Harlequin Ducks *Histrionicus histrionicus* show a strong long-term response to conservation measures in overseas North Atlantic French islands

JULIA BREYTON[1], MATTHIEU GUILLEMAIN[2]*, VICTOR GENEVOIS[1], HELENE UDO[3] & BRUNO LETOURNEL[1]

[1]Service départemental de St Pierre et Miquelon, Office Français de la Biodiversité, Saint Pierre, France.
[2]Service Conservation et Gestion Durable des Espèces Exploitées, DRAS, Office Français de la Biodiversité, Arles, France.
[3]Service Connaissance, Direction des outre-mer, Office Français de la Biodiversité, Vincennes, France.
*Correspondence author. E-mail: matthieu.guillemain@ofb.gouv.fr

Abstract

Declines in population size sometimes require that strong management measures be taken. Given plummeting numbers, the Harlequin Duck *Histrionicus histrionicus* population of eastern North America was classified as endangered, and its harvest was banned in Canada in 1990. A hunting ban was likewise introduced in France in 1991, at which time small groups were recorded only episodically on the French overseas islands of Saint-Pierre and Miquelon, a small archipelago off the coast of Newfoundland. Here we analyse land- and boat-based monitoring survey data for Harlequin Ducks wintering in Saint-Pierre and Miquelon, following implementation of these management measures, and describe a marked annual increase in the land-based counts between 2012 and 2025. The boat surveys, first introduced in 2020, have allowed coverage of parts of the archipelago difficult to monitor from the ground, and these found a sevenfold increase in numbers in only 6 years. These trends accord with a clear recovery of the species in the overall region. Combination of the two data sources indicates that *c.* 2,000 Harlequin Ducks wintered on Saint-Pierre and Miquelon in 2025, with the archipelago possibly now being the most important winter quarters for the species in eastern Canada. The availability of safe and high-quality seashore habitats, together with a limited human footprint, may explain such an increase. The results highlight the long-term importance of continued protection and monitoring of Harlequin Ducks in the region.

Key words: Harlequin Duck, population recovery, Saint-Pierre and Miquelon, wintering.

© The Author(s). Published by Wildfowl Press

The eastern North American population of the Harlequin Duck *Histrionicus histrionicus* experienced substantial declines during the late 20th century, prompting its classification as endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 1990 (MacCallum 2001). This precipitated the immediate implementation of a hunting ban in Canada that year and in the French overseas territory of Saint-Pierre and Miquelon (SPM, an archipelago situated south of Newfoundland at the northern limit of the eastern North American Harlequin Duck wintering range; Wickett 1999) in 1991. Subsequent conservation actions included the establishment of a management plan in 2007, which aimed to increase the eastern North American wintering population to at least 3,000 individuals, including 1,000 breeding-age females, in three out of five consecutive years (Environment Canada 2007; see also preliminary work in Montevecchi *et al.* 1995). Subsequently, the species expanded its range and wintering numbers increased in eastern Canada in the late 1990s and early 2000s, at an annual rate of as much as 8.6% between 2001 and 2013 (Bowman *et al.* 2015). Data from the annual Christmas Bird Count (CBC) have also showed increased abundance in eastern Canada since 1988, although the rate of change may have slowed in recent years (Gutowsky *et al.* 2022).

Despite this regional recovery, long-term data on numbers of Harlequin Ducks wintering around SPM are lacking from the 20th century. Accounts from that time suggest occasional groups of 10–20 individuals (Tuck & Borotra 1972; Etcheberry & Borotra 1982), with fewer than 15 wintering on southern Saint-Pierre Island in the "Diamant" area in 1994 (B. Letournel, pers. obs.). As sightings became more regular, a monitoring programme was initiated in the mid-1990s, culminating in full land-based surveys in 2012 and more effective boat-based surveys from 2020. The SPM archipelago is small enough to allow near-complete coverage, and its coastline provides extensive rocky, shallow (< 10 m deep) foraging habitat favoured by Harlequin Ducks (Goudie & Ankney 1986; Robertson & Goudie 1999).

The existing research literature confirms that the Harlequin Duck is vulnerable due to high female summer mortality, low clutch sizes (*e.g.* 6.1 eggs per 7 nests in Alaska, Crowley 1999; 5.7 eggs on average in Iceland, Bengtson 1972), and low juvenile survival rates (Smith *et al.* 2000). Furthermore, while Harlequin Duck females can breed as early as two years of age, breeding success rate remains low until they are at least five years old (Reichel *et al.* 1997). These demographic features make the Harlequin Duck particularly sensitive to sources of additional mortality; hence, hunting pressure could potentially impact population growth rates significantly. For this reason, monitoring long-term changes in wintering distribution and abundance is an essential means of assessing whether the hunting ban has resulted in a population recovery since the change in legislation.

