, Saint Pierre and Miquelon (France) and along the southern coast of Newfoundland east of Bay d'Espoir. Grey seals were only observed hauled out in southern Newfoundland, primarily west of Placentia Bay. No seals were seen hauled out in Sandwich Bay, Labrador. Despite differences in methodology compared to previous work, the results indicate that harbour seals have disappeared from previously occupied areas. Although increases have probably occurred in some areas, this species has likely not regained the abundance levels present before the bounty hunt (1952-1976). Future surveys are needed to understand regional population trends and gain a better understanding of counts and distribution in Labrador.

RÉSUMÉ

Hamilton C.D., Goulet, P.J., Stenson, G.B., and Lang, S.L.C. 2023. Counts and spatial distribution of harbour seals (*Phoca vitulina*) and grey seals (*Halichoerus grypus*) from an aerial survey of the coast of the Newfoundland Shelf and Sandwich Bay, Labrador during the summer of 2021. Can. Tech. Rep. Fish. Aquat. Sci. 3566 : v + 39 p.

Les phoques communs résident toute l'année autour de Terre-Neuve-et-Labrador (T.-N.-L.) en nombre inconnus. La première étude systématique des phoques communs a eu lieu le long du plateau continental de T.-N.-L. en juillet et août 2021 afin d'obtenir des décomptes aux échoueries et d'évaluer leur répartition. Des phoques gris ont également été dénombrés, car ces deux espèces peuvent partager des sites d'échouerie. Des relevés photographiques ont été effectués le long du littoral avec un hélicoptère Bell 429. 3 341 phoques ont été énumérés et identifiés comme étant des phoques communs, gris ou inconnus. Les décomptes corrigés étaient de 2 961 phoques communs et 380 phoques gris après que les phoques inconnus aient été attribués aux espèces. Le plus grand nombre de phoques communs a été trouvé dans les îles Grey, à Saint-Pierre-et-Miquelon (France) et le long de la côte sud de Terre-Neuve, à l’est de la baie d’Espoir. Des phoques gris n'ont été observés que dans le sud de Terre-Neuve, principalement à l'ouest de la baie de Plaisance. Aucun phoque n'a été aperçu dans la baie Sandwich, au Labrador. Malgré les différences de méthodologie par rapport aux travaux antérieurs, les résultats indiquent que les phoques communs ont disparu de quelques zones précédemment occupées. Même si des augmentations ont probablement eu lieu dans certaines zones, cette espèce n'a probablement pas retrouvé les niveaux d'abondance présents avant la chasse à prime (1952-1976). De futurs relevés sont nécessaires pour comprendre les tendances démographiques régionales et mieux comprendre les dénombrements et la répartition au Labrador.

1. INTRODUCTION

Population abundance information is an integral component of successful management and conservation plans for animals worldwide. Successive surveys to assess abundance provide both status and trend information for animal populations. These data are used by organizations such as the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and the International Union for Conservation of Nature (IUCN) Red List of Threatened Species to assess species status, providing a classification from Least Concern to Extinct. Population abundance information is also vital for determining the level of human induced mortality populations can experience without becoming depleted (e.g. sustainable harvest levels, bycatch). Under the precautionary approach in the Atlantic Seal Management Strategy, precautionary and critical reference levels are set as a percentage of the maximum population size that divide the population into healthy, cautious and critical zones of abundance (Stenson & Hammill 2010). Under this management strategy, sustainable removals of data poor populations are estimated using the potential biological removal (PBR) approach. Any marine mammal population with a human-caused mortality level greater that its PBR has the potential to become depleted (Wade 1998).

Harbour seals in Canada are found in coastal waters in the Atlantic, Pacific and Arctic oceans (e.g. Mansfield 1967; Hammill et al. 2010; Bajzak et al. 2013; Majewski & Ellis 2022). A subspecies, *Phoca vitulina mellonae*, also resides year-round in freshwater lakes in the Ungava Peninsula in northern Quebec (Mansfield 1967; Smith et al. 2006). Harbour seals also occur on the French archipelago of Saint Pierre and Miquelon (SPM) which is located off of southern Newfoundland (Ling et al. 1974, Figure 1). Although harbour seals are relatively sedentary, long distance movements do occur, primarily in pups (Lesage et al. 2004; Sharples et al. 2012). Some seals also make movements up rivers into freshwater lakes (Mansfield 1967; Sjare & Reddin 2004). Harbour seals generally haul out daily on sandy beaches, small islets, rocks, reefs or on sea ice when their usual terrestrial haul-out locations are not available (Hammill et al. 2010; Hamilton et al. 2014). The proportion of time hauled out follows a seasonal cycle, with peaks occurring in the summer during the pupping and moulting (i.e. when seals replace their hair and upper layers of the skin) periods (Dubé et al. 2003; Harris et al. 2003; Cunningham et al. 2009; Granquist & Hauksson 2016). Hauling out during moulting helps facilitate hair and skin regrowth (Watts 1996). Hauling out is also dependent on meteorological and tidal variables, with most populations of harbour seals hauling out preferentially during low tide under warm conditions with low wind speeds and no precipitation (Pauli & Terhune 1987; Simpkins et al. 2003; Hamilton et al. 2014; Granquist & Hauksson 2016). Due to these factors, surveys to determine harbour seal abundance are generally carried out during either the pupping or moulting periods in the hours around low tide when environmental conditions are favourable.

Limited information is available on population abundance of harbour seals in Atlantic Canada, in part due to the greater research effort devoted to pinniped species that are commercially harvested and/or are suspected of having negative impacts on commercial fish

stocks (i.e. harp seals and grey seals; Hammill et al. 2021; DFO 2022). A bounty for harbour seals was introduced in 1927 and 1952 in Atlantic Canada (except Newfoundland and Labrador (NL)) and NL, respectively. The bounty ended in 1976 due to concerns over declines in harbour seal abundance, including observations that the species had disappeared from areas where they were previously abundant (Bouvla & McLaren 1979). Bounty returns along with interviews and questionnaires were used to estimate the population abundance of harbour seals in Atlantic Canada in the mid-1970s. (Bouvla & McLaren 1979). Since that time, surveys have occurred in some areas of Atlantic Canada (e.g. Gulf of St. Lawrence, areas of Nova Scotia) to estimate abundance (Stobo & Fowler 1994; Lesage et al. 1995; Robillard et al. 2005) but in other areas (e.g. NL), limited information on population abundance since that time is available. Bouvla & McLaren (1979) estimated an abundance of 2,010 harbour seals in Newfoundland. Sjare et al. (2005) conducted opportunistic counts and interviews in southern and western Newfoundland in 2001-2003. Although a direct comparison with Bouvla & McLaren (1979) was not possible due to differences in methodology, Sjare et al. (2005) had the impression that harbour seals might have increased in abundance at some sites in the south and south-western parts of the province, while decreases or stable trends likely occurred in north and north-eastern parts of the province. Bouvla & McLaren (1979) did not cover Labrador, however reports noting them as “common” from the 1800’s and bounty returns in the thousands in the 1950’s and 1960’s show that they were once numerous in this region (Bangs 1898; Templeman et al. 1957; Wiles 1968). Interviews with hunters, fishermen and Fisheries Officers (Fisheries and Oceans Canada (DFO)) in Labrador during the early 2000’s noted the continued presence of harbour seals in limited areas, including Sandwich Bay, with varying relative abundances throughout the region, but accounts conflicted on population trends (Sjare et al. 2005). Present abundance and distribution in Labrador remains unknown.

Grey seals also occur throughout Atlantic Canada. They breed on Sable Island, on islands in the southern Gulf of St. Lawrence and along the Atlantic coast of Nova Scotia from December to mid- February (Mansfield & Beck 1977; den Heyer et al. 2017). There was a bounty on grey seals from 1978 until 1990, although the bounty program was not well known in NL until 1985 due to a lack of publicity (Stobo et al. 1990). The population abundance of grey seals in Canadian waters has increased greatly from a few thousand individuals in 1960 to around 360,000 seals in 2021 (DFO 2022) with Sable Island being the largest breeding colony in the world for this species. Pupping has not been observed during surveys along the coast of NL, but grey seals disperse after breeding and are found in NL and SPM during the summer and autumn (Ling et al. 1974; Mansfield & Beck 1977; Breed et al. 2009; DFO 2022). Grey seals frequently haul out on the same types of substrate as harbour seals. The proportion of time grey seals haul out varies both intra and inter-annually, with grey seals hauling out more during the moulting and breeding periods than during the summer months (Leeney et al. 2010). There is variation in the likelihood of grey seals hauling out in relation to tidal state, which is likely site dependent (Leeney et al. 2010; Pérez Tadeo et al. 2021). In many locations, including in NL, harbour seals and grey seals haul out in the same larger area with local variation in the level of separation

between the two species. Harbour and grey seals may either use slightly different habitats within the larger region or both haul out at the same site (Sjare et al. 2005; Lidgard et al. 2023). In the latter case, the two species may be either spatially separated or intermixed.

This study marks the first attempt to arrive at a survey-based count of harbour seals for the waters of the NL Shelf. Since harbour seals and grey seals are both present in the region and may share haul-out sites in NL, haul-out counts were also conducted for grey seals across the survey region. The harbour seal counts from this survey will be combined with the surveys conducted in the Gulf of St. Lawrence and areas of the Scotian Shelf in 2019 and 2020, respectively (Lidgard et al. 2023; Mosnier et al. 2023) to produce an estimate of total harbour seal abundance for Atlantic Canada.

2. METHODS

2.1 STUDY AREA

An aerial survey was conducted for harbour seals along the coast of the NL Shelf and in Sandwich Bay, Labrador from 6 July to 19 August, 2021. Areas surveyed included the south coast of Newfoundland (Chance Cove Provincial Park west to Burgeo), parts of north-eastern Newfoundland (from Bonavista Bay northwest to Belle Island) and Sandwich Bay, Labrador (Figures 1-3, Table 1). Grey seals encountered during the survey were also recorded as grey and harbour seals share some haul-out locations in the study area. The west coast of Newfoundland was surveyed for harbour and grey seals in June, 2019 by DFO's Quebec Region (Mosnier et al. 2023).

2.2 SURVEY METHODOLOGY

The areas selected to be surveyed were chosen based on published information on the distribution of harbour seals (Bouvla & McLaren 1979; Sjare et al. 2005) and from interviews conducted in the spring of 2021 with fishermen, commercial sealers and Fisheries Officers (DFO) in NL. The survey was carried out during July and August as this is when harbour seals are moulting and when conditions are generally suitable for flying aerial surveys in NL (i.e. low wind speed (≤ 10 knots), no fog).

All potential areas with harbour seals were surveyed using a Canadian Coast Guard Bell 429 helicopter flying approximately 90 m from the coastline, at an altitude of 150 m and a speed of 70 knots. Surveys only occurred from two hours before to two hours after low tide, between 9:30 and 18:30 on days with favourable meteorological conditions (low wind speed (≤ 10 knots), no rain and no fog), based on previous research of harbour seal haul-out behaviour (Pauli & Terhune 1987; Simpkins et al. 2003; Hamilton et al. 2014; Table 1). Times of low tide were retrieved from the Canadian Hydrographic Service (www.tides.gc.ca) for relevant locations around NL. The helicopter flew with the port side facing the coast with two observers seated on

the port side; one in the co-pilot seat and one in the rear forward-facing seat. A Bad Elf GPS Pro+ (Bad Elf, West Hartford, CT, USA) was used to track the helicopter's position in real time using Memory Map (Memory-Map Inc., Ithaca, NY, USA) run on an iPad (Apple Inc., Cupertino, CA, USA). The two observers used either a Nikon D800 digital camera with a Nikon AF-S NIKKOR 28-300 mm lens or a Nikon D7100 camera with a Nikon AF-S NIKKOR 28-300 mm lens. When a seal was sighted, oblique photographs were taken of the hauled out seal(s) by both observers and the position of the haul-out location was marked on Memory Map. Photographs were taken of all seal sightings if possible; some sightings did not have photographs available due to the seal(s) entering the water ahead of the helicopter's arrival. There was variability in the distance between the cameras and hauled out seals, leading to variation in the ground resolution of the photographs. Circling of the helicopter occurred at select haul-out locations when it was deemed beneficial to try for additional photographs due to reasons such as e.g. spotting a haul-out location when the helicopter was almost past it and a high proportion of the hauled out seals flushing quickly due to disturbance from the helicopter. Notes were made by both recorders on the species, approximate count, if the seal(s) entered the water before the photographs were taken and if there were photographs of that haul-out site.

Photos were counted in QGIS version 3.22.0 (QGIS Development Team 2021) by two photo readers. Most haul-out locations had multiple photos available from both observer positions. Photo readers chose the best photo (i.e. most seals available or best photo quality) to count seals and used additional photos when necessary to count seals on the haul-out areas which were not covered by the primary photo. Photo readers identified seals in six categories that included three species designations (harbour seal, grey seal, unknown seal) and two substrate categories (on land, in water) for each species. Seals were not separated between young of the year and age 1+ animals. Seals were specified as unknowns (i.e. uncertain if harbour or grey seal) when poor image resolution, photo angle or distance to the target made it difficult to distinguish features or if the seal(s) entered the water before the photographs were taken. Variation in the colour of wet versus dry animals can also make species identification difficult (with the exception of adult male grey seals). In cases such as these and in the absence of other reliable information (i.e. observer notes), the readers erred on the side of caution by specifying the seals as unknown. Seals in the water were included in the survey count when it was indicated in the survey notes or could be determined from the photographs that the seals had entered the water due to disturbance from the helicopter. Additional seals were added to the count when necessary to include seals not captured by the photographs that were in the observers' notes (e.g. seals that entered the water ahead of the helicopter's arrival, haul-out locations that were not photographed).

