Sub-Indicator: Fish-Eating and Colonial Nesting Waterbirds

Note: The status and trends presented in this report are based on Canadian data only. The Canadian portion of the Great Lakes Binational Decadal Colonial Waterbird Survey was completed in 2022-2024, but data for the American portion of the survey are not available for the current reporting cycle (survey to be completed in 2025). Species population trends are generally similar on both sides of the international border, so the Canadian trends reported here should provide an adequate assessment of this indicator for the Great Lakes as a whole. See the Methods and Discussion sections for more details.

Overall Assessment – Canadian Only

Status: Fair

Trends:

Short-term Trend (2009-2024): Deteriorating

Long-term Trend (1976-2024): Deteriorating

Rationale: Since 1976, three species of fish-eating birds (Common Tern, Herring Gull, Ring-billed Gull) have undergone large declines in population (>50%) of areas surveyed (up to one kilometer inland from the shoreline of the Great Lakes). Great Blue Herons have experienced a moderate decline (-46%). Black-crowned Night-Heron and Caspian Tern populations are small but considered stable. Two species (Double-crested Cormorant, Great Egret) have undergone large increases (although the population of egrets is small; Figure 1). Population trends since 2009 mirror the long-term trends for these species. For species where the population objective is to maintain or increase numbers, five of nine species experienced large to moderate declines, while two other species increased dramatically (Table 1). Populations of the two abundant species that can cause conflicts with humans ('conflict' species) have either declined (Ring-billed Gulls, -70%) or the growth rate has decelerated (cormorants; 9% increase), which is consistent with the population goals for these species (although the magnitude of the decline for Ring-billed Gulls is concerning; Table 1). For most species, declines were more pronounced on Lake Huron and Lake Superior than in the lower Great Lakes.

Lake-by-Lake Assessment – Canadian Only

Lake Superior

Status: Poor

Short-term Trend (2009-2024): Deteriorating

Long-term Trend (1976-2024): Deteriorating

Rationale: Since 2009, three species have experienced large declines in population (cormorants, -50%; Herring Gulls, -71%; Great Blue Herons, -99%). Ring-billed Gulls have undergone a moderate decline (-46%; Table 1).

Lake Michigan

Status: Not Assessed

Short-term Trend: Not assessed

Long-term Trend: Not assessed

Rationale: The status and trends for Lake Michigan are not assessed, as this report only assesses Canadian data (see Methods section for more details).

report.

Lake Huron (including St. Marys River)

Status: Poor

Short-term Trend (2009-2024): Deteriorating

Long-term Trend (1976-2024): Deteriorating

Rationale: Since 2009, two species have experienced large declines in population (night-herons, -69%; Ring-billed Gulls, -53%), four species had moderate declines (Caspian Terns, -39%; Common Terns, -34%; cormorants, -38%; Herring Gulls, -32%;) and two species were stable to increasing (Great Blue Heron, -11%; egrets, +8%). Numbers of nests for both 'conflict' species have declined (Table 1).

Lake Erie (including St. Clair-Detroit River Ecosystem)

Status: Fair

Short-term Trend (2009-2024): Unchanging

Long-term Trend (1976-2024): Unchanging

Rationale: Since 2009, two species have experienced large declines in population (Ring-billed Gulls, -98%; Caspian Terns, -90%; the latter species has only ever been represented by a small number of nests), two species have experienced moderate declines (Herring Gulls, -48%; Great Blue Herons, -35%), two species have been stable (cormorants, -18%; egrets, +7%) and one experienced a moderate increase (night-herons, +62%). Nest numbers for both 'conflict' species have declined (Table 1).

Lake Ontario (including Niagara River and St. Lawrence River)

Status: Fair

Short-term Trend (2009-2024): Deteriorating

Long-term Trend (1976-2024): Deteriorating

Rationale: Since 2009, three species have experienced large declines in population (Common Terns, -57%; Ring-billed Gulls, -65%; night-herons, -73%), two species have experienced moderate declines (Caspian Terns, -30%; Great Blue Herons, -48%), one species has been stable (Herring Gulls, +13%) and two have experienced moderate (cormorants, +78%) or large (egrets, almost a 7-fold increase) increases. Nest numbers for one of the two 'conflict' species have increased (cormorants, Table 1).