The aim of this study is to quantify long-term trends in wintering Harlequin Duck abundance and distribution in SPM, based on 14 years of consistent land-based January counts and six years of archipelago-wide boat-based surveys. Specifically, we assess:

(i) whether wintering numbers have increased following the hunting bans, (ii) whether the wintering distribution has extended throughout the archipelago, and (iii) whether sex ratios indicate any demographical imbalance. These data offer the first comprehensive assessment of the status of Harlequin Duck on SPM (now a wintering stronghold in the region), as well as contributing to understanding population processes in this species in Eastern North America.

Methods

Study area

SPM is a 242 km² archipelago and French overseas territory located in the mouth of the Gulf of St. Lawrence, off the southern coast of Newfoundland (Fig. 1). The archipelago's geology is primarily of volcanic rock and it experiences a cold, humid oceanic climate. Its coastline consists of wetlands, salt marshes, rocky and sandy coasts, whilst a significant portion of the coastal seabed is made up of rocky slopes, or boulders colonised and dominated by macroalgae, amphipods and Blue Mussel *Mytilus edulis* beds (Andres *et al.* 2025), attractive to wintering Harlequin Ducks (Blein *et al.* 2017; Muller 2025).

Land-based surveys

Although counts were made on some parts of SPM from 2000 onwards, data from comprehensive monthly surveys of Harlequin Ducks were available for October–April (the main wintering period; Baldassarre 2014) from 2012–2025. Monthly counts (recording sex where possible) could only be carried out in calm weather (wind speeds < 20 knots), so some counts are therefore missing

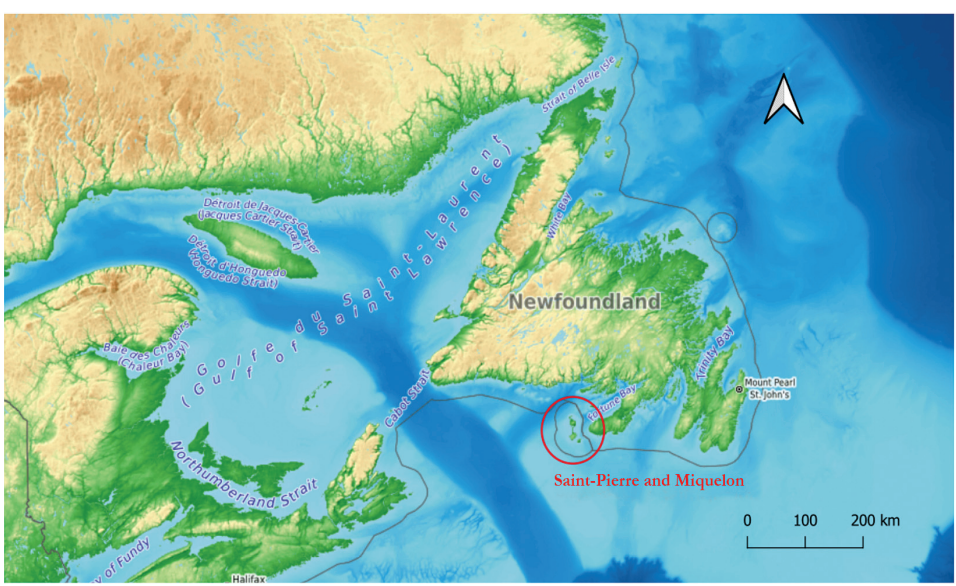


Figure 1. Location of the Saint-Pierre and Miquelon archipelago in the western North Atlantic.