Thirty haul-out locations per reader (i.e. total of 60) were selected to check for perception bias. A best count was reached for these 60 locations through comparison of the photos and shapefiles produced from each reader. Linear models comparing the best count with each readers' count provided correction factors for perception bias for each reader. The linear models were run with a gaussian distribution and identity link. The intercept in each model was not

significantly different from zero so each model was repeated assuming a zero intercept. The slope was used to correct each readers' count from the respective model. The 60 haul-out locations were also counted by a third expert reader. The third reader's counts were used to investigate potential differences between readers in species identification. Counts were not corrected for the seals that were in the water (i.e. not hauled out) when the survey took place.

Unknown seals were assigned to species based on the proportion of harbour and grey seals identified in photographs taken during the survey that day (Table 2). Daily proportions were used to assign the unknown seals to species due to spatial and temporal variation in the relative proportions of harbour and grey seals. Different areas in NL had different proportions of these two species and grey seals are believed to increase in number in southern Newfoundland during late summer (Breed et al. 2009; SLCL & PJG pers. obs.).

Analyses of survey counts were conducted in R version 4.2.2 (R Core Team 2022) and QGIS. All haul-out locations within 7 km of each other were grouped to aid in visualization (R package sf, function st_is_within_distance; Pebesma 2018). Place names were taken from toponymic feature maps produced by CanVec (Natural Resources Canada, https://open.canada.ca/data/en/dataset/b3fdcd34-4533-415f-8f83-68f17f9d5d68).

3. RESULTS

3.1 AERIAL SURVEY

The harbour seal survey was flown on 16 days between 6 July and 19 August 2021, with a total survey effort of 53 hours (Table 1, Figure 3). The days with no survey effort during that time had unfavourable weather conditions or low tides occurring before 10:45 or after 16:30. On two days (12 July and 24 July), survey effort ended prematurely due to adverse weather conditions or fog. One survey day (4 August) also had a delayed start due to fog in the survey area.

3.2 HARBOUR AND GREY SEAL COUNTS

Harbour and grey seals were spotted at 202 terrestrial locations in southern and northern Newfoundland. The total number of seals counted was 3,341: 2,577 harbour seals, 315 grey seals and 449 unknown seals (Tables 3 & 4, Figures 4-6). When the unknown seals were assigned to species by the proportion of identified harbour and grey seals from each survey day, it was estimated that 2,961 harbour seals and 380 grey seals were counted during the survey (Tables 2 & 3, Figures 4-6). Harbour seals were spotted at 161 terrestrial locations with a mean group size of 18 seals (range 1 to 292; Table 3, Figure 5) and grey seals were spotted at 81 terrestrial locations with a mean group size of five seals (range 1 to 42; Table 3, Figure 6). Both harbour and grey seals were found at 40 terrestrial locations. Harbour seals dominated in number at the majority of these locations while grey seals dominated in number at a few (n=4; Table 3, Figures

5 & 6).There were no hauled out seals spotted in Sandwich Bay, Labrador although one grey seal and two harp seals were observed swimming in the bay (Tables 3 & 4).

The best counts from the 60 comparison haul-out locations were slightly higher than the counts done by each reader (Table 5, Figure 7). Due to the high similarity in the counts produced by both readers and the small differences between them and the best count, the survey counts were not corrected for perception bias. The third expert reader identified a similar number of total seals as the two readers but there was a difference in species identification among readers. One reader identified a similar proportion of grey seals as the expert reader while the other reader had less grey seals and a higher proportion of unknown seals. These differences were not corrected for as the different proportions among readers were not large (< 10%) and most grey seals were present later in the survey period when the unknown seals were mostly assigned to grey seals based on the proportion of seals identified to species from each survey day (Table 2).

3.3 HARBOUR AND GREY SEAL SPATIAL DISTRIBUTION

Harbour and grey seals shared haul-out locations in areas where they overlapped in distribution. Harbour and grey seals shared haul-out locations in southern Newfoundland and SPM, although the highest concentration of each species were often found in slightly different areas (Tables 3 & 4, Figures 4-6). When there were several grey seals on the same beach as harbour seals there was often a spatial separation between the two groups (e.g. Grand Barachois on SPM, Trepassey Bay). When there were only one or a few grey seals present on the beach they were generally mixed with the harbour seals. The majority of rocky haul-out sites had only one of the two species present. Only harbour seals were seen hauled out in northern Newfoundland, with a large number found on the islands immediately south of the Grey Islands and smaller numbers found in Hare and Pistolet Bays (Tables 3 & 4, Figures 4-6).

The largest concentration of harbour seals in southern Newfoundland was found between SPM and Broad Cove (south-eastern Avalon), specifically on SPM, on the Little Green Islands (south of Green Island between the Burin Peninsula and SPM), islands in Lamaline Bay (southern Burin Peninsula), Jude Island and surrounding islands (western Placentia Bay), Merasheen Island and the islands surrounding it (northern Placentia Bay), South Point on Great Colinet Island (St. Mary’s Bay), between Cape English and False Cape (south-eastern St. Mary’s Bay), Trepassey Bay and Broad Cove (south-eastern Avalon; Tables 3 & 4, Figure 5). Smaller concentrations were encountered fairly frequently along southern Newfoundland between Bay D’Espoir and Lowler Bay (eastern Avalon; Tables 3 & 4, Figure 5).

The largest concentration of grey seals was found between the Burgeo Islands (south of Burgeo) and Jude Island (western Placentia Bay), specifically on the Burgeo Islands, Penguin Islands (south-east of Ramea), south of Pass Island (southern Hermitage Bay), Salmon Island (Connaigre Bay), Dog Island (western Belle Bay), Grand Barachois (SPM), the Little Green Islands and Jude Island and the surrounding islands (Tables 3 & 4, Figure 6). Larger concentrations were also found on the south-eastern Avalon at Freshwater Cove (eastern

Trepassey Bay) and the Black Rocks (southern Chance Cove; Tables 3 & 4, Figure 6). Small numbers (e.g. 1 to 10) were encountered fairly frequently along the coast between the Burgeo Islands and south-eastern Avalon, especially on small islands off the coast (Tables 3 & 4, Figure 6).

Seals which could not be identified to species (unknown seals) were found in generally low numbers in southern Newfoundland throughout the area where harbour and grey seals were found (Tables 3, 4, Figure 4). A few sites had larger numbers (10+) of unknown seals including western Trepassey Bay, western Placentia Bay, eastern Miquelon, eastern Brunette Island, Hermitage Bay and Bay d'Espoir. Reasons for larger numbers of unknown seals at a haul-out location include blurry photos from both observers and seals entering the water before the helicopter arrived.

Harbour and grey seals hauled out on sandy beaches, sand bars and rocks. Beaches used by the seals were often in inaccessible locations, in wavy exposed areas with many rocks and often backed by high, steep cliffs. These beaches were primarily located on the southern Avalon Peninsula. Available beach habitat was also used infrequently for hauling out throughout the rest of southern Newfoundland. The large sandy beaches in the Grand Barachois (large lagoon) in SPM were also used for hauling out by both harbour and grey seals. Sandbars were used for hauling out in Pistolet Bay and Hare Bay in northern Newfoundland. Rocky substrates and islands were used for hauling out in most other areas surveyed.

4. DISCUSSION

This survey was the first systematic survey for harbour seals completed for the NL Shelf. A total count of 2,961 harbour seals was obtained along the coast of the NL Shelf with no harbour seals spotted in Sandwich Bay, Labrador. The largest concentrations of harbour seals were found in the Grand Barachois on the island of Miquelon (SPM) and the Grey Islands off the north-eastern coast of Newfoundland. Harbour seals were also prevalent along the southern coast, primarily east of Bay d'Espoir. Although previous work on harbour seal abundance and distribution is not directly comparable to the present study due to differences in methodology (Bouvla & McLaren 1979; Sjare et al. 2005; Vincent et al. 2022), the present survey counts are higher than the estimated abundance at the end of the harbour seal bounty program in 1976 and the distribution of harbour seals has shifted (Table 6, Figure 8). Harbour seals have disappeared from areas where they were previously present and are also now recorded in areas not mentioned in prior work (Bouvla & McLaren 1979; Sjare et al. 2005; Table 6, Figure 8). Although grey seals were not the primary target species of this survey, they share many haul-out areas with harbour seals so their abundance and distribution were also recorded. These findings also represent the first information on the abundance and distribution of grey seals along the coast of the NL Shelf during the summer. Three hundred and eighty grey seals were recorded during the course of the survey. They were found on the southern coast of Newfoundland with the majority of sightings west of the Burin Peninsula, which is opposite to the distributional pattern found for harbour seals on the south coast (i.e. majority of sightings east of the Burin Peninsula).

The number of harbour and grey seals counted along the coast of the NL Shelf during this survey should be considered as a minimum count for this area. An unknown fraction of seals were hauled out but not photographed due to imperfect detection. The pelage of harbour seals closely resembled the rocky substrate in some regions making them difficult to spot. A larger, unknown fraction of seals of both species were in the water and thus not available to be counted when the survey took place. Correcting for the seals that were not hauled out is needed before a final estimate of the total number of harbour seals along the coast of the NL Shelf will be available. The survey was only flown when conditions were favourable for hauling out according to studies conducted in other areas (e.g. Pauli & Terhune 1987; Boveng et al. 2003; Hamilton et al. 2014; Granquist & Hauksson 2016). However, no studies investigating harbour seal haul-out behaviour have been conducted in NL and optimal conditions for hauling out varies among regions as well as by sex and age group (Härkönen et al. 1999; Cowles et al. 2013; Merkel et al. 2013; Lidgard et al. 2023). There can also be large daily variation in the numbers hauled out under ideal environmental conditions due to a variety of reasons such as day of the year, presence of aquatic or terrestrial predators, human disturbance, feeding conditions or individual behaviour (Cunningham et al. 2010; Galatius et al. 2021). Correction factors to account for the number of seals hauled out are generally calculated either from telemetry data or visual studies that model the effect of environmental and temporal variables on the number of seals hauled out (e.g. Gilbert et al. 2005; Harvey & Goley 2011; Cowles et al. 2013).

Despite attempts to complete the survey during as short a time as possible, this survey took six weeks to complete due to the large survey area and periods of unfavourable environmental conditions. Long periods of rain and fog can persist along the NL coast, especially the southern coastline, during the summer. Due to the long time period covered, it is possible that seals of both species moved between regions during the course of the survey and were either double-counted or were not available to be counted. This should have a minimal impact on the final count unless the movement was directed (i.e. non-random). Telemetry data will be needed to assess the likelihood of directed movement patterns occurring.

Six species of seals are found in NL with different seasonal patterns of residence (Stenson 1994). It is unlikely that any of the unknown seals in Newfoundland were not harbour or grey seals. Harp and hooded seals whelp in the drifting pack ice off north-eastern Newfoundland in March and travel to Arctic areas during the summer months (Stenson & Sjare 1997; Andersen et al. 2013; Grecian et al. 2022). Northern Newfoundland marks the southern limit of the distribution for both ringed and bearded seals with very few sightings of either species occurring in the summer months (Stenson 1994; CDH & SLCL unpub. data). Two harp seals were seen during the survey in Sandwich Bay, Labrador but no seals were seen hauled out in this area. There is a higher likelihood of encountering seals other than harbour and grey seals in the summer in Labrador than in Newfoundland which should be considered when flying future surveys in this northern area.

Some of the largest concentrations of harbour seals were found in the Grand Barachois on the island of Miquelon (SPM) and the Grey Islands in north-eastern Newfoundland. The Grand

Barachois is an inlet opening to the sea through one narrow entrance. It is filled with sand banks that are a well-known haul-out site for both harbour and grey seals. Harbour seals were first recorded in this area (including breeding individuals) in the 1970's and approximately doubled in number by the 1980's (Ling et al. 1974; Davis & Renouf 1987). Monthly censuses carried out in the Grand Barachois since 2006 show large intra-annual variation in the number of seals (both harbour and grey seals) with increased numbers in the spring and summer, coinciding with the harbour seal whelping and moulting periods (Vincent et al. 2022). Beginning in 2017, a sharp decrease in the number of seals counted in the Grand Barachois in July compared to June was first observed, suggesting that in recent years harbour seals redistribute following the whelping period and use other haul-out sites for moulting (Vincent et al. 2022). Censuses carried out across SPM from 2016 to 2022 found between 900 to over 2100 seals (both species) with the highest number of seals counted during the spring and summer months (Vincent et al. 2022). Roughly 80% of the seals were harbour seals and 20% were grey seals, with higher proportions of harbour seals during winter and no grey seals observed between January and March (Vincent et al. 2022). The present survey counted 754 seals across SPM which is at the lower end of the counts in Vincent et al. (2022) in recent years. In the present survey, 82% of the hauled out seals counted were harbour seals, 10% were grey seals and 8% were unknown, similar to previous counts in this area (Vincent et al. 2022). The survey on SPM occurred on a Sunday in July with ideal surveying weather; a lot of boat traffic was observed which might have disturbed the seals prior to the helicopter arrival resulting in lower total counts than have been observed previously in SPM for the same time period (Vincent et al. 2022). In addition, groups of seals were seen in the water at multiple locations around the islands of SPM that were not included in the present survey count as it was not believed that disturbance from the helicopter had caused the seals to flush from the haul-out sites being surveyed. The difference in numbers between the present survey and the numbers reported by Vincent et al. (2022) may be caused by different proportions of seals hauled out when the surveys occurred due to reasons such as human activity.