Status Assessment Definitions

Status assessment is dependent upon the species as population objectives differ. Status assessment compares current population sizes to benchmarks. This indicates whether the population size is appropriate or not; for instance, population size that is not appropriate would refer to both 'conflict' species (e.g. Double-crested Cormorants, Ring-billed Gulls; populations are considered too large) or declining species (e.g. Common Terns) with populations that are considered too low or rates of decline considered too high (see Methods section for more

details). Each species is assessed against a population benchmark: 2009 for the two conflict species and the 1970s for all other species.

Good: The sizes of waterbird populations are considered appropriate.

Fair: The sizes of waterbird populations are considered close to appropriate.

Poor: The sizes of waterbird populations are considered inappropriate.

Undetermined: Data are unavailable or are insufficient to assess status.

Trend Assessment Definitions

Robust estimates of abundance and distribution, and an assessment of change in these population metrics over long (since monitoring began in the 1970s) and short (since the last survey period in 2009) time scales, by discrete water bodies and for the Canadian Great Lakes as a whole, are available to report. The current survey design for the Great Lakes region is considered to have a high reliability (i.e. high precision, low survey bias and high geographic coverage). Estimates of population vital rates (e.g. productivity) for the Great Lakes have not been collected systematically in either space or time, but may be adequate for general comparisons with other parts of the breeding range (i.e. data from reference sites), for some parameters / species.

Due to the current census frequency, population status can only be assessed every 10-15 years. Short- and long-term trends will be assessed according to the following scale (or equivalent annual rate of change for shorter time frames), which has been widely applied to avian population trend assessment in Canada (see Environment Canada's "*Status of Birds in Canada*" website: wildlife-species.canada.ca/bird-status/index-eng.aspx?sY=2019&sL=e):

- Large decline: ≥50% decline over 20 years
- Moderate decline: ≥25% to <50% decline over 20 years
- Stable: <25% decline to <33% increase over 20 years
- Moderate increase: ≥33% to <100% increase over 20 years
- Large increase: ≥100% increase over 20 years

Qualitative population trends (based on the criteria above) were weighted equally and summed across species to create an index of colonial waterbird community status. Overall community status was assigned to one of the change categories listed below, such that the majority of species met the criteria for that category:

Improving:

(1) populations of species experiencing long-term declines are increasing (either moderate or large)

(2) populations of 'conflict' species (cormorants and Ring-billed Gulls) are decreasing (either moderate or large)

(3) populations for species considered to be at appropriate levels remain stable

Unchanging:

(1) populations of species experiencing long-term decline remain stable

(2) populations of 'conflict' species remain stable

(3) populations for species considered to be at appropriate levels remain stable

No Trend: Population trends are mixed with half of the focal waterbird species in the Improving or Unchanging population categories, and half in the Deteriorating population categories

Deteriorating:

(1) populations of species experiencing long-term declines continue to decrease (either moderate or large)

(2) populations of 'conflict' species are increasing (either moderate or large)

(3) populations for species considered to be at appropriate levels in the previous assessment have declined

Undetermined: Data are unavailable or are insufficient to assess trends.

Endpoints and/or Targets

- Healthy, self-sustaining populations of each waterbird species.
- Populations of stable or declining species remain stable or increase, respectively.
- Populations of 'conflict' species (cormorants and Ring-billed Gulls) either remain stable or decline.

There are no specific quantitative population targets for these species, other than within a few Great Lakes Areas of Concern (e.g., Hamilton Harbour, ON).

One conservation goal to consider as an endpoint in the future is the number of historically important breeding sites that have some form of protected conservation status. Conservation of island breeding habitat is critical for maintaining healthy populations of the eight species of colonial waterbirds breeding on the Great Lakes. There has been some loss of these islands in the past due to development (e.g. cottages, etc.). Currently, very few breeding sites have any form of meaningful protected status, leaving them vulnerable to loss or degradation. For the next State of the Great Lakes reporting cycle, it is recommended that this indicator include an inventory of colonial waterbird breeding sites by protected status, and that an indicator of habitat conservation should be developed.