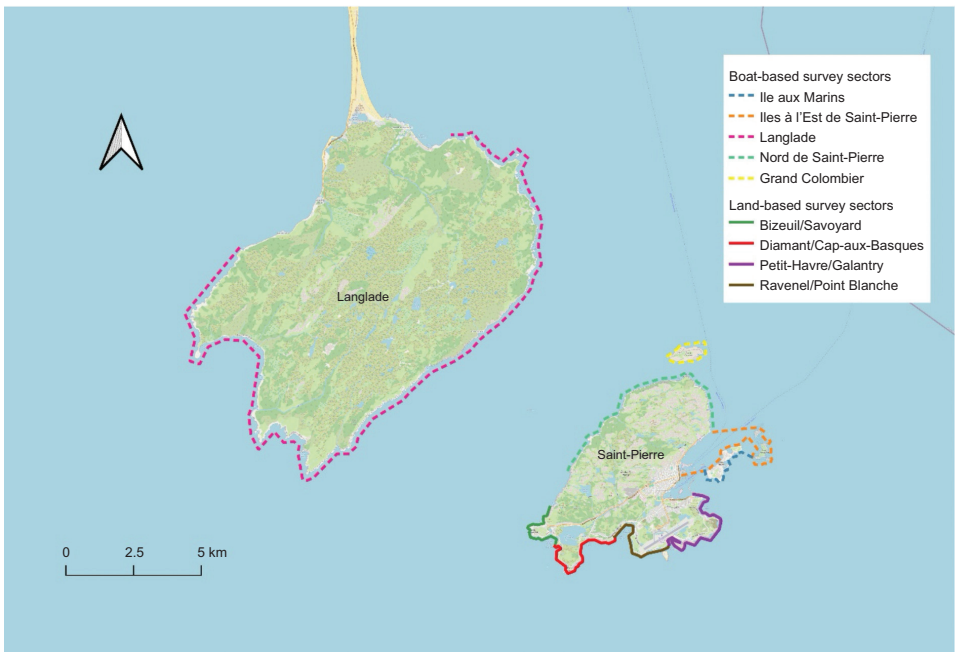


Figure 2. Map of the boat-based (dashed) and land-based (plain lines) Harlequin Duck survey sectors on Saint-Pierre and Miquelon archipelago, 2012–2025.

because of inclement conditions. Counts were performed as close as possible to the 15th of the month, depending on the weather. Only data from January were used in the present analysis of land-based counts (following Delany 2005). Counts were conducted along predefined permanent sectors across the archipelago (Fig. 2), initially along the southern coast of Saint-Pierre Island, where most birds historically occurred. Surveys were completed within a few hours (morning or afternoon) by two or three experienced observers to avoid double-counting. Morning counts were only initiated after birds arrived and settled at their feeding sites (about an hour after sunrise). Birds were observed using binoculars and spotting scopes and only complete counts were retained, although occasional estimates of large, distant groups were made when unavoidable. In areas subject to regular bird movements, observers stood at vantage points on the coast to record potential bird flights and avoid double counting. Juvenile male Harlequin Ducks acquire adult male plumage gradually during their first winter (Reeber 2015). Juvenile male plumage has some features allowing sex identification at close range or in very good observation conditions, but from a distance under poor light some juvenile males may have been counted as females. This should not affect our results massively since the counts were conducted relatively late in the season (January), but the proportion of males in the data may be slightly underestimated.

Boat-based surveys

Beginning in 2020, annual March boat-based surveys were added to cover the increasing numbers of Harlequin Ducks wintering along Saint-Pierre Island's northern coast and nearby islets (Île aux Marins, Île aux Vainqueurs, Île aux Pigeons, and south and southwest of Langlade Island; Fig. 2), areas difficult to access from land, to provide better information on the birds' use of new areas among the islands. March was selected because weather conditions are more favourable and the days longer, prior to birds leaving on spring migration (Baldassare 2014). Boat surveys were completed in a single day concurrently with land-based counts to derive total wintering numbers across the entire archipelago.

Data handling and analyses

All data were stored into a species-specific database and shared on eBird. Year 2012 was chosen as the baseline for the analyses of the land-based dataset, as this is when comprehensive land-based surveys were initiated. Sex ratio data were available from 2020 onward.

Temporal trends in abundance from January land-based and March boat-based counts were analysed using generalized linear models with a negative binomial distribution using the glmmTMB package (Magnusson *et al.* 2017). QQ-plots using the DHARMa package (Hartig 2020) detected no deviations from the expected distribution (*i.e.* no over/underdispersion in the data), with non-significant Kolmogorov-Smirnov, dispersion and outlier tests for each of the count sectors (not shown). All analyses were conducted using R-4.5.2 (R Core Team 2025). All analyses of land-based counts were based on data from January, the period of the winter during which waterfowl populations are the most stable, and for which we had the longest dataset. January counts are also used to establish flyway-scale waterfowl population trends through the International Waterbird Census in France (Delany 2005; LPO 2025). Trends were estimated at both whole-island and count sector levels. Note however that although the whole area was surveyed in January 2018, the detailed data per sector were not recorded. Hence data are missing for that year for analyses at the sector level, but not for the whole survey area.

Results

Land-based counts (southern Saint-Pierre coastline)

Between 2012 and 2025, numbers of wintering Harlequin Ducks along the southern coast of Saint-Pierre in January increased from 97 to 564 individuals (peak = 735 in 2023), representing an estimated annual growth rate of 1.12 ± 1.02 s.e. ($Z = 6.86$, $P < 0.001$; Fig. 3). All sectors showed significant increases (Table 1, Fig. 4).