The Grey Islands in northeastern Newfoundland also had a large concentration of harbour seals. The harbour seals in Grey Islands likely re-colonized the area sometime since 1980 as Bouvla & McLaren (1979) reported that harbour seals in this area had disappeared sometime in the 1960's or 1970's (Table 6, Figure 8). Harvester interviews in the early 2000's also reported that harbour seals were rarely observed in the Northern Peninsula region (Sjare et al. 2005). Juvenile harbour seals harvested in the Notre Dame Bay region in recent years as part of DFO NL Region's winter sampling program are likely from the Grey Islands haul-out sites, as harbour seals were not seen in the present survey or reported by Fisheries Officers in the spring of 2021 in the Notre Dame Bay region. Juvenile seals of many species, including harbour seals, often have higher movement rates than adults and disperse to areas outside of the natal colony (Thompson et al. 1994; Raum-Suryan et al. 2002; Blanchet et al. 2016).

Additional haul-out sites in northern Newfoundland have likely relocated in recent decades. The current survey counted 22 hauled out harbour seals in Pistolet Bay and six in Hare Bay while no harbour seals were seen in the immediate vicinity of St. Anthony. Twenty harbour

seals were reported with a downward trend in St. Anthony with no entries for Hare Bay or Pistolet Bay by Bouvla & McLaren (1979) while Templeman et al. (1957) reported bounty kills in 1952-55 for both Hare Bay (101-200 seals) and Pistolet Bay (21-50 seals) with no entries for St. Anthony (Table 6, Figure 8). Harbour seals were also rarely observed around St. Anthony in the early 2000's (Sjare et al., 2005). Differences in the area harbour seals were found in the northern Peninsula over time may be due to individual movement patterns or differences in the location where bounty kills were assigned. Telemetry studies will be needed to assess the degree of movement and localized space use of harbour seals in this area. Although direct comparison with earlier work cannot be done due to differences in methodology, it seems likely that the declining trend has at least ceased with more harbour seals likely being present on the northern tip of Newfoundland than in the 1970's but less than in the 1950's. Intensive hunting might also have led to a redistribution of harbour seals in northern Newfoundland to e.g. sites in the Grey Islands (Boles et al. 1980; Olsen et al. 2010; Rosing-Asvid 2010).

Harbour seals have likely disappeared from areas in Newfoundland where they were present half a century ago. Bouvla & McLaren (1979) reported 685 harbour seals with a declining trend in the Bonavista Bay – Kittiwake Coast – Notre Dame Bay regions. This study did not find any seals when this area was surveyed on 9 July, 2021 (Table 6, Figure 8). Fisheries Officers (DF) contacted in this region during the spring of 2021 also did not report knowledge of harbour or grey seals in this area. High sources of mortality likely included unsustainable bounty kills prior to 1976 and potentially other factors such as high levels of pup mortality in exposed areas (Templeman et al. 1957; Bouvla & McLaren 1979). Relocation to other areas due to high mortality levels is also possible (Boles et al. 1980; Olsen et al. 2010; Rosing-Asvid 2010).

Harbour seals are present at many locations on the southern coast, primarily east of Bay d'Espoir. Harbour seals were common in Placentia Bay and St. Mary's Bay, similar to previous work (Templeman et al. 1957; Bouvla & McLaren 1979; Sjare et al. 2005; Table 6, Figure 8). Sjare et al. (2005) reported over 150 seals around Chance Cove, NL while the present survey found only small numbers (less than 20) in this area (Table 6, Figure 8). Conversely, several hundred harbour seals were found in Trepassey Bay while earlier work indicated a small presence of harbour seals in the 1950's and an absence in later decades (Templeman et al. 1957; Bouvla & McLaren 1979; Sjare et al. 2005; Table 6, Figure 8). Harbour seals were also found hauled out on multiple islands in Fortune Bay for the first time since the 1950's (number unknown; Templeman et al. 1957). It is unclear whether these new haul-out locations represent a seasonal, short-term or longer-term shift (i.e. range expansion) in haul-out areas as it is unknown whether the absence of seals in Trepassey Bay and Fortune Bay in earlier work is a true or perceived absence due to lack of effort in these areas. Harbour seals do seasonally shift haul-out areas, even across long distances, and long term relocations have also been observed (Lesage et al. 2004; Cunningham et al. 2009; Olsen et al. 2010; Cordes et al. 2011; Hamilton et al. 2014). Further research is required to better understand intra and inter-annual variation in harbour seal movements and distribution.

No harbour seals were seen in Sandwich Bay in Labrador. Harbour seals were previously prevalent in Labrador, as evidenced by harbour seal remains found in 18th century Inuit settlements (Woollett 2010). They were noted as "common along the whole coast and in the lower part of rivers" in a list of mammals found in Labrador in the 1890's (Bangs 1898) and a large number of harbour seals (i.e. thousands) were killed for bounty returns in Labrador in the 1950's and 1960's (Templeman et al. 1957, Wiles 1968). Brice-Bennett (1977) reported that declines in abundance occurred due to intensive bounty hunting in the 1950's and 1960's and that this species shifted to small seaward islands. Only limited numbers of harbour seals have been observed in boat surveys or reported by local fishermen between 1979 and 2012 (Boles et al. 1980; Sjare et al. 2005; Chaulk et al. 2013). The degree to which the population has recovered is uncertain but they appear not to have regained their previous abundance in this region of Labrador. More extensive survey effort is needed in Labrador to determine the present abundance and distribution of harbour seals.

Although grey seals were not the focus of this survey, they were also counted as they share many of the same haul-out areas as harbour seals. This survey was the first time grey seal distribution was studied around Newfoundland. They had an almost inverse relationship to harbour seals along the south coast, as the majority of harbour seals were found east of the Burin Peninsula whereas the majority of grey seals were found west of the Burin Peninsula. This could be due to multiple reasons including predation, competition or differences in the relative abundance of different prey species along the southern coast of Newfoundland. Grey seals do prey on harbour seals so different distributions may be due to predator avoidance behaviour (van Neer et al. 2015). No harbour seals carcasses with wounds characteristic of grey seal attacks have been reported (van Neer et al. 2021), but many harbour seal haul-out locations in NL are in relatively inaccessible locations. Also, only a few beaches had both species present. Interspecific competition may also be responsible for the differences between grey and harbour seal haul-out locations, as these two species can have high levels of dietary overlap although different size ranges of prey are generally targeted by each species (Thompson et al. 1996; Hammill & Stenson 2000; Wilson & Hammond 2019; Planque et al. 2021).

The largest number of grey seals were found in SPM, Fortune Bay and west of Bay d'Espoir. Grey seals were recorded in the Grand Barachois in the 1960's with several hundred grey seals harvested at this location at this time, with less than 100 grey seals recorded there in the 1980's (Mansfield 1967; Davis & Renouf 1987). There are reports of grey seals pupping in the Grand Barachois prior to the 1950's although the accuracy of this is uncertain (D. Sergeant, unpub. data); presently no grey seal pupping colonies exist on SPM or NL. Seventy-four grey seals were recorded in SPM during this survey on 25 July with 43 of these seals present in the Grand Barachois. Multiple small groups were also present in Fortune Bay and west of Bay d'Espoir. It is possible that the lack of mention of grey seals in NL in earlier work done in Atlantic Canada may be due, at least partly, to a lack of significant sighting effort in this area rather than a true absence (e.g. Mansfield 1967; Mansfield & Beck 1977). Records of hundreds of grey seal tag returns (grey seal pups were tagged on Sable Island and the Gulf of St.

Lawrence) and bounty returns exist from across Newfoundland with the highest number in Placentia Bay (Stobo et al. 1990). The overall abundance of tag and bounty returns was not great however, with the majority of locations having fewer than 25 returns (Stobo et al. 1990).

No grey seals were spotted in the Notre Dame Bay-Bonavista Bay regions or northern Newfoundland and only one grey seal was seen in the water in Sandwich Bay, Labrador. Lists of mammals in Labrador from the late 1800's notes that grey seals were rare or fail to mention them (Stearns 1883; Bates 1898) and only limited numbers of grey seals were included in bounty returns and grey seal research in the 1970's and 1980's (Mansfield & Beck 1977; Boles et al. 1980; Stobo et al. 1990). However, tagged grey seal pups have been recovered along the coast of Labrador up to Hopewell and one grey seal jaw was also recovered from Port Burwell (present day Nunavut; Mansfield & Beck 1977). A grey seal was also observed by one of the authors (GBS) off of Nain, Labrador in 1988. More recently, 48 grey seals were collected for DFO NL's region sampling program in NAFO divisions 2J and 3K (44 of these are from 2J; Hammill et al. 2007). The majority of these seals were collected in the 1990's with none collected since 2008, possibly due to reduced spring and summer sampling effort. Of the 25 seals with ages, 9 were young of the year and 5 were greater than 10 years old (SLCL & CDH unpub. data). It is unknown whether grey seal abundance was already low due to hunting prior to the late 1800's but a more intensive survey effort in Labrador is needed to better understand current abundance and distribution.

The grey seals found along the coast of Newfoundland are present primarily during the summer and autumn months, although low numbers have been reported during the winter and spring (Stenson 1994; SLCL & CDH unpub. data). Tracking studies show that less than 5% of grey seals in Atlantic Canada travel to Newfoundland and Labrador during the summer and autumn (Breed et al. 2009; W.D. Bowen & M.O. Hammill, unpub. data). Additionally, 15 grey seals tagged in SPM in 2017 all left NL waters between September and December to return to Sable Island for the breeding period (Goulet et al. in prep). Pup production surveys to estimate grey seal population abundance take place approximately every 5 years in Atlantic Canada (most recently in 2021; DFO 2022). The majority of grey seal breeding takes place on Sable Island, Nova Scotia and southern areas of the Gulf of St. Lawrence. The south and west coasts of Newfoundland are also checked during these surveys but to date no pupping has been documented. The number of grey seals in NL has likely increased over the last decades with the increase in the population size of grey seals in Atlantic Canada. However, reports of grey seals seen during the summer in NL and SPM date back multiple decades when the total population size was much smaller than the present day, indicating that recent reports of grey seals in NL are not evidence of a range expansion to new areas (Mansfield 1967; Clay & Nielsen 1985).

This study marked the first attempt to arrive at a survey-based count of the number of harbour seals in NL. Future surveys may be able to make use of technological advances to increase the availability of seals to be photographed as both species were sometimes quite difficult to spot from the helicopter, especially if their pelage was a similar colour to the haul-out substrate. Photographic methods that simultaneously use infrared and visual colour streams could

enhance the ability to identify hauled out seals from a distance. Methods to increase picture quality would also enable the helicopter to fly further away from the shore which could hopefully reduce disturbance of hauled out seals. More effort should also be directed toward surveying the Labrador coastline as harbour seals were previously abundant in this area and present abundance and distribution is still largely unknown.

Despite differences in methodology between the present study and earlier research (Bouvla & McLaren 1979; Sjare et al. 2005), the results indicate that over the last decades harbour seals have increased in abundance in areas where they were once rare and disappeared from areas where they were once prevalent. However, comparison of the counts with bounty figures suggests that harbour seals have not returned to their historical abundance level, especially in Labrador. Repetitions of this survey will be needed to fully understand trends in the abundance and distribution of harbour seals in NL as well as regional variability in these metrics.

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TABLES

Table 1. Time and date of flights for the harbour seal survey flown along the coastline of the Newfoundland Shelf and in Sandwich Bay, Labrador during the summer of 2021 including the closest tide station and time of low tide.