Sub-Indicator Purpose

- Assessment of ecosystem health by examining long-term trends in the abundance and distribution of colonial waterbird populations breeding on the Great Lakes.
- The sub-indicator tracks changes in the number of breeding pairs (nests), breeding colonies, and populations of eleven species of fish-eating birds since the mid-1970s, at multiple geographic scales
- Secondarily, some ecological endpoints can be assessed for representative colonial waterbird species at selected sites on the Great Lakes.

The purpose of this sub-indicator, "Fish-Eating and Colonial-Nesting Birds", is to assess ecosystem health by examining ~10-year and long-term trends in the abundance and distribution of colonial waterbird populations breeding on the Great Lakes. This sub-indicator tracks changes in the number of breeding pairs (nests), breeding colonies, and populations of eight species of fish-eating birds since the mid-1970s, at multiple geographic scales, and secondarily, can assess some ecological endpoints in representative colonial waterbird species at selected sites on the Great Lakes.

Ecosystem Objective

Maintenance of self-sustaining populations (i.e. no further declines in abundance or reductions in distribution) of each of the eight waterbird species that comprise that avian community. Fish-eating, colonial waterbirds are distributed across all five Great Lakes, their connecting channels, and the St. Lawrence River, both in Canadian and US waters.

This sub-indicator best supports work towards General Objective #5 of the 2012 Great Lakes Water Quality Agreement which states that the Waters of the Great Lakes should "support healthy and productive wetlands and other habitats to sustain resilient populations of native species."

Methods

Eight focal species of colonial waterbirds breed at sites (predominantly islands) distributed across all of the Great Lakes: Herring and Ring-billed gulls, Caspian and Common terns, Great Blue Herons, Great Egrets, Black-crowned Night-Herons and Double-crested Cormorants. Of these eight species, Double-crested Cormorants and Ring-billed Gulls have experienced large population increases since the 1970s and can cause conflicts with humans (e.g. perceived impacts to fisheries, destruction of vegetation on private lands and in protected areas, nesting on anthropogenic structures, etc.). The population goal for these two species is a net growth of zero (i.e. maintain at 2009 levels). The population goal for the remaining six species is to maintain or increase the number of breeding pairs relative to 1970s levels.

A complete census of all waterbird colonies on the Great Lakes, their connecting channels and the St. Lawrence River (up to 1 km inland from shorelines) was conducted, jointly, by the Canadian Wildlife Service and the U.S. Fish and Wildlife Service, approximately every 10 years, from 1976-80 to 2007-09 (four complete census periods; survey timing and methodologies were coordinated between Canada and the USA.).

For the most recent survey period (2022-24), a sampling framework was developed, rather than conducting a complete census (mainly to increase survey efficiency and reduce overall costs). Based on modeling results, the optimal sampling design (i.e. one where error in the estimation of population trend was ≤10% for all species) was weighted heavily toward 'high' abundance/biodiversity sites, with some sampling of 'medium' and low 'strata', and where surveys included ~50% of historically-occupied sites. This change in survey design has been implemented in both Canada and the United States; the Canadian portion of the survey has been completed (and is reported here), but data for the American portion of the survey are not available for the current reporting cycle (survey to be completed in 2025). In Canada, the 2022-24 survey effort was equivalent to ~70% of a complete census of Canadian colony sites.

Measures include:

1. Breeding population estimates (nest counts) of eight species of colonial waterbird species across all water bodies and connecting channels at relevant temporal and spatial scales (at ~10-year intervals)
2. Periodic measurement of waterbird demographic parameters known to be directly or indirectly impacted by environmental stressors, including (but not limited to): clutch size, egg volume, hatching and fledging success, natal and breeding site fidelity, age at first breeding and age-specific survivorship. Additional monitoring considerations include: avian disease surveillance (e.g. botulism type E, highly pathogenic H5N1 avian influenza) and studies tracking adults through the full annual cycle to establish connectivity between breeding and wintering areas.