Sex ratio data from January counts since 2020 indicated a slight male bias (0.54, 0.53 and 0.50 for 2023, 2024 and 2025, respectively; 0.52 overall, based on 4,489 females and 4,982 males).

Boat-based counts (Langlade, northern/eastern Saint-Pierre)

Boat-based surveys conducted each March from 2020 to 2025 showed that numbers of Harlequin Ducks rose from 187 to 1,355

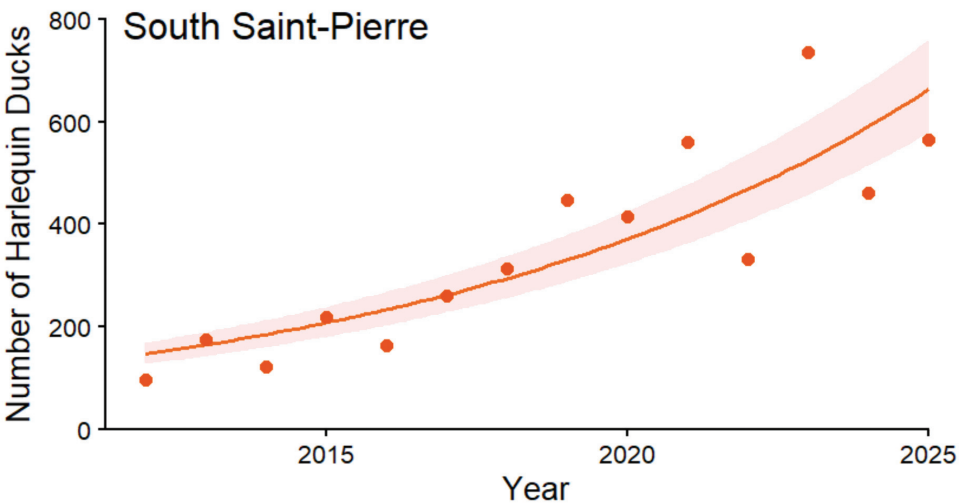


Figure 3. Number of wintering Harlequin Ducks counted from land in January along the southern coast of Saint-Pierre, 2012–2025. The shaded area shows the confidence interval around the regression curve. See text for statistics.

individuals, greater than a sevenfold increase (estimated annual growth rate = 1.28 ± 1.07 s.e.; $Z = 3.65$, $P < 0.001$; Fig. 5, Supporting Materials Table S1), despite the small ($n = 6$ years) sample size. The Langlade distribution of Harlequin Ducks expanded markedly, initially concentrated in the southwest in 2020, but by 2025 the species occupied much of southern and eastern coastlines. Changes along the northern coastline of Saint-Pierre were less obvious (Fig. 6).

Discussion

Wintering Harlequin Ducks around SPM have increased dramatically and extended their range throughout the islands over the years. They have expanded from small sporadic groups of 10–20 birds reported in the late 20th century (Tuck & Borotra 1972; Etcheberry & Borotra 1982) to nearly 2,000 birds across the archipelago. The increase reflects the broader recovery of the eastern North American population following hunting bans in Canada (in 1990) and SPM (1991), occurring in parallel with increases at other major wintering sites such as in eastern Maine, USA and Cape St. Mary's, Newfoundland (Bowman *et al.* 2015; Gutowski *et al.* 2022), along with simultaneous expansion of their range into new areas elsewhere (Boyne 2008; Mittelhauser 2008; Thomas 2008; Bowman *et al.* 2015).

The magnitude of the growth rate in numbers at SPM is notable. Land-based counts increased from 97 in 2012 to 564 in 2025. Boat-based surveys revealed rapid colonisation of Langlade and northern Saint-Pierre, reaching 1,355 individuals by 2025. Some land-based counts were missing in March but, for the years available, they recorded on average a similar number of Harlequin Ducks (348) to the January

Table 1. Estimated annual growth rates (± s.e.) for the number of Harlequin Ducks wintering in the various sectors of the southern coast of Saint-Pierre in January, 2012–2025. Values are from the general linear models with a negative binomial distribution. Fig. 2 shows the location for each sector. Fig. 4 illustrates the count values and fitted trend.