Date	Area	Survey start	Survey end	Closest tide station	Time of low tide
6-Jul-21	Argentia to St. Vincent	10:30	13:20	Argentia	11:24
8-Jul-21	St. Vincent to St. John's	10:45	12:30	Bay Bulls	12:01
9-Jul-21	Willis Island to Little Fogo Islands	11:00	13:45	Twillingate	12:22
12-Jul-21	Horse Islands, Grey Islands, Southern Hare Bay	12:05	14:15	St. Anthony	14:07
13-Jul-21	Pistolet Bay, Grey Islands, Hare Bay	12:50	16:40	St. Anthony	14:44
14-Jul-21	White Islands, Belle Isle, Sandwich Bay	13:25	18:40	Cartwright	16:14
24-Jul-21	East side of Fortune Bay, Brunette Island, Sagona Island, southern Connaigre Peninsula	11:55	15:20	Hermitage	14:49
25-Jul-21	Southern Burin Peninsula, SPM	13:20	17:10	Burin	14:54
26-Jul-21	West side of Placentia Bay	14:00	17:30	Burin	15:36
4-Aug-21	Northeastern Placentia Bay	10:35	13:05	Argentia	10:52
5-Aug-21	Northwestern Placentia Bay	9:45	13:45	Argentia	11:46
9-Aug-21	Northwestern Placentia Bay	12:35	16:30	Argentia	14:33
10-Aug-21	Northern Fortune Bay	13:50	16:20	Hermitage	15:53
11-Aug-21	Northeastern Placentia Bay	13:50	14:40	Argentia	15:52
18-Aug-21	Facheux Bay to Hermitage Bay	8:52	13:23	Hermitage	10:57
19-Aug-21	Ramea, Burgeo, Penguin Islands and Connaigre Bay	10:10	13:24	Ramea	12:18

Table 2. Proportion of seals that were identified as either harbour or grey seals each day from the aerial survey flown along the coastline of the Newfoundland Shelf and in Sandwich Bay, Labrador during the summer of 2021. These proportions were used to give a species designation to the unknown seals from each survey day. Pv and Hg indicate harbour and grey seals, respectively.

Date	Number of identified Pv	Number of identified Hg	Total number of identified seals	Proportion identified Pv	Proportion identified Hg
2021-07-06	263	2	265	0.99	0.01
2021-07-08	330	33	363	0.91	0.09
2021-07-12	63	0	63	1.00	0.00
2021-07-13	324	0	324	1.00	0.00
2021-07-24	60	31	91	0.66	0.34
2021-07-25	815	99	914	0.89	0.11
2021-07-26	277	12	289	0.96	0.04
2021-08-04	120	1	121	0.99	0.01
2021-08-05	152	4	156	0.97	0.03
2021-08-09	198	11	209	0.95	0.05
2021-08-10	17	16	33	0.52	0.48
2021-08-18	21	28	49	0.43	0.57
2021-08-19	0	78	78	0.00	1.00

Table 3. The number of harbour (Pv), grey (Hg), unknown (Unk) and total seals at each location where seals were spotted during the harbour seal aerial survey flown along the coastline of the Newfoundland Shelf and in Sandwich Bay, Labrador during the summer of 2021. The adjusted counts are the number of harbour and grey seals when the number of unknown seals was corrected by the proportion of identified harbour and grey seals from each survey day (Table 2).

							Counts			Adjusted Counts		
Haulout	Date	Time	Lat (°N)	Lon (°E)	Location	Region	Pv	Hg	Unk	Pv	Hg	Total seals
HO178	2021/07/06	10:44	47.097	-54.077	Ship Cove	E Placentia Bay	1	0	0	1	0	1
HO001	2021/07/06	10:45	47.092	-54.089	Ballast Cove	E Placentia Bay	10	0	5	15	0	15
HO003	2021/07/06	11:46	46.953	-53.716	South Point	Great Colinet Island	52	1	0	52	1	53
HO004	2021/07/06	12:44	46.814	-53.655	N of Cent Cove	E St. Mary's Bay	120	0	16	136	0	136
HO005	2021/07/06	12:46	46.800	-53.665	Cape English	E St. Mary's Bay	68	1	0	68	1	69
HO006	2021/07/06	13:16	46.825	-53.664	False Cape Cove	E St. Mary's Bay	12	0	6	18	0	18
HO007	2021/07/08	10:53	46.680	-53.644	S of Watern Cove	E St. Mary's Bay	13	0	0	13	0	13
HO179	2021/07/08	10:54	46.665	-53.633	Boat Cove Gulch	E St. Mary's Bay	3	0	0	3	0	3
HO008	2021/07/08	11:02	46.658	-53.470	Caplin Cove	W Trepassey Bay	33	0	24	55	2	57
HO009	2021/07/08	11:04	46.693	-53.423	Little Pond Cove	W Trepassey Bay	0	0	63	57	6	63
HO010	2021/07/08	11:05	46.707	-53.405	Skinner Rocks	NW Trepassey Bay	23	0	2	25	0	25
HO011	2021/07/08	11:10	46.697	-53.328	S of Cape Mutton Head	NW Trepassey Bay	21	0	0	21	0	21
HO180	2021/07/08	11:11	46.699	-53.328	Cape Mutton Head	Trepassey Bay	1	0	0	1	0	1
HO012	2021/07/08	11:16	46.652	-53.235	The Rookery	E Trepassey Bay	73	0	0	73	0	73
HO013	2021/07/08	11:17	46.645	-53.227	Freshwater Cove	E Trepassey Bay	23	15	0	23	15	38
HO014	2021/07/08	11:22	46.638	-53.106	S of Cripple Cove	SE Avalon	6	0	4	10	0	10
HO015	2021/07/08	11:24	46.652	-53.082	Money Gulch	SE Avalon	13	0	0	13	0	13
HO016	2021/07/08	11:26	46.687	-53.063	Broad Cove	SE Avalon	40	0	0	40	0	40
HO017	2021/07/08	11:27	46.693	-53.055	N of Broad Cove	SE Avalon	57	1	0	57	1	58
HO018	2021/07/08	11:27	46.708	-53.044	S of Bells of Clam Cove	SE Avalon	10	0	0	10	0	10
HO019	2021/07/08	11:33	46.748	-53.005	Black Rocks	SE Avalon	0	17	1	1	17	18
HO020	2021/07/08	11:54	46.996	-52.897	Lawler Bay	E Avalon	14	0	0	14	0	14

Table 3 continued

							Counts			Adjusted Counts		
Haulout	Date	Time	Lat (°N)	Lon (°E)	Location	Region	Pv	Hg	Unk	Pv	Hg	Total seals
HO021	2021/07/13	13:11	51.535	-55.729	W of Muddy Gut Island	Pistolet Bay	22	0	0	22	0	22
HO022	2021/07/13	14:38	50.688	-55.613	Ile aux Canes	S of Bell Island	292	0	0	292	0	292
HO023	2021/07/13	14:56	50.773	-55.606	NW Bell Island	Grey Islands	3	0	0	3	0	3
HO181	2021/07/13	15:10	50.979	-55.626	N of Graois Island	Grey Islands	1	0	0	1	0	1
HO024	2021/07/13	15:47	51.257	-56.045	Goose Tickle Arm	Hare Bay	6	0	0	6	0	6
HO099	2021/07/24	13:04	47.273	-55.850	Little Cape	Brunette Island	0	0	11	7	4	11
HO100	2021/07/24	13:06	47.280	-55.868	E Brunette Island	Brunette Island	0	0	1	1	0	1
HO192	2021/07/24	13:08	47.300	-55.881	Northward Friar	Brunette Island	0	3	0	0	3	3
HO182	2021/07/24	13:13	47.278	-55.957	NW Brunette Island	Fortune Bay	0	1	0	0	1	1
HO101	2021/07/24	13:15	47.260	-55.975	Green Island	Brunette Island	3	0	1	4	0	4
HO102	2021/07/24	13:19	47.188	-56.057	Plate Islands	Fortune Bay	0	9	0	0	9	9
HO103	2021/07/24	13:21	47.184	-56.062	Little Plate Island	Fortune Bay	16	0	0	16	0	16
HO183	2021/07/24	13:27	47.250	-55.948	Bird Island	S of Brunette Island	0	0	3	2	1	3
HO104	2021/07/24	13:28	47.253	-55.939	Puffin Island	Fortune Bay	0	1	0	0	1	1
HO184	2021/07/24	13:28	47.253	-55.939	Puffin Island	S of Brunette Island	0	1	0	0	1	1
HO193	2021/07/24	13:32	47.266	-55.957	E of Northwest Head	Brunette Island	0	0	1	1	0	1
HO105	2021/07/24	13:36	47.260	-55.903	S of Forward's Cove	Brunette Island	0	1	0	0	1	1
HO106	2021/07/24	13:46	47.373	-55.778	Eastern Cove	Sagona Island	2	0	0	2	0	2
HO107	2021/07/24	13:47	47.378	-55.772	Little Sagona Island	Fortune Bay	5	1	0	5	1	6
HO108	2021/07/24	13:48	47.372	-55.795	N Sagona Island	Fortune Bay	20	6	0	20	6	26
HO109	2021/07/24	14:37	47.450	-55.777	Eastern Head	N Fortune Bay	0	3	0	0	3	3
HO110	2021/07/24	14:52	47.552	-55.608	Sandy Point	Great Bay de l'Eau	0	5	0	0	5	5
HO111	2021/07/24	15:08	47.439	-55.664	N of St. John's Head	N Fortune Bay	4	0	0	4	0	4
HO194	2021/07/24	15:13	47.409	-55.632	E of St. John's Island	N Fortune Bay	0	0	1	1	0	1
HO112	2021/07/24	15:14	47.405	-55.647	S of St. John's Island	N Fortune Bay	10	0	0	10	0	10
HO113	2021/07/24	15:15	47.405	-55.647	S of St. John's Island	N Fortune Bay	0	0	2	1	1	2
HO025	2021/07/25	13:34	47.022	-55.929	N of Lee Beach	SE Fortune Bay	1	0	0	1	0	1

Table 3 continued

							Counts			Adjusted Counts		
Haulout	Date	Time	Lat (°N)	Lon (°E)	Location	Region	Pv	Hg	Unk	Pv	Hg	Total seals
HO026	2021/07/25	13:43	46.887	-55.913	Point May Pond	S Burin Peninsula	19	0	0	19	0	19
HO027	2021/07/25	13:53	46.860	-56.094	Little Green Islands	S of Burin Peninsula	72	24	3	75	24	99
HO028	2021/07/25	14:06	46.896	-56.272	Cap aux Morts	SPM	49	0	0	49	0	49
HO029	2021/07/25	14:13	46.990	-56.302	Grand Barachois	SPM	203	43	0	203	43	246
HO030	2021/07/25	14:25	47.058	-56.226	E of Pte aux Soldats	SPM	70	4	22	90	6	96
HO031	2021/07/25	14:26	47.051	-56.243	E of Pte aux Soldats	SPM	17	1	14	29	3	32
HO032	2021/07/25	14:30	47.093	-56.327	Pte du Chapeau	SPM	1	0	0	1	0	1
HO033	2021/07/25	14:32	47.097	-56.341	Batture de la Chatte	SPM	71	2	0	71	2	73
HO034	2021/07/25	14:39	47.132	-56.384	Le Gros Bec	SPM	0	1	0	0	1	1
HO035	2021/07/25	14:46	47.035	-56.515	W of Grande Miquelon	SPM	11	2	8	18	3	21
HO036	2021/07/25	14:50	47.018	-56.385	N of Pte à la Jument	SPM	0	9	0	0	9	9
HO037	2021/07/25	14:59	46.856	-56.386	Cap Sauveur	SPM	20	0	3	23	0	23
HO038	2021/07/25	15:00	46.833	-56.407	Cap Corbeau	SPM	52	0	0	52	0	52
HO039	2021/07/25	15:04	46.807	-56.376	W of Cap Bleu	SPM	4	0	0	4	0	4
HO040	2021/07/25	15:06	46.798	-56.365	E of Cap Bleu	SPM	49	0	1	50	0	50
HO041	2021/07/25	15:07	46.790	-56.354	W of Point du Ouest	SPM	0	5	0	0	5	5
HO042	2021/07/25	15:08	46.783	-56.343	Point du Ouest	SPM	0	0	3	3	0	3
HO043	2021/07/25	15:09	46.804	-56.311	SW of Les Pointes Vertes	SPM	19	0	0	19	0	19
HO044	2021/07/25	15:10	46.810	-56.298	SW of Les Pointes Vertes	SPM	15	0	0	15	0	15
HO045	2021/07/25	15:10	46.815	-56.290	SW of Les Pointes Vertes	SPM	24	0	0	24	0	24
HO046	2021/07/25	15:10	46.818	-56.283	Les Pointes Vertes	SPM	14	0	0	14	0	14
HO047	2021/07/25	15:11	46.822	-56.273	NE of Les Pointes Vertes	SPM	0	0	1	1	0	1
HO048	2021/07/25	15:18	46.756	-56.193	Anse à Ravenel	SPM	0	0	9	8	1	9
HO049	2021/07/25	15:23	46.798	-56.133	Ile aux Pigeons	SPM	0	7	0	0	7	7
HO050	2021/07/25	15:45	46.847	-55.831	E of Morgan's Island	S Burin Peninsula	6	1	4	10	1	11
HO051	2021/07/25	15:51	46.861	-55.782	Lamaline Bay	S Burin Peninsula	58	0	0	58	0	58
HO052	2021/07/25	16:04	46.905	-55.605	Split Cove	S Burin Peninsula	16	0	0	16	0	16