Discussion

Fish-eating, colonial waterbirds are distributed across all five Great Lakes, their connecting channels, and the St. Lawrence River, both in Canadian and US waters. Colonial waterbirds function as apex predators in freshwater systems and provide an important linkage between aquatic and terrestrial habitats. As a guild, waterbirds derive a large proportion of their diet from fish and other aquatic prey (species range from obligate piscivores to having a mix of aquatic and terrestrial prey). On the Great Lakes, waterbird species differ in the foraging strategies they employ, and thus, differ in the aquatic habitats and trophic levels they utilize (e.g. surface feeders or pursuit divers in open water; sit-and-wait predators in littoral zones and wetlands, surface feeders in wetlands). Another life-history trait that waterbirds share is that they nest in dense aggregations (i.e. colonially) and almost exclusively on islands. As such, they can also serve as an important indicator of change in status of this unique habitat within the Great Lakes system.

Changes in waterbird population abundance, distribution and demography can reflect changes in ecosystem trophic structure and/or island or wetland nesting habitat and, therefore, are important metrics for assessing the health of a variety of Great Lakes ecosystem components. Inter-specific differences in foraging and nesting strategies make it possible to assess and integrate trend information across a variety of temporal, spatial and ecosystem scales. Declining waterbird populations (number of breeding pairs or nests) or vital rates (hatching success, fledging success, mortality rates, etc.) can be indicators of local environmental stress (e.g. Grasman *et al*. 1998; Amat and Green 2010; Satterthwaite *et al*. 2012).

The Great Lakes-wide population of colonial waterbirds has been censused jointly, by the Canadian Wildlife Service and the U.S. Fish and Wildlife Service since the 1970s, approximately every 10 years. Four “decadal” censuses have been conducted to date: in the 1970s, 1980s, 1990s and 2000s (e.g. Courtney and Blokpoel 1983, Morris *et al*. 2010, 2011, 2012; Cuthbert and Wires 2013, 2018; Rush *et al*. 2015). To reduce survey effort and associated costs, the current (2022-24) survey results were based on a sampling framework, designed to provide robust estimates of population change at a Great Lakes wide spatial scale (<5% error for most species; Pearce et al. *in prep*). However, there is greater uncertainty regarding trends at the level of individual lakes (10-20% error depending on the species; Pearce *unpubl.*) and estimates at this scale of resolution should only be considered qualitative. Data from the U.S. Great Lakes were not available for this SOGL reporting period (anticipated in 2025). Species population trends generally track on both sides of the international border (e.g. Morris *et al*. 2010, Rush *et al*. 2015), so the Canadian trends reported here should provide an adequate assessment of this indicator for the Great Lakes as a whole.

In the long-term (1976-2024), the breeding numbers of four species have undergone moderate to large declines: Herring Gull, Ring-billed Gull, Great Blue Heron and Common Tern. Anecdotal evidence suggests that there has been increased (but unquantified) urbanization of Ring-billed Gulls, mainly in the Greater Toronto Area (many of these gulls are now nesting on the rooftops of industrial buildings in urban centres). Since the Great Lakes Binational Decadal Colonial Waterbird survey focuses mainly on natural, island breeding sites, the trend reported here may represent an over-estimate of the rate of decline for this species. Two species, Black-crowned Night Herons and Caspian Terns, exhibited stable, long-term population trends (the number of breeding pairs has fluctuated widely among survey periods for the former). Both species are characterized by low population sizes in the Great Lakes region, making them more sensitive to rapid or significant environmental perturbations. The remaining two species have increased. Since the last survey period, Double-crested Cormorants have declined markedly on the upper Great Lakes, but continue to increase on the lower lakes, resulting in decelerated growth overall (a positive outcome in terms of this sub-indictor). Great Egrets have increased rapidly, consistent with continental trends and a general northward range expansion (McCrimmon *et al*. 2020).