	Year effect ± s.e.	*Z*-value	*P*
Bizeuil/Savoyard	1.10 ± 1.05	1.995	0.046
Diamant/Cap aux Basques	1.13 ± 1.04	3.609	< 0.001
Ravenel/Pointe Blanche	1.22 ± 1.05	4.327	< 0.001
Petit-Havre/Galantry	1.26 ± 1.05	5.080	< 0.001
Ile aux Marins	1.38 ± 0.11	3.200	0.001

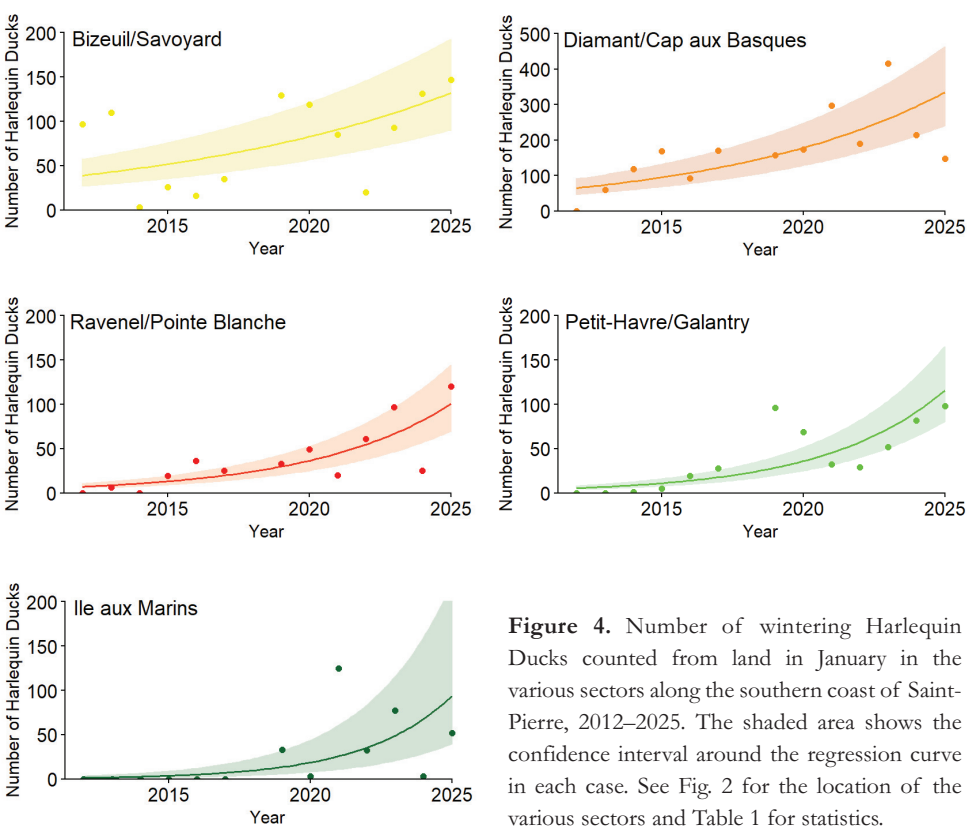


Figure 4. Number of wintering Harlequin Ducks counted from land in January in the various sectors along the southern coast of Saint-Pierre, 2012–2025. The shaded area shows the confidence interval around the regression curve in each case. See Fig. 2 for the location of the various sectors and Table 1 for statistics.

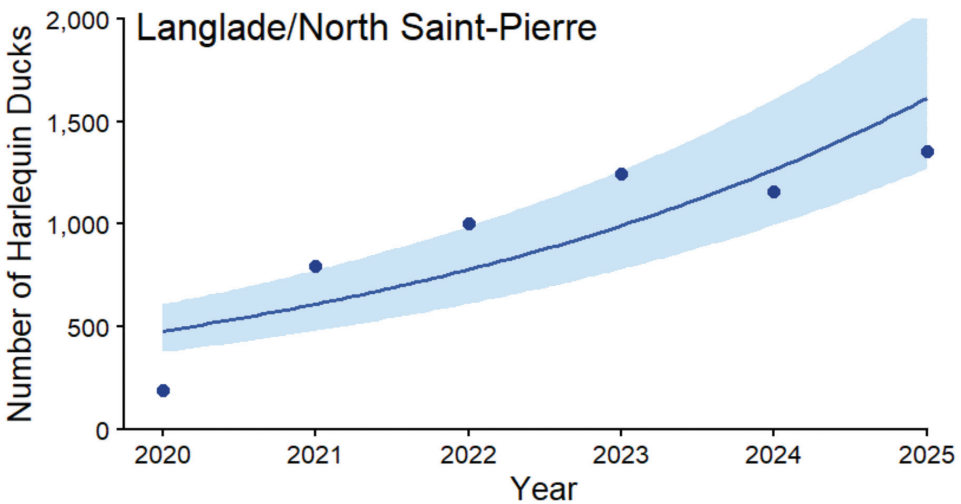


Figure 5. Number of wintering Harlequin Ducks counted from boat in March along the coasts of Langlade and north of Saint-Pierre, 2020–2025. The shaded area shows the confidence interval around the regression curve. See text for statistics.