Table 3 continued

							Counts			Adjusted Counts		
Haulout	Date	Time	Lat (°N)	Lon (°E)	Location	Region	Pv	Hg	Unk	Pv	Hg	Total seals
HO053	2021/07/25	16:48	46.877	-55.482	Lawn Point	S Burin Peninsula	4	0	5	8	1	9
HO054	2021/07/25	17:01	46.908	-55.321	Middle Bight Cove	SW Placentia Bay	3	0	1	4	0	4
HO055	2021/07/25	17:04	46.912	-55.282	Teddy Bear Cove	SW Placentia Bay	6	0	0	6	0	6
HO056	2021/07/25	17:06	46.926	-55.256	Georges Cove	SW Placentia Bay	6	0	0	6	0	6
HO185	2021/07/25	17:07	46.933	-55.249	Pork Cove	W Placentia Bay	0	0	2	2	0	2
HO057	2021/07/25	17:08	46.938	-55.243	L'Anse au Diable	SW Placentia Bay	5	0	0	5	0	5
HO114	2021/07/26	14:27	47.011	-55.150	Seal Cove	Burin Island	9	0	0	9	0	9
HO115	2021/07/26	15:39	47.144	-55.076	Ball Island	W Placentia Bay	35	0	0	35	0	35
HO116	2021/07/26	15:39	47.144	-55.076	Ball Island	W Placentia Bay	20	0	14	33	1	34
HO117	2021/07/26	15:50	47.249	-55.016	Red Landing Head	W Placentia Bay	23	0	0	23	0	23
HO118	2021/07/26	15:55	47.250	-54.960	Great Colombier Rocks	W Placentia Bay	6	0	4	10	0	10
HO119	2021/07/26	16:01	47.270	-54.886	Tinkershare Island	W Placentia Bay	5	0	0	5	0	5
HO120	2021/07/26	16:08	47.245	-54.877	Green Island	W Placentia Bay	32	0	0	32	0	32
HO121	2021/07/26	16:11	47.221	-54.836	South of Jude Island	W Placentia Bay	82	1	0	82	1	83
HO122	2021/07/26	16:15	47.233	-54.782	Harbour Rocks	W Placentia Bay	49	8	10	59	8	67
HO123	2021/07/26	16:19	47.273	-54.789	N Jude Island	W Placentia Bay	0	1	0	0	1	1
HO124	2021/07/26	16:20	47.274	-54.801	N Jude Island	W Placentia Bay	3	0	1	4	0	4
HO125	2021/07/26	16:21	47.270	-54.838	N of Poplars Head	Jude Island	0	2	0	0	2	2
HO126	2021/07/26	16:30	47.309	-54.793	NW Emberleys Island	W Placentia Bay	13	0	0	13	0	13
HO127	2021/07/26	16:41	47.245	-54.948	Long Rock	W Placentia Bay	0	0	13	12	1	13
HO128	2021/08/04	10:59	47.426	-53.966	E of Harbour Island	E Placentia Bay	3	1	0	3	1	4
HO129	2021/08/04	12:18	47.382	-54.146	N of Red Head	Red Island	2	0	1	3	0	3
HO195	2021/08/04	12:20	47.412	-54.155	Wild Cove	Red Island	1	0	0	1	0	1
HO130	2021/08/04	12:25	47.379	-54.216	Blue Point	Red Island	2	0	0	2	0	2
HO131	2021/08/04	12:26	47.369	-54.221	Hole in the Wall Point	Red Island	8	0	0	8	0	8
HO186	2021/08/04	12:28	47.359	-54.205	Red Point	Red Island	0	0	1	1	0	1
HO132	2021/08/04	12:29	47.356	-54.185	Ragged Point	Red Island	17	0	0	17	0	17

Table 3 continued

							Counts			Adjusted Counts		
Haulout	Date	Time	Lat (°N)	Lon (°E)	Location	Region	Pv	Hg	Unk	Pv	Hg	Total seals
HO133	2021/08/04	12:31	47.356	-54.188	Ragged Point	Red Island	12	0	0	12	0	12
HO134	2021/08/04	12:32	47.359	-54.180	E of Ragged Point	Red Island	3	0	2	5	0	5
HO135	2021/08/04	12:34	47.376	-54.147	N of Red Head	Red Island	0	0	6	6	0	6
HO196	2021/08/04	12:34	47.361	-54.169	Stony Point	Red Island	0	0	5	5	0	5
HO136	2021/08/04	12:37	47.455	-54.138	N of Little Seal Island	E Placentia Bay	39	0	0	39	0	39
HO187	2021/08/04	12:37	47.450	-54.137	SE of Little Seal Island	N Placentia Bay	0	0	1	1	0	1
HO188	2021/08/04	12:37	47.453	-54.135	Little Seal Island	N Placentia Bay	0	0	3	3	0	3
HO197	2021/08/04	12:38	47.452	-54.141	W of Little Seal Island	N Placentia Bay	6	0	0	6	0	6
HO137	2021/08/04	12:39	47.481	-54.107	N of Great Seal Island	E Placentia Bay	22	0	0	22	0	22
HO138	2021/08/04	12:40	47.470	-54.127	N of Great Seal Island	E Placentia Bay	2	0	0	2	0	2
HO198	2021/08/04	12:55	47.587	-54.083	N of Collett Cove	Long Island	2	0	0	2	0	2
HO139	2021/08/04	13:01	47.703	-54.085	The Jerseyman	N Placentia Bay	1	0	0	1	0	1
HO140	2021/08/05	10:18	47.388	-54.273	Dirty Rocks	S of Merasheen Island	61	0	0	61	0	61
HO141	2021/08/05	10:20	47.396	-54.249	S of Redland Point	Merasheen Island	17	0	0	17	0	17
HO142	2021/08/05	10:20	47.402	-54.241	Redland Point	Merasheen Island	6	0	0	6	0	6
HO143	2021/08/05	10:25	47.491	-54.176	SE Rose au Rue Island	N Placentia Bay	22	0	0	22	0	22
HO144	2021/08/05	10:27	47.512	-54.157	Duck Rocks	E of Rose au Rue Island	0	1	0	0	1	1
HO145	2021/08/05	10:41	47.583	-54.141	Little Butler Island	E of Little Brule	1	0	0	1	0	1
HO146	2021/08/05	10:46	47.623	-54.117	The Castles	E of Little Brule	0	1	1	1	1	2
HO147	2021/08/05	10:51	47.677	-54.117	Batts Island	E of Little Brule	2	0	2	4	0	4
HO148	2021/08/05	10:54	47.694	-54.127	N of White Island	N Placentia Bay	0	1	0	0	1	1
HO149	2021/08/05	11:27	47.393	-54.322	W of Little Bald Head	Merasheen Island	8	0	0	8	0	8
HO150	2021/08/05	11:27	47.393	-54.310	Little Bald Head	Merasheen Island	8	0	0	8	0	8
HO152	2021/08/05	11:29	47.393	-54.313	Little Bald Head	Merasheen Island	7	0	0	7	0	7
HO151	2021/08/05	11:30	47.392	-54.298	Big Bald Head	Merasheen Island	0	0	4	4	0	4
HO153	2021/08/05	11:30	47.391	-54.287	E of Big Bald Head	Merasheen Island	0	0	2	2	0	2
HO154	2021/08/05	11:31	47.391	-54.277	N of Dirty Rocks	Merasheen Island	4	0	0	4	0	4

Table 3 continued

							Counts			Adjusted Counts		
Haulout	Date	Time	Lat (°N)	Lon (°E)	Location	Region	Pv	Hg	Unk	Pv	Hg	Total seals
HO155	2021/08/05	12:25	47.336	-54.574	Eddy Point	Marticot Island	0	1	7	7	1	8
HO156	2021/08/05	12:33	47.310	-54.699	SW Long Island	E Placentia Bay	0	0	1	1	0	1
HO157	2021/08/05	12:37	47.344	-54.644	Long Island Point	Long Island	0	0	2	2	0	2
HO158	2021/08/05	13:00	47.388	-54.687	S of Gooseberry Island	Nonsuch Inlet	0	0	13	13	0	13
HO199	2021/08/05	13:02	47.376	-54.675	Nonsuch Head	W Placentia Bay	2	0	0	2	0	2
HO159	2021/08/05	13:08	47.388	-54.633	Sound Island	E Placentia Bay	5	0	9	14	0	14
HO200	2021/08/05	13:09	47.397	-54.617	E of Sound Island	Paradise Sound	3	0	0	3	0	3
HO189	2021/08/05	13:10	47.421	-54.589	SW of Gilberts Cove	Paradise Sound	0	0	1	1	0	1
HO160	2021/08/05	13:46	47.348	-54.527	Black Rock	E Placentia Bay	6	0	0	6	0	6
HO058	2021/08/09	12:58	47.426	-54.433	Long Point	W Placentia Bay	5	0	0	5	0	5
HO059	2021/08/09	12:58	47.436	-54.419	S of Rocky Cove	W Placentia Bay	5	0	13	17	1	18
HO060	2021/08/09	12:59	47.441	-54.414	Rocky Cove	W Placentia Bay	0	0	2	2	0	2
HO061	2021/08/09	13:16	47.470	-54.399	Canary Islands	W Placentia Bay	1	0	0	1	0	1
HO062	2021/08/09	13:21	47.494	-54.372	Pete Cove	W Placentia Bay	12	0	0	12	0	12
HO063	2021/08/09	13:25	47.532	-54.365	Grandmother Rocks	NW Placentia Bay	24	0	3	27	0	27
HO064	2021/08/09	14:23	47.682	-54.246	Duck Rock	NW Placentia Bay	1	0	0	1	0	1
HO065	2021/08/09	15:21	47.491	-54.307	Black Rock	NW Placentia Bay	18	1	0	18	1	19
HO066	2021/08/09	15:22	47.496	-54.302	Green Islands	NW Placentia Bay	0	0	2	2	0	2
HO067	2021/08/09	15:23	47.500	-54.299	Sugarloaf Island	NW Placentia Bay	0	0	3	3	0	3
HO068	2021/08/09	15:25	47.503	-54.289	Tinker Rocks	NW Placentia Bay	7	0	0	7	0	7
HO069	2021/08/09	15:27	47.518	-54.293	Tinker Rocks	NW Placentia Bay	17	0	0	17	0	17
HO070	2021/08/09	15:36	47.519	-54.291	N of Crane Island	NW Placentia Bay	0	0	4	4	0	4
HO071	2021/08/09	15:41	47.549	-54.231	E of South Tilt Island	NW Placentia Bay	0	0	4	4	0	4
HO201	2021/08/09	15:48	47.577	-54.239	W of Pond Head	NW Placentia Bay	0	0	1	1	0	1
HO072	2021/08/09	15:50	47.567	-54.249	Ragged Islands	NW Placentia Bay	0	1	6	6	1	7
HO073	2021/08/09	15:51	47.574	-54.261	S of Roost Rock	NW Placentia Bay	7	0	0	7	0	7
HO074	2021/08/09	15:54	47.592	-54.272	S of Greens Island	NW Placentia Bay	7	0	14	20	1	21

Table 3 continued

							Counts			Adjusted Counts		
Haulout	Date	Time	Lat (°N)	Lon (°E)	Location	Region	Pv	Hg	Unk	Pv	Hg	Total seals
HO075	2021/08/09	15:54	47.596	-54.277	Gooseberry Island	NW Placentia Bay	6	0	4	10	0	10
HO076	2021/08/09	15:58	47.578	-54.281	West Island	NW Placentia Bay	46	5	4	50	5	55
HO077	2021/08/09	16:00	47.560	-54.260	W of Fish Islands	NW Placentia Bay	12	0	0	12	0	12
HO078	2021/08/09	16:01	47.559	-54.260	W of Fish Islands	NW Placentia Bay	0	0	1	1	0	1
HO079	2021/08/09	16:01	47.551	-54.269	W of Harbour Island	NW Placentia Bay	4	0	2	6	0	6
HO202	2021/08/09	16:10	47.635	-54.162	E of North Tilt Island	NW Placentia Bay	0	0	1	1	0	1
HO080	2021/08/09	16:12	47.635	-54.179	W of North Tilt Island	NW Placentia Bay	0	0	2	2	0	2
HO081	2021/08/09	16:17	47.625	-54.202	Marshall Island	NW Placentia Bay	26	0	0	26	0	26
HO082	2021/08/09	16:19	47.618	-54.222	SW of Green Island	NW Placentia Bay	0	4	0	0	4	4
HO190	2021/08/10	13:57	47.410	-55.615	N of Blanchard Cove	S St. John's Bay	0	0	3	2	1	3
HO161	2021/08/10	13:59	47.398	-55.609	Shepard Rock	N Fortune Bay	16	3	8	20	7	27
HO203	2021/08/10	14:00	47.398	-55.602	Blanchet	N Fortune Bay	0	0	2	1	1	2
HO162	2021/08/10	15:11	47.607	-55.355	Dog Island	Belle Bay	0	12	0	0	12	12
HO163	2021/08/10	16:00	47.589	-55.098	Gull Island	Long Harbour	0	1	0	0	1	1
HO191	2021/08/10	16:07	47.599	-54.993	Wood Island	Fortune Bay	1	0	0	1	0	1
HO164	2021/08/18	9:13	47.726	-56.091	Pot Harbour	Bay d'Espoir	0	1	0	0	1	1
HO165	2021/08/18	9:18	47.630	-56.159	Saddle Island	Bay d'Espoir	5	0	0	5	0	5
HO204	2021/08/18	9:32	47.715	-56.151	N of Stone Island	Bay d'Espoir	0	0	1	0	1	1
HO166	2021/08/18	10:00	47.708	-56.105	Goblin Bay	Bay d'Espoir	1	0	0	1	0	1
HO168	2021/08/18	10:05	47.691	-56.118	Goblin Head	Bay d'Espoir	0	0	12	5	7	12
HO169	2021/08/18	12:20	47.636	-56.104	Engine Cove	Bay d'Espoir	0	1	0	0	1	1
HO170	2021/08/18	12:22	47.629	-56.095	Whale Island	Bay d'Espoir	0	2	0	0	2	2
HO171	2021/08/18	12:32	47.615	-56.050	Tinker Rocks	N Hermitage Bay	4	0	0	4	0	4
HO172	2021/08/18	12:34	47.614	-56.030	Patricks Harbour	N Hermitage Bay	8	0	16	15	9	24
HO173	2021/08/18	12:38	47.607	-55.982	SE of King Island	N Hermitage Bay	2	0	0	2	0	2
HO174	2021/08/18	12:41	47.598	-55.927	S of Thornhill Cove	N Hermitage Bay	0	0	8	3	5	8
HO175	2021/08/18	13:04	47.564	-55.966	Fox Island	N Hermitage Bay	0	0	1	0	1	1