Drivers of population change are likely complex and multifaceted and will vary among species. Potential stressors include: habitat loss or degradation (e.g. Brandis *et al*. 2018); changes in trophic structure and abundance of prey (Hebert *et al*. 2008, 2009); reduced access to alternate sources of food (for gulls, resulting from changes in fisheries, agricultural and waste disposal practices; e.g. Votier *et al*. 2004; Bicknell *et al*. 2013); inter-specific competition for nesting space (e.g. increased pressure from abundant species such as cormorants and Ring-billed Gulls; Sommers *et al*. 2007, 2011); factors related to changing weather and other physical conditions - for colonial waterbirds, mainly water-level fluctuations and the effects of intensified storms (Erwin *et al*. 2011; Wyman *et al*. 2014; McKellar *et al*. 2021; Moore *et al. in prep*.); and contaminants-related impairments (e.g. Grasman *et al*. 1998; Hebert *et al*. 1999). Unidentified stressors during migration and in overwintering areas also likely play a role in regulating migratory, waterbird populations. Recent advances in tracking technologies will allow identification and assessment of these factors. Consideration should also be made that the population trends observed on the Great Lakes may reflect those occurring at national or continental scales and not directly linked to specific conditions in that region (e.g. Great Egrets). In some cases, increased populations, or slowing of declines, are the result of ongoing conservation or habitat remediation efforts. For example, the Hamilton Harbour Remedial Action Plan supports habitat creation and management efforts with the goal of maintaining waterbird species diversity and abundance in Hamilton Harbour (Zanchetta et al., 2016).

Linkages

Waterbird population trends and breeding habitat are indicators in some of the Great Lakes Areas of Concern, and are used for delisting criteria.
Linkages to other sub-indicators in the indicator suite include:

- **Toxic Chemicals in Herring Gull Eggs** –Since the 1970s, concentrations of many contaminants in Herring Gull eggs have decreased and stabilized in recent years; however, relatively high levels of contaminants persist in gull eggs in certain areas of the Great Lakes (e.g. de Solla et al., 2016). In particular, legacy contaminants persist in some areas of the Great Lakes which has led to contaminants like dioxins, furans, PCBs and metals being found in eggs. The effects of these contaminants can include lethal or sub-lethal effects such as decreased viability of eggs, deformities in chicks, and impaired reproduction and immune function in adults (e.g. Grasman *et al*. 1998; Bustnes *et al*. 2004).
- **Toxic Chemicals in Whole Fish** – Given their position on the trophic level food web, waterbirds are vulnerable to consuming toxic chemicals found in fish prey. These contaminants include pesticides, polychlorinated bi-phenyls, oil hydrocarbons, and heavy metals. Contaminants can accumulate in the tissue or gills of whole fish, and cause acute toxicity in waterbirds once they ingest these organisms. Fish and gull eggs have shown similar trends in mercury among lakes (e.g. Blukacz-Richards *et al*, 2017; McGoldrick *et al*., 2018).
- **Water Levels** – High water levels can disrupt the habitat of colonial waterbirds, rending their environment susceptible to the introduction of invasive species and nutrient loading, as well as the loss of biodiversity (Zohary and Ostrovsky, 2011). Increased water levels have also led to habitat loss and displacement in waterbird populations (e.g. Wyman *et al*. 2014; McKellar *et al*. 2021).
- **Changes in Physical Conditions** – Increases in temperature, rainfall, wildfires, and storms cause changes in egg laying patterns, migration timing, behaviour, disruption in habitat, and increased extinction rates in fish and colonial waterbird populations (Wormworth and Mallon, 2006). In addition, birds could be moving out of the Great Lakes region (i.e. a shift in distribution) in response to directional changes in environmental variables, with no net change in abundance at larger spatial scales.