counts (377). In 2025, 564 Harlequin Ducks were counted in January, and 547 in March. Combined with the boat-based count, these numbers suggest that SPM, with *c.* 2,000 wintering birds may now rival or exceed historic eastern Canadian strongholds, although recent data from Cape Saint Mary's are lacking (see annual totals in Supporting Materials Table S1).

Protection from hunting is the most plausible driver of this recovery. Harlequin Ducks exhibit low clutch sizes, delayed maturity and high female mortality, demographic traits that make them sensitive to additional mortality sources (Grzegorczyk *et al.* 2024). Removing harvest pressure likely facilitated sustained population growth, as seen in other protected sea ducks such as Barrow's Goldeneye *Bucephala islandica* in the region (Environment Canada 2011; Canadian Wildlife Service 2025). No habitat management actions specific to Harlequin Ducks were implemented in SPM, but the archipelago's extensive rocky coastline and shallow foraging habitat provide favourable wintering conditions that likely supported rapid expansion.

Sex ratio data indicate a near-parity ratio, with only a slight male bias (*c.* 0.52 males), similar to those from previous studies showing relatively even sex ratios in Harlequin Ducks compared with other Anatidae (Rodway *et al.* 2003). This implies no demographic constraint on population growth caused by female availability. Note however that a part of the juvenile males, which gradually acquire breeding plumage through the winter, may have been recorded as females during counts at far distance or under poor light conditions, hence the sex ratio may be slightly more unbalanced than computed here.

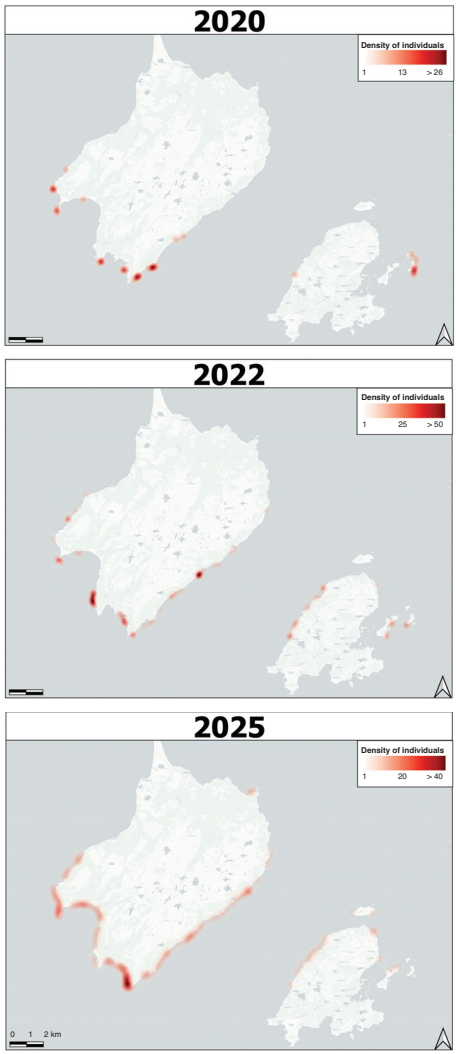


Figure 6. Distribution of Harlequin Duck numbers along the coasts of Langlade and northern Saint-Pierre during the March boat-based surveys, 2020–2025.

The recent appearance of small groups on Miquelon Island (29 individuals on 7 January 2025) hints at continued range expansion, though habitat there is less suitable because more sandy, and it remains unclear whether sustained colonisation will occur. Improved monitoring, particularly expanding boat-based surveys and increasing coverage during mid-winter, together with an analysis of available habitat, would help clarify seasonal dynamics, habitat use and potential limits to local carrying capacity.

Overall, the recovery of Harlequin Ducks in SPM reflects the combined effects of long-term protection and the availability of high-quality coastal habitat. Continued monitoring and conservation of these habitats remain essential, particularly as the archipelago now appears to hold a substantial proportion of the eastern North American wintering population.

Acknowledgements

We would like to thank all the observers who contributed to the Harlequin Duck surveys on SPM over the years, Sarah Gutowsky for providing information about the Harlequin Duck Christmas Bird Counts, and David Vallecillo for providing useful advice about the statistical analyses. Eileen Rees, Tony Fox and two anonymous referees provided very constructive comments on a former version of the manuscript.