Table 3 continued

							Counts			Adjusted Counts		
Haulout	Date	Time	Lat (°N)	Lon (°E)	Location	Region	Pv	Hg	Unk	Pv	Hg	Total seals
HO176	2021/08/18	13:17	47.485	-56.205	W of Pass Island	S Hermitage Bay	0	2	0	0	2	2
HO177	2021/08/18	13:19	47.479	-56.204	SW of Pass Island	S Hermitage Bay	1	22	3	2	24	26
HO205	2021/08/19	10:12	47.538	-56.955	Naked Man	E of Ramea	0	0	1	0	1	1
HO083	2021/08/19	10:17	47.569	-57.003	Gulch Cove Islands	E of Ramea	0	6	0	0	6	6
HO084	2021/08/19	10:19	47.569	-57.015	Gulch Cove Islands	E of Ramea	0	1	0	0	1	1
HO085	2021/08/19	10:34	47.508	-57.440	Ramea Colombier	W of Ramea	0	0	1	0	1	1
HO086	2021/08/19	10:45	47.469	-57.282	SE of Great Island	E of Ramea	0	3	0	0	3	3
HO087	2021/08/19	11:21	47.583	-57.703	West Flat Island	S of Burgeo	0	4	0	0	4	4
HO088	2021/08/19	11:23	47.579	-57.679	SE of Harbour Island	S of Burgeo	0	0	2	0	2	2
HO089	2021/08/19	11:27	47.554	-57.665	S of Miffel Island	S of Burgeo	0	8	0	0	8	8
HO090	2021/08/19	11:32	47.580	-57.631	Seal Islands	S of Burgeo	0	0	2	0	2	2
HO091	2021/08/19	11:58	47.634	-57.350	NE of Seal Island	White Bear Bay	0	1	2	0	3	3
HO092	2021/08/19	12:30	47.378	-56.985	Penguin Islands	E of Ramea	0	15	0	0	15	15
HO093	2021/08/19	12:30	47.379	-56.986	Penguin Islands	E of Ramea	0	9	0	0	9	9
HO094	2021/08/19	12:50	47.493	-56.020	Salmon Island	W Connaigre Bay	0	24	0	0	24	24
HO095	2021/08/19	13:00	47.541	-55.828	Doughball Point	N Connaigre Bay	0	1	0	0	1	1
HO096	2021/08/19	13:11	47.516	-55.872	Great Island	Connaigre Bay	0	6	0	0	6	6
HO206	2021/08/19	13:20	47.436	-55.932	Connaigre Head	Fortune Bay	0	0	1	0	1	1
TOTAL							2577	315	449	2961	380	3341

Table 4. Summary counts of harbour (Pv), grey (Hg), unknown (Unk) and total number of seals in regions around Newfoundland and Labrador observed in the aerial survey flown along the coastline of the Newfoundland Shelf and in Sandwich Bay, Labrador during the summer of 2021. The adjusted counts are the number of harbour and grey seals when the number of unknown seals was corrected by the proportion of identified harbour and grey seals from each survey day (Table 2). SPM stands for Saint Pierre and Miquelon, France.

	Counts			Adjusted Counts		
	Pv	Hg	Unk	Pv	Hg	Total seals
Sandwich Bay (Labrador)	0	0	0	0	0	0
Pistolet Bay	22	0	0	22	0	22
Hare Bay	6	0	0	6	0	6
Grey Islands	296	0	0	296	0	296
Southeastern Avalon	140	18	5	145	18	163
Trepassey Bay	174	15	89	255	23	278
St. Mary's Bay	268	2	22	290	2	292
Placentia Bay	778	28	177	951	32	983
Southern Burin Peninsula	175	25	12	186	26	212
Fortune Bay	73	37	17	82	45	127
Sagona Island	2	0	0	2	0	2
Brunette Island	3	5	17	15	10	25
Great Bay de l'Eau	0	5	0	0	5	5
Connnaigre Bay	0	31	0	0	31	31
Hermitage Bay	15	24	28	26	41	67
Bay D'Espoir	6	4	13	11	12	23
West of Bay D'Espoir	0	47	8	0	55	55
Grand Barachois (SPM)	203	43	0	203	43	246
SPM (excluding Grand Barachois)	416	31	61	471	37	508
TOTAL	2577	315	449	2961	380	3341

Table 5. Results of the linear models used to compare each reader's count to the best count for the aerial survey of harbour seals flown along the coastline of the Newfoundland Shelf and in Sandwich Bay, Labrador during the summer of 2021. Shown are the estimate, standard error, t value, p value and multiple r-squared from the model run for each reader.

Reader	Estimate	Std. Error	t value	p value	R-squared
Reader 1	1.029	0.011	95.220	<0.001	0.994
Reader 2	1.059	0.009	118.300	<0.001	0.996

Table 6. Comparison of the number of harbour seals from Templeman et al. (1957; number of bounty returns, 1952-55), Bouvla & McLaren (1979; population estimate from bounty returns), Sjare et al. (2005; small boat or shore based surveys over limited areas) and the present aerial survey of harbour seals flown along the coastline of the Newfoundland Shelf and in Sandwich Bay, Labrador during the summer of 2021. Disappeared indicates that harbour seals had disappeared from the location during the last 15 years and NA indicates that this location was not mentioned in that study. SPM stands for Saint Pierre and Miquelon, France.

Location	Templeman et al. (1957)	Bouvla & McLaren (1979)	Sjare et al. (2005)	Present survey
Sandwich Bay region	210-314	NA	NA	0
Pistolet Bay	21-50	NA	NA	22
Hare Bay	101-200	NA	NA	6
St. Anthony	NA	20 (declining)	NA	0
Grey Islands	NA	Disappeared	NA	296
White Bay	101-200	Disappeared	NA	0
Notre Dame Bay	201-314	685 (declining)	NA	0
Bonavista Bay	21-50		NA	0
Trinity Bay	NA	Disappeared	NA	NA
Chance Cove	21-50	20 (stable)	164	1
Trepassey Bay	8-20	NA	NA	255
St. Mary's Bay	21-50	910 (declining)	296	290
Placentia Bay	21-50			951
Southern Burin Peninsula	NA	NA	46	186
Fortune Bay	Presence	NA	24	99
Bay d'Espoir	NA	NA	NA	11
Ramea/Penguin Islands	NA	NA	NA	0
Burgeo	8-20	100 (declining)	NA	0
SPM	NA (grey seal colony)	300 (declining)	NA	674
TOTAL	734-1318	2035		2791

FIGURES

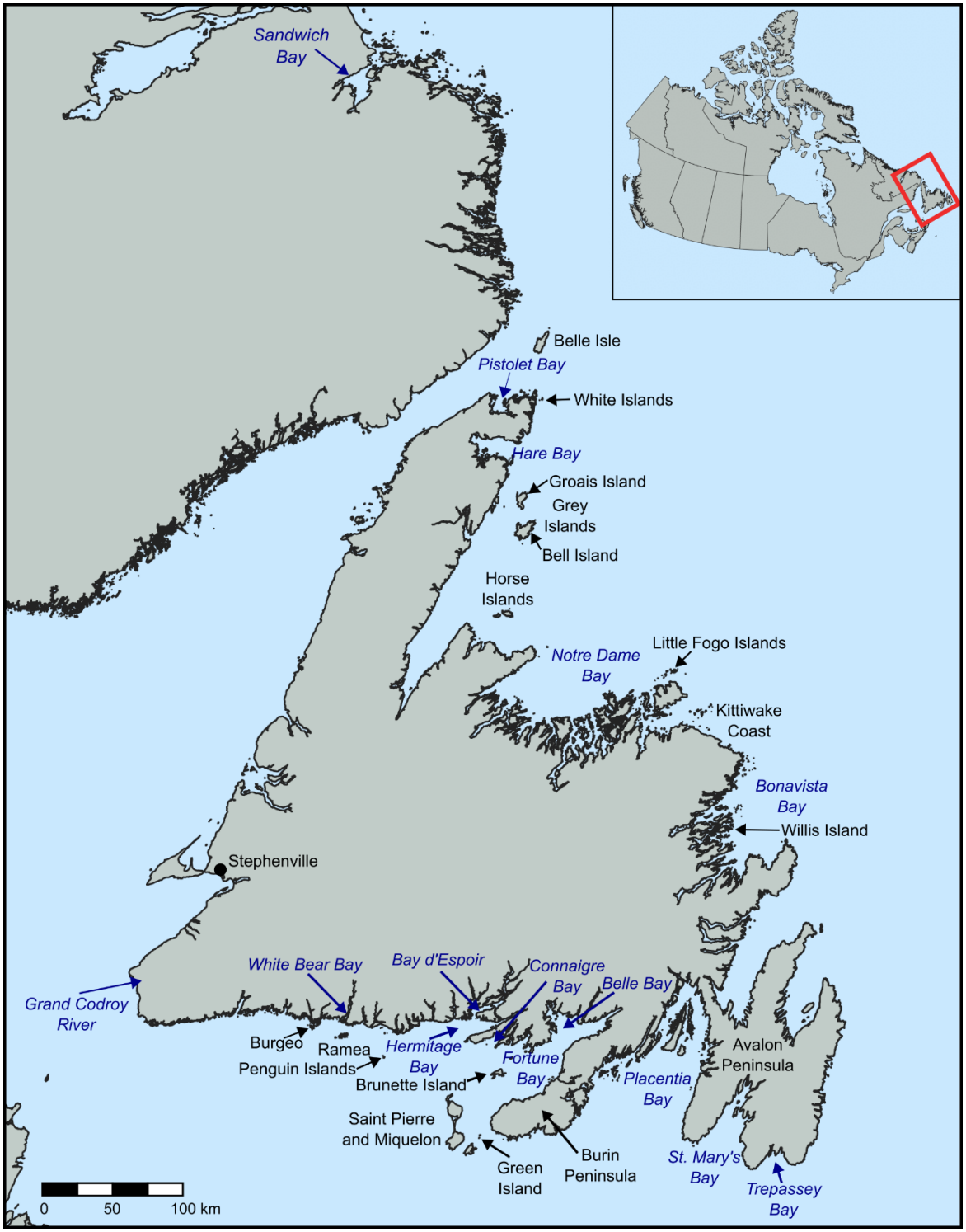

Figure 1. Map of Newfoundland and Sandwich Bay, Labrador with place names in black and water bodies in blue.

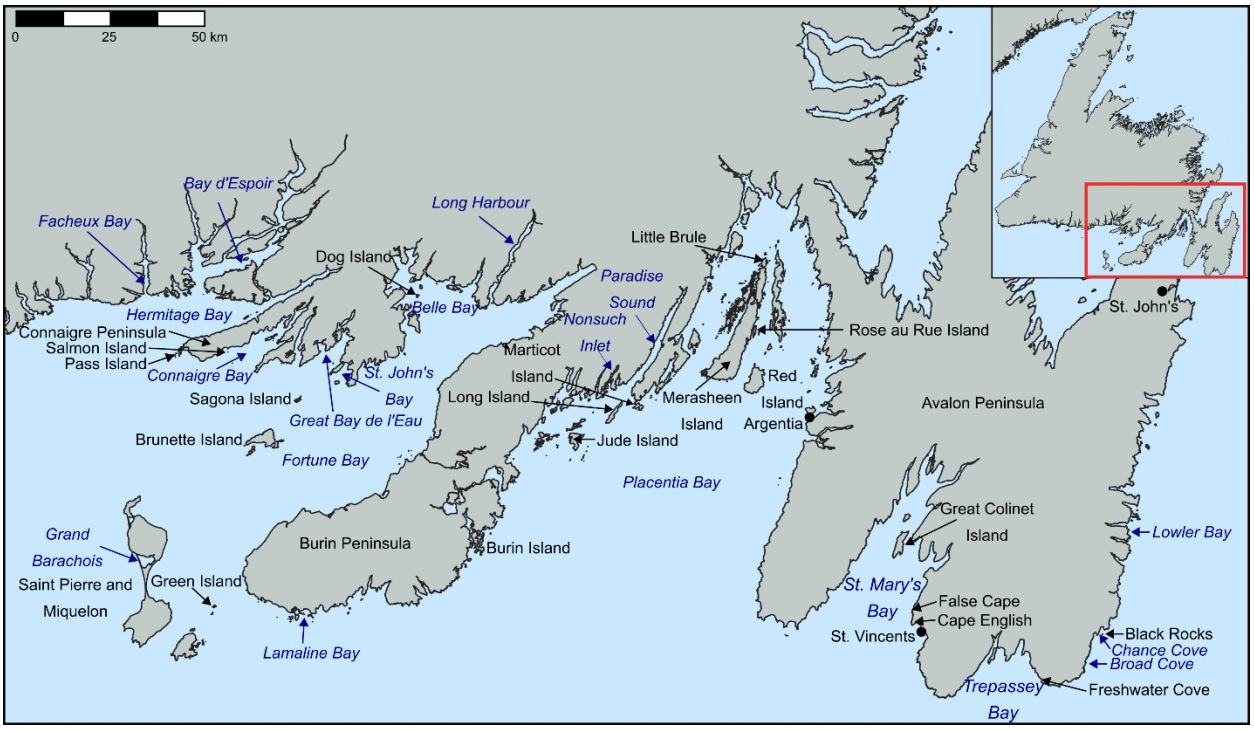

Figure 2. Map of southern Newfoundland with place names in black and water bodies in blue.