This sub-indicator also links directly to the other sub-indicators in the Habitat and Species indicator, particularly:

- **Lake Sturgeon, Lake Trout, Walleye, and Native Preyfish Diversity –** There is potential for fish-eating and colonial waterbirds to impact the fish populations of Lake Sturgeon, Lake Trout, Walleye, and native preyfish in some areas of the Great Lakes. Cormorants have been shown to cause local impacts to populations of some species of sport fish (e.g. Dorr *et al*. 2012; Shultz *et al*. 2022), although assessments of the magnitude or generality of such impacts is equivocal (e.g. Diana *et al* 2006; Wires and Cuthbert 2006), resulting in disagreements over appropriate management actions. Alternately, cormorants may provide ecosystem benefits in areas where their diet consists of high proportions of invasive fish species (e.g. Madura and Jones 2016).

Assessing Data Quality

Data Characteristics	Agree	Neutral or Unknown	Disagree	Not Applicable
Data are documented, validated, or quality-assured by a recognized agency or organization	X			
Data are from a known, reliable and respected generator of data and are traceable to original sources	X			
Geographic coverage and scale of data are appropriate to the Great Lakes Basin	X			
Data obtained from sources within the U.S. are comparable to those from Canada	X			
Uncertainty and variability in the data are documented and within acceptable limits for this sub-indicator report	X			
Data used in assessment are openly available and accessible	No			

Notes on Accessing Data

Data available upon request. Contact sub-indicator report author for more details

Data Limitations

- Most waterbird species are migratory. Changes in population status or trends could reflect environmental or anthropogenic stressors experienced during the non-breeding period (or cumulative effects over the full annual cycle, inside and outside of the Great Lakes region).
- Data are collected at approximately 10-year intervals, which is longer than the reporting cycle for State of the Great Lakes Reporting.

- The status and trends presented in this report are based on Canadian data only. Species population trends are generally similar on both sides of the international border, so the Canadian trends reported here should provide an adequate assessment of this indicator for the Great Lakes as a whole.

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List of Tables

Table 1. Proportional changes in estimated population size (nests; current estimate in brackets) of eight species of colonial waterbirds nesting on Canadian waters of the Great Lakes and connecting channels, 2007-09 to 2022-24. BCNH = Black-crowned Night-Heron, CATE = Caspian Tern, COTE = Common Tern, DCCO = Double-crested Cormorant, GBHE = Great Blue Heron, GREG = Great Egret, RBGU = Ring-billed Gull, HERG = Herring Gull.

Source: Environment and Climate Change Canada, Canadian Wildlife Service, Great Lakes Decadal Colonial Waterbird Survey, unpublished data.

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Figure 1. Population trends for the entire Great Lakes region (black line) and by water body (coloured lines, see legend) for eight species of colonial waterbirds census used during four ‘decadal’ periods, 1976-2009.

Sources: Canadian Wildlife Service- Ontario Region, Environment and Climate Change Canada, Burlington, ON; Cuthbert and Wires (2013).

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Water Bodies	BCNH	CATE	COTE	DCCO	GBHE	GREG	HERG	RBGU	OVERALL STATUS	OVERALL TREND
Lake Superior				-50%	-99%		-71%	-46%	Poor	Deteriorating
Lake Huron & St. Marys River	-69%	-39%	-34%	-38%	-11%	+8%	-32%	-53%	Poor	Deteriorating
Lake Erie & Detroit River	+62%	-90%		-18%	-35%	+7%	-48%	-98%	Fair	Unchanging
Lake Ontario, Niagara River & St. Lawrence River	-73%	-30%	-57%	+78%	-48%	+685%	+13%	-65%	Fair	Deteriorating
Great Lakes	-64% (924)	-37% (2,469)	-39% (3,400)	+9% (65,743)	-43% (538)	+78% (565)	-40% (20,020)	-70% (96,060)	Fair	Deteriorating

Large decline: ≥50% decline
Moderate decline: ≥25% to <50% decline
Stable: <25% decline to <33% increase
Moderate increase: ≥33% to <100% increase
Large increase: ≥100% increase