References

Andres, S., Pinsivy, L., Amice, E., Grall, J. & Chauvraud, L. 2025. *Typologie des Habitats Benthiques de Saint-Pierre-et-Miquelon*. PatriNat (OFB-MNHN-CNRS-IRD) Report V.1. PatriNat Paris, France.

Baldassarre, G.A. 2014. *Ducks, Geese, and Swans of North America*. Johns Hopkins University Press, Baltimore, USA.

Bengtson, S.-A. 1972. Breeding ecology of the Harlequin duck *Histrionicus histrionicus* (L.) in Iceland. *Ornis Scandinavica* 3: 1–19.

Blein, O., Audru, J.-C. & Cormier, V. 2017. *Curiosités Géologiques de Saint-Pierre-et-Miquelon*. BRGM Éditions, Orléans, France.

Bowman, T.D., Silverman, E.D., Gilliland, S.G. & Leirness, J.B. 2015. Status and trends of North American sea ducks: reinforcing the need for better monitoring. *In* J.-P.L. Savard, D.V. Derksen, D. Esler & J.M. Eadie (eds.), *Ecology and Conservation of North American Sea Ducks*, pp. 1–27. CRC Press, New York, USA.

Boyne, A.W. 2008. Harlequin ducks in the Canadian Maritime provinces. *Waterbirds* 31 (Special Publication 2): 50–57.

Canadian Wildlife Service Waterfowl Technical Committee. 2025. *Population Status of Migratory Game Birds in Canada: 2025*. CWS Migratory Birds Regulatory Report No. 61. Canadian Wildlife Service, Gatineau, Canada.

Crowley, D.W. 1999. Productivity of Harlequin Ducks breeding in Prince William Sound, Alaska. *In* R.I. Goudie, M.R. Petersen & G.J. Robertson (eds.), *Behaviour and Ecology of Sea Ducks*, pp. 14–20. Canadian Wildlife Service Occasional Paper No. 100. CWS, Ottawa, Canada.

Delany, S. 2005. *Guidelines for Participants in the International Waterbird Census (IWC)*. Wetlands International, Wageningen, the Netherlands.

Environment Canada. 2007. *Management Plan for the Harlequin Duck* (Histrionicus histrionicus) *Eastern Population, in Atlantic Canada and Québec [Proposed]*. Species at Risk Act Management Plan Series. Environment Canada, Ottawa, Canada.

Environment Canada. 2011. *Management Plan for the Barrow's Goldeneye* (Bucephala islandica)*, Eastern Population, in Canada [Proposed]*. Species at Risk Act Management Plan Series. Environment Canada, Ottawa, Canada.

Etcheberry, R. & Borotra, M. 1982. *Les Oiseaux de St Pierre et Miquelon*. Office National de la Chasse, Paris, France.

Goudie, R.I. & Ankney, C.D. 1986. Body size, activity budgets, and diets of sea ducks wintering in Newfoundland. *Ecology* 67: 1475–1482.

Grzegorczyk, E., Caizergues, A., Eraud, C., Francesiaz, C., Le Rest, K. & Guillemain, M. 2024. Demographic and evolutionary consequences of hunting of wild birds. *Biological Reviews* 99: 1298–1313.

Gutowsky, S.E., Robertson, G.J., Mallory, M.L., McLellan, N.R., Gilliland, S.G., Paquet, J., d'Entremont, A.A. & Ronconi, R.A. 2022. Increased abundance and range expansion of Harlequin Ducks *Histrionicus histrionicus* wintering in Eastern Canada. *Endangered Species Research* 49: 187–200.

Hartig, F. 2020. *DHARMa: Residual Diagnostics for Hierarchical (Multi-Level/Mixed) Regression Models*. Available at https://CRAN.R-project.org/package=DHARMa (last accessed 6 August 2026).

LPO 2025. *Comptage des Oiseaux d'Eau à la Mi-Janvier en France. Résultats 2025 du Comptage Wetlands International*. LPO BirdLife France – Service Connaissance, Wetlands International, Ministère de la Transition Écologique, de la Biodiversité, de la Forêt, de la Mer et de la Pêche, Rochefort, France.

MacCallum, B. 2001. *Status of the Harlequin Duck* (Histrionicus histrionicus) *in Alberta*. Alberta Sustainable Resource Development, Edmonton, Canada.

Magnusson, A., Skaug, H., Nielsen, A., Berg, C., Kristensen, K., Maechler, M., van Bentham, K., Bolker, B. & Brooks, M.M. 2017. *Package 'glmmTMB'*. Available at https://github.com/glmmTMB (last accessed 6 August 2026).