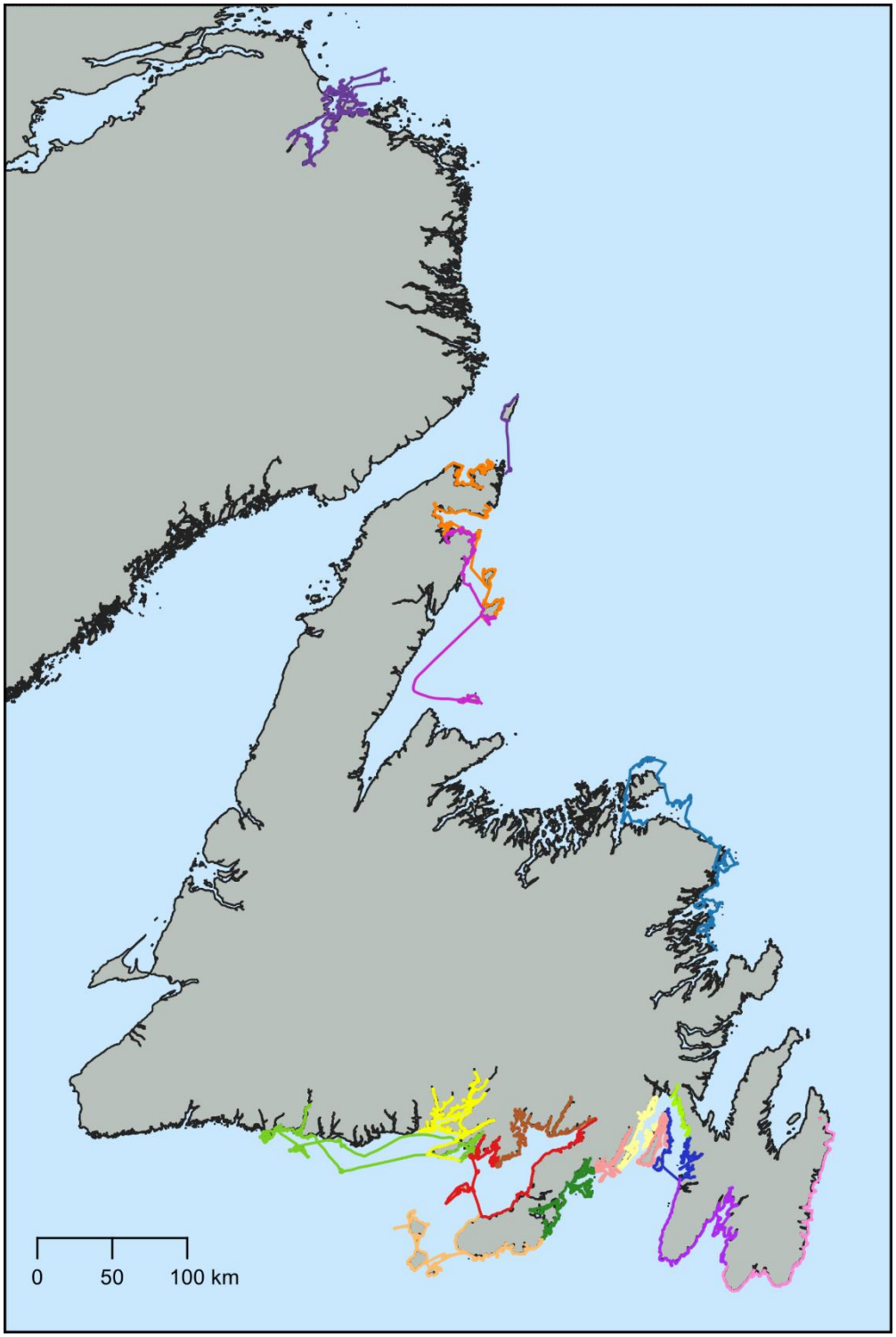

Figure 3. Flight paths for the harbour seal survey flown along the coastline of the Newfoundland Shelf and in Sandwich Bay, Labrador during the summer of 2021. Different colours denote the helicopter survey track on different flight days.

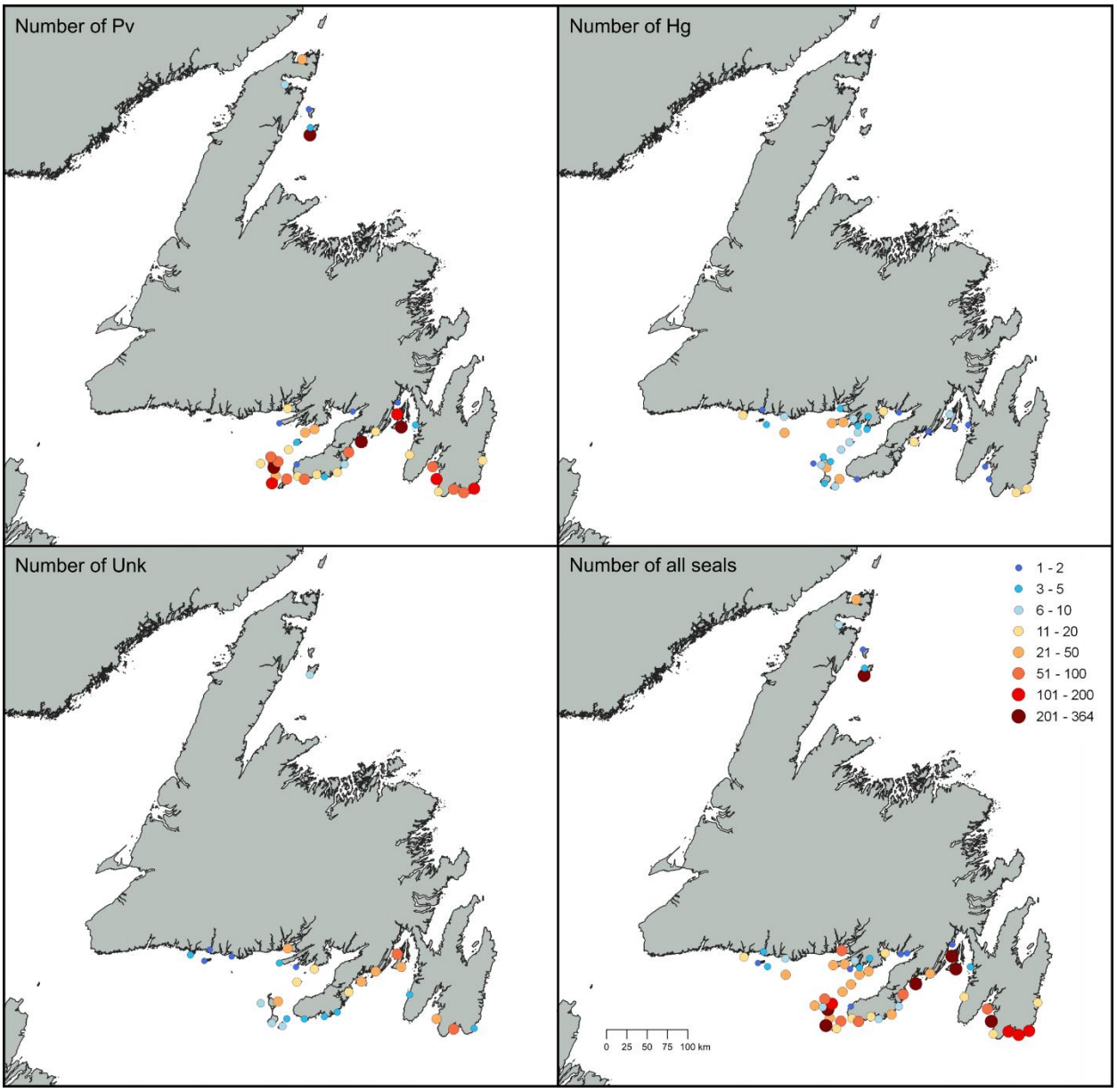

Figure 4. Maps of the count and distribution of harbour (Pv), grey (Hg), unknown (Unk) and all seals seen hauled out during the harbour seal aerial survey flown along the coastline of the Newfoundland Shelf and in Sandwich Bay, Labrador (no sightings of hauled out seals) in July and August 2021. The sightings are grouped by all sightings that occurred within 7 km of each other for visualization purposes.

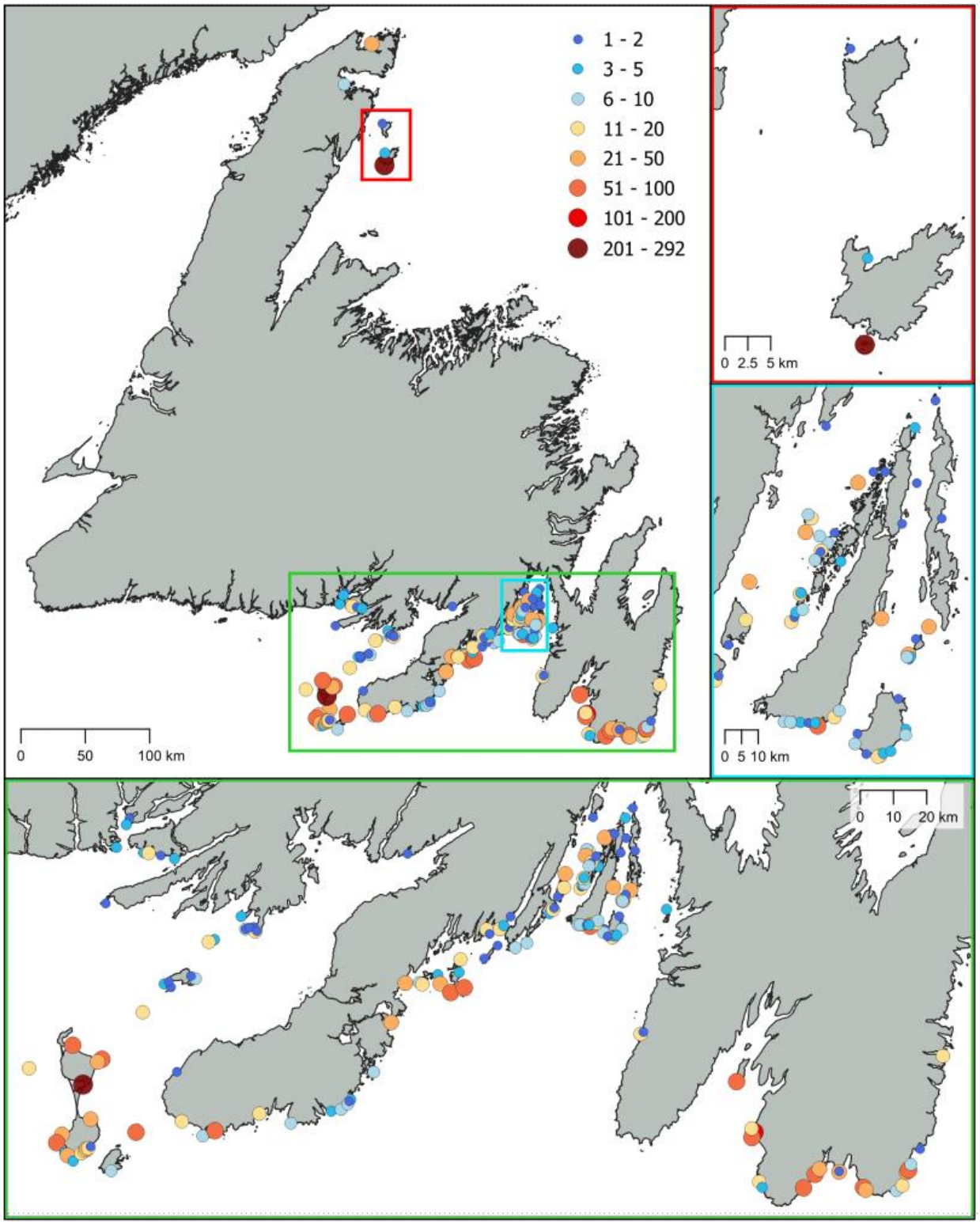

Figure 5. Counts of the number of hauled out harbour seals seen during the harbour seal aerial survey flown along the coastline of the Newfoundland Shelf and in Sandwich Bay, Labrador (no sightings of hauled out seals) during the summer of 2021. These counts of harbour seals include the unknown seals assigned to species by the proportion of identified seals from each survey day.