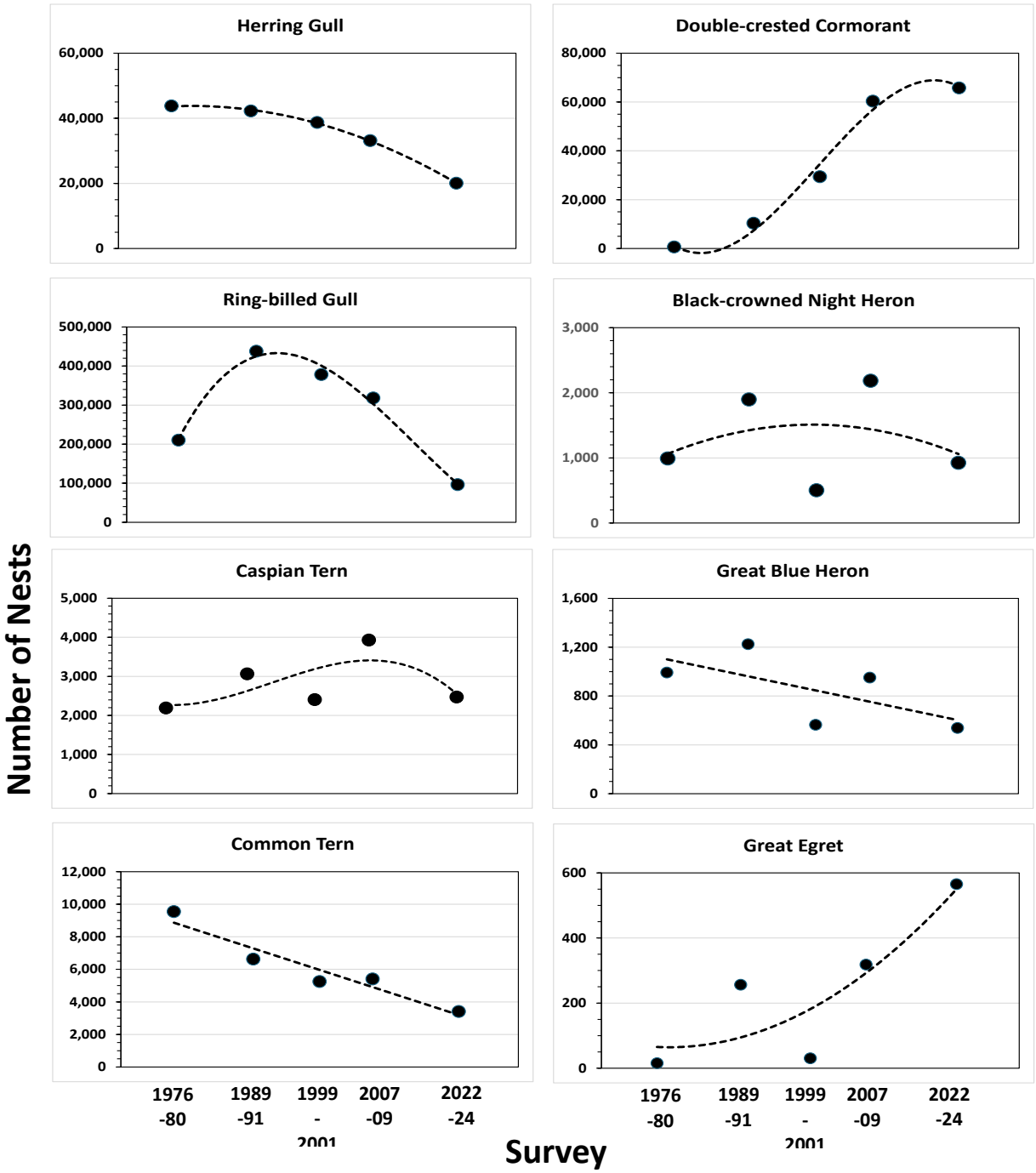

Figure 1. Population trends for eight species of colonial waterbirds breeding in the Canadian waters of the Great Lakes, 1976-2024. The estimated number of nests for 2022-24 are based on the per capita rate of change from the previous census period, estimated from a sample (~70%) of colony sites; all other time periods represent a complete census.

Sources: Canadian Wildlife Service- Ontario Region, Environment and Climate Change Canada, Burlington, ON; Cuthbert and Wires (2013).