Mittelhauser, G.H. 2008. Harlequin Ducks in the Eastern United States. *Waterbirds* 31 (Supplement No. 2): 58–66.

Montevecchi, W.A., Bourget, A., Brazil, J., Goudie, R.I., Hutchinson, A.E., Johnson, B.C., Kehoe, P., Laporte, P., McCollough,

M.A., Milton, R. & Seymour, N. 1995. *National Recovery Plan for the Harlequin Duck in Eastern North America*. Report No. 12, Recovery of Nationally Endangered Wildlife Committee, Ottawa, Canada.

Muller, S. 2025. Bilan des connaissances sur la flore, la fonge et les habitats naturels de l'archipel de Saint-Pierre-et-Miquelon. *Naturae* 2025 (6): 71–94.

R Core Team 2025. *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria. Available at https://www.R-project.org/ (last accessed 6 August 2026).

Reeber, S. 2015. *Wildfowl of Europe, Asia and North America*. Christopher Helm, London, UK.

Reichel, J.D., Hendricks, D.P. & Genter, D.L. 1997. *Harlequin Duck Research and Monitoring in Montana: 1996*. Montana Natural Heritage Program, Helena, USA.

Robertson, G.J. & Goudie, R.I. 1999. Harlequin Duck (*Histrionicus histrionicus*). *In* A. Poole & F. Gill (eds.), *The Birds of North America*, No. 466. The Birds of North America, Inc., Philadelphia, USA.

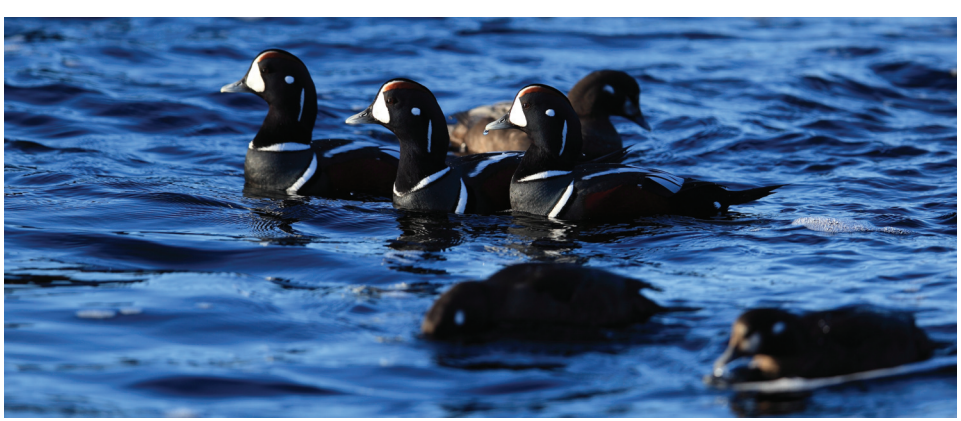
Rodway, M.S., Regehr, H.M., Ashley, J., Clarkson, P.V., Goudie, R.I., Hay, D.E., Smith, C.M. & Wright, K.G. 2003. Aggregative response of harlequin ducks to herring spawning in the Strait of Georgia, British Columbia. *Canadian Journal of Zoology* 81: 504–514.

Smith, C.M., Robertson, G.J., Goudie, R.I., Cooke, F. & Boyd, W.S. 2000. Population dynamics of Harlequin Ducks in British Columbia and Alberta. *In* L.M. Darling (ed.), *At Risk: Proceedings of a Conference on the Biology and Management of Species and Habitats at Risk, Kamloops, B.C., 15–19 Feb. 1999. Volume One*, pp. 283–287. British Columbia Ministry of Environment, Lands & Parks, Air Resources Branch, Victoria, Canada.

Thomas, P.W. 2008. Harlequin ducks in Newfoundland. *Waterbirds* 31 (Special Publication 2): 44–49.

Tuck, L.M. & Borotra, M.J. 1972. Additions to the avifauna of St. Pierre and Miquelon. *Canadian Field-Naturalist* 86: 259–263.

Wickett, M.R. 1999. *Harlequin Duck Assessment*. Maine Department of Inland Fisheries and Wildlife Report. Maine Department of Inland Fisheries and Wildlife, Augusta, USA. Available at https://www.maine.gov/ifw/docs/species_planning/birds/harlequinduck/speciesassessment.pdf (last accessed 2 August 2026).



Photograph: Male Harlequin Ducks on water, by Bruno Letournel.