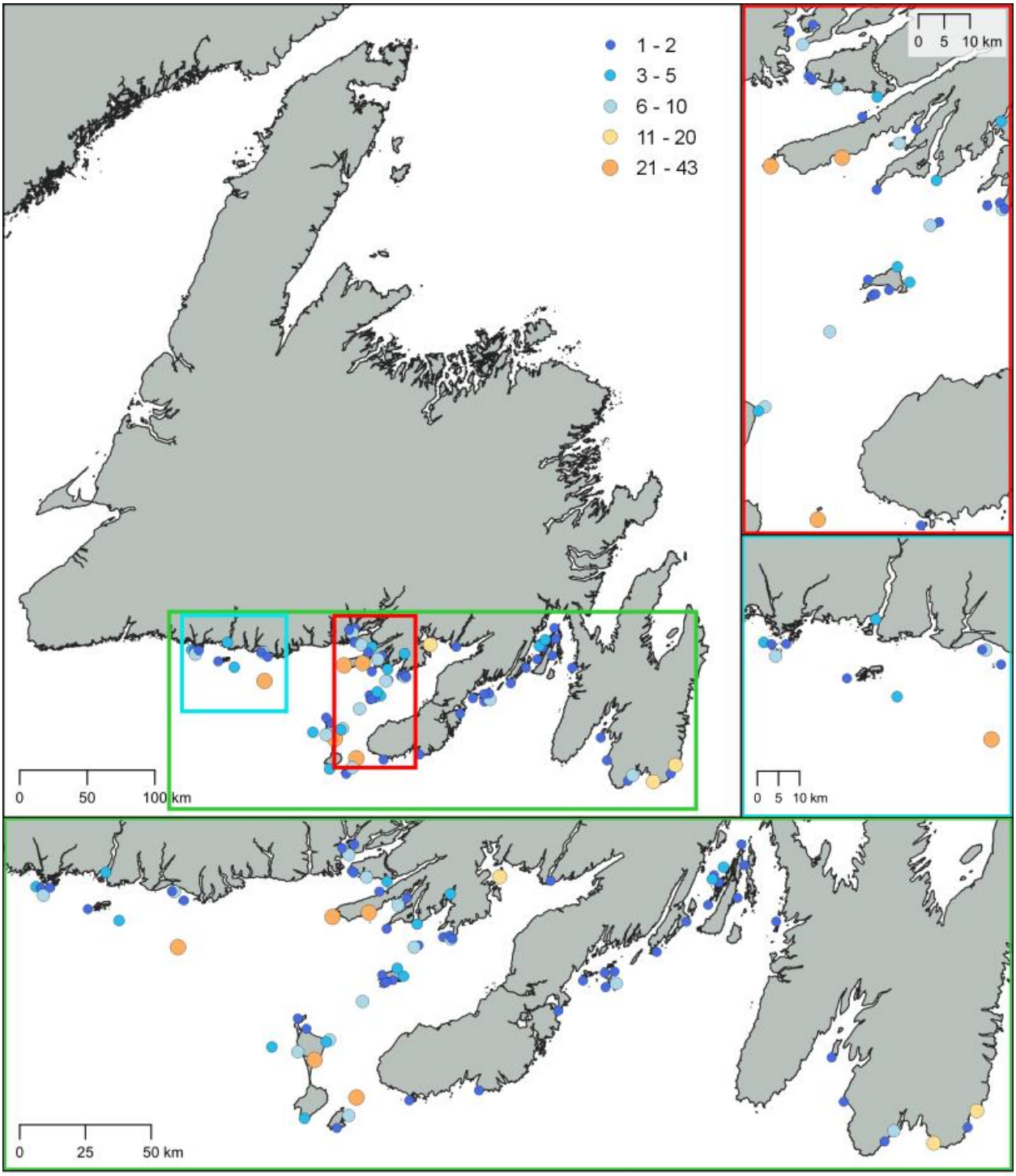

Figure 6. Counts of the number of hauled out grey seals seen during the harbour seal aerial survey flown along the coastline of the Newfoundland Shelf and in Sandwich Bay, Labrador (no sightings of hauled out seals) during the summer of 2021. These counts of grey seals include the unknown seals assigned to species by the proportion of identified seals from each survey day. Counts HO092 and HO093 (furthest west orange point) were combined as the close proximity of the points meant that both sightings could not be seen in the figure.

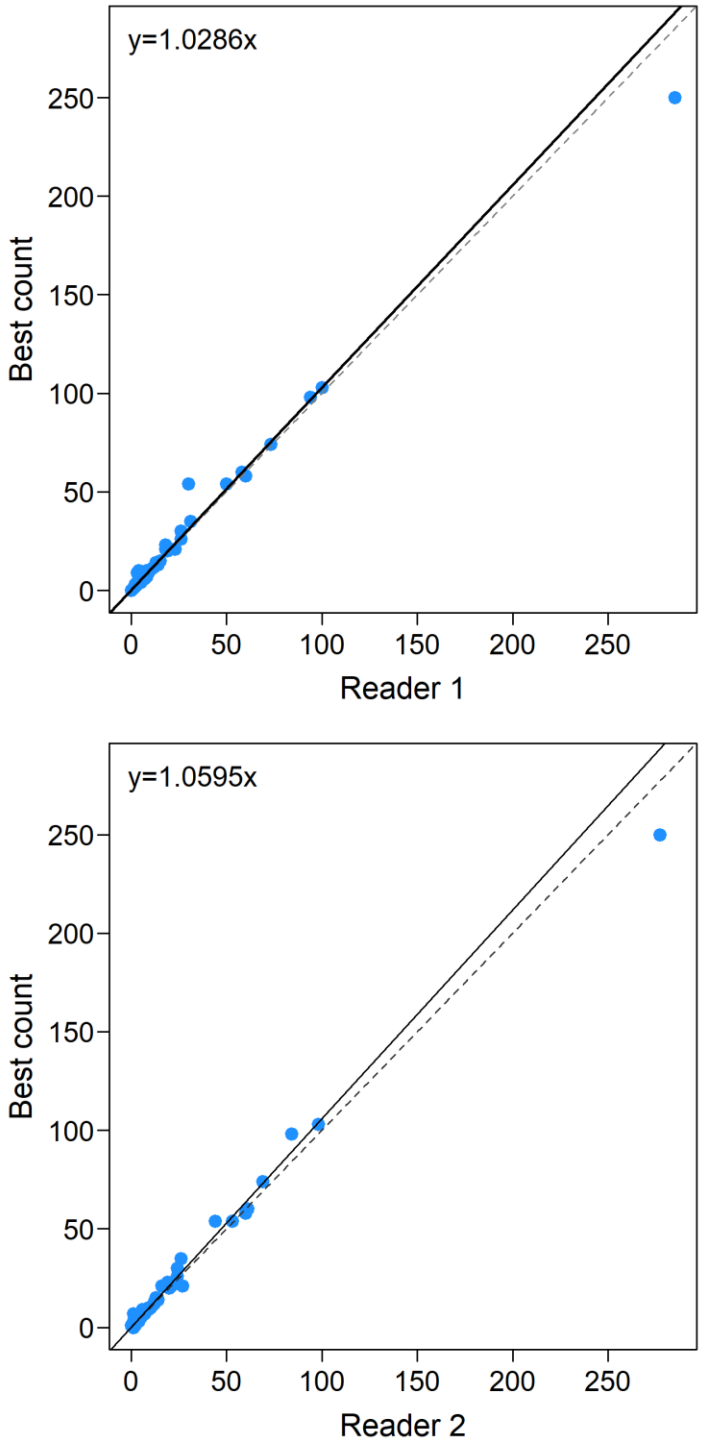

Figure 7. Comparison of the difference between the best count and the count done by each reader for the 60 comparison photos from the aerial survey of harbour seals flown along the coastline of the Newfoundland Shelf and in Sandwich Bay, Labrador during the summer of 2021. The black solid line and equation are the results of the linear regressions with the intercept fixed to zero and the grey dotted lines are the identity line.

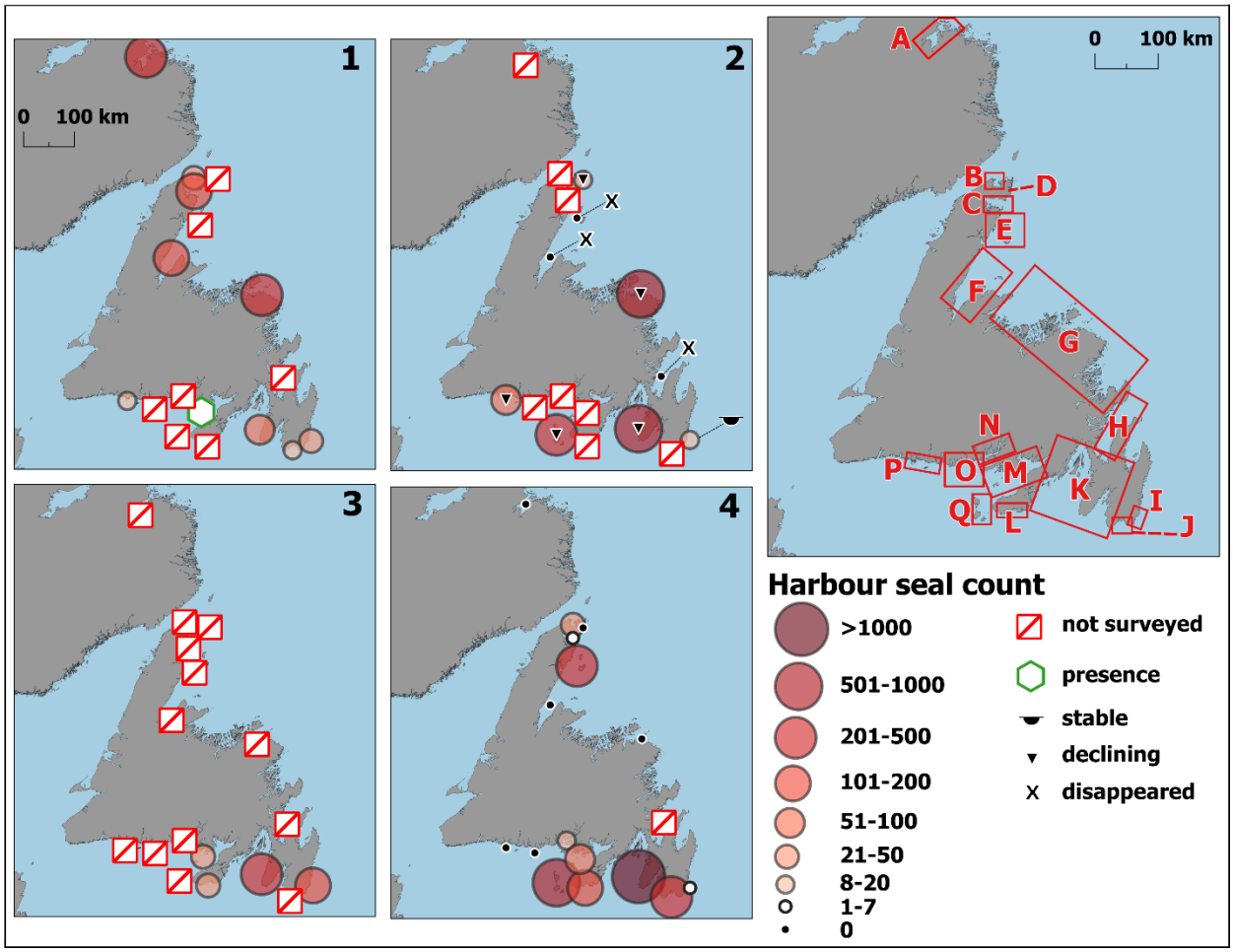

Figure 8. Comparison of the number of harbour seals from 1) Templeman et al. (1957; bounty returns, 1952-55), 2) Bouvla & McLaren (1979; population estimate from bounty returns), 3) Sjare et al. (2005; small boat or shore based surveys over limited areas) and 4) the present aerial survey, for the locations delineated in the map on the right: A) Sandwich Bay region, B) Pistolet Bay, C) Hare Bay, D) St. Anthony, E) Grey Islands, F) White Bay, G) Notre Dame Bay/Bonavista Bay, H) Trinity Bay, I) Chance Cove, J) Trepassey Bay, K) St. Mary's Bay/Placentia Bay, L) Southern Burin Peninsula, M) Fortune Bay, N) Ramea, O) Burgeo and P) Saint Pierre and Miquelon. 'Disappeared' indicates that harbour seals had disappeared in that area during the last 15 years.