

COSEWIC **Assessment and Status Report**

on the

Harlequin Duck *Histrionicus histrionicus*

Eastern population

in Canada



SPECIAL CONCERN
2013

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada



COSEPAC
Comité sur la situation
des espèces en péril
au Canada

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For additional copies contact:

COSEWIC Secretariat
c/o Canadian Wildlife Service
Environment Canada
Ottawa, ON
K1A 0H3

Tel.: 819-953-3215

Fax: 819-994-3684

E-mail: COSEWIC/COSEPAC@ec.gc.ca
<http://www.cosewic.gc.ca>

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COSEWIC Assessment Summary

Assessment Summary – November 2013

Common name

Harlequin Duck - Eastern population

Scientific name

Histrionicus histrionicus

Status

Special Concern

Reason for designation

Though increases have been recorded in southern parts of its breeding range, the population size of this sea duck remains relatively small. Its tendency to congregate in large groups when moulting and on its marine wintering areas makes it susceptible to catastrophic events such as oil spills. Such threats are substantial and are likely increasing, and are of particular significance for populations of long-lived species such as this sea duck, which can be slow to recover. Its population also appears to rely on continued management efforts, particularly those involving restrictions on hunting.

Occurrence

Nunavut, Quebec, New Brunswick, Nova Scotia, Newfoundland and Labrador

Status history

The Eastern population was designated Endangered in April 1990. Status re-examined and designated Special Concern in May 2001 and November 2013.



COSEWIC Executive Summary

Harlequin Duck *Histrionicus histrionicus*

Eastern population

Description

The Harlequin Duck is a small sea duck. Breeding males are striking in appearance with their slate blue colour highlighted by streaks of white, copper, and black. Females are brown, with a pale belly, plus three white spots on each side of their head.

Distribution

Globally, Harlequin Ducks breed in eastern and western North America, southeastern Russia, Japan, Greenland and Iceland. In Canada, there are two widely disjunct populations: one in the east and one in the west. The western population breeds in Alberta and British Columbia. The eastern population breeds in Québec, Newfoundland and Labrador, New Brunswick, and Nunavut. Based largely on wintering ranges, the eastern population can be segregated into two management units: an Eastern North American Wintering Population (EWP) and a Greenland Wintering Population (GWP).

Individuals within the EWP breed in northern New Brunswick, the Gaspé Peninsula of Québec, and on rivers emptying into the Québec North Shore, southern and central Labrador, and Newfoundland. Adults within the GWP breed in northern Québec, northern Labrador, Nunavut, and southern areas of western and eastern Greenland. The EWP wintering areas are situated primarily in coastal Atlantic Canada, Saint-Pierre-et-Miquelon (Territory of France), and the eastern seaboard of the United States as far south as Virginia. The GWP overwinters off the southwestern coast of Greenland.

Habitat

During the breeding season, Harlequin Ducks occupy clear, fast-flowing rivers and streams. Their wintering habitat is rugged, outer-marine coastline.

Biology

Harlequin Ducks have delayed sexual maturity, variable breeding success, and a long lifespan. Their diet changes throughout the year, with larval insects being important on the breeding grounds, and crustaceans and molluscs important in marine wintering areas.

Population Size and Trends

Little information is available on the numbers of Harlequin Ducks from the GWP that breed in Canada, but a crude population estimate suggests that it consists of about 4600 mature individuals. No trend estimates are available for this wintering population. An estimated 3226-3420 EWP adults winter along the east coast of North America. All birds from this wintering population originate from Canadian breeding areas. Though still small relative to historical levels, this wintering population has increased since cessation of hunting in 1990. The population trend since 1981 (3 generations) for birds wintering in eastern North America is estimated to be increasing at about 5% per year (an increase of about 350% overall).

Limiting Factors and Threats

The original decline in Harlequin Duck numbers was attributed primarily to hunting. A hunting ban has been in place in most regions of eastern Canada since 1990, but an unknown amount of incidental and subsistence hunting could still be limiting recovery.

Concentrations of some moulting and wintering Harlequin Duck populations are located in areas of intense oil production and exploration, as well as along major national and international shipping routes, which increases their susceptibility to oil contamination and pollution. Wintering concentrations can also be disturbed by human activities (e.g., boating, fishing). On the breeding grounds, hydroelectric developments, mining developments, and industrial forestry could also negatively affect the species. Changing climatic conditions could be resulting in a northward shift in the species' wintering distribution in eastern North America.

Existing Protection

The eastern population of the Harlequin Duck is listed as a species of 'Special Concern' in Canada under the *Species at Risk Act*. Under provincial legislation, it is 'Endangered' in New Brunswick and Nova Scotia, and 'Vulnerable' in Newfoundland and Labrador, and Québec. It is 'Threatened' in Maine. In Saint-Pierre-et-Miquelon, efforts are under way to add the species to the endangered list. A management plan is in place for eastern Canada, and a hunting ban is in effect for most regions. Habitat protection for Harlequin Ducks is not extensive on either its wintering or breeding grounds.

TECHNICAL SUMMARY

Histrionicus histrionicus

Harlequin Duck

Eastern Population

Range of Occurrence in Canada: Nunavut, Québec, New Brunswick, Nova Scotia, Newfoundland/Labrador

Arlequin plongeur

Population de l'Est

Demographic Information

Generation time (average age of parents in the population)	10 years
Is there an observed continuing decline in number of mature individuals? - Population has increased	No
Estimated percent of continuing decline in total number of mature individuals within 2 generations	Not applicable
Estimated percent increase in total number of mature individuals over the last 3 generations - The EWP component has increased by an average of about 5% per year (350% over 30 yrs), but the trend for the GWP component is unknown	Unknown rate of increase
Projected percent change in total number of mature individuals over the next 3 generations	Unknown
Observed, estimated, inferred or suspected percent change in total number of mature individuals over any 3-generation period, over a time period including both the past and the future.	Unknown, but generally increasing
Are the causes of the decline clearly reversible and understood and ceased? - The EWP has been increasing; no information on the trend for the GWP, but apparently stable. Hunting has ceased, but incidental take continues at a low level; risks from catastrophic oil spills continue and are increasing	Not applicable
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence	>20,000 km ²
Index of area of occupancy (IAO)	Unknown, but >2000 km ²
Is the population severely fragmented?	No
Number of locations -Based on wintering sites	Unknown, but >100
Is there an inferred continuing decline in extent of occurrence?	No
Is there a continuing decline in index of area of occupancy?	No
Is there a continuing decline in number of populations	No
Is there a continuing decline in number of locations?	No
Is there an inferred and projected continuing decline in area, extent and/or quality of habitat? - Decline in habitat quality (food resources) may be occurring in southern portion of winter range owing to climate change	Possibly
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals in each Population

Population	N Mature Individuals
Greenland Wintering Population (Canadian origin)	~4000-10,000
Eastern North American Wintering Population	~3226-3420
Total	~7226-13,420

Quantitative Analysis

Probability of extinction in the wild	Insufficient information
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Threats (actual or imminent, to populations or habitats)

<ul style="list-style-type: none"> - Catastrophic oil spills and chronic oiling - Hydroelectric development - Industrial forestry and mining - Incidental take from hunting (includes subsistence hunting) - Climate change
--

Rescue Effect (immigration from outside Canada)

Status of outside populations? (Greenland)	Apparently secure
Is immigration known or possible?	Possible
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Is rescue from outside populations likely?	Possible, but information is insufficient

Data-Sensitive Species

Is this a data-sensitive species?	No
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Status History

COSEWIC: The Eastern population was designated Endangered in April 1990. Status re-examined and designated Special Concern in May 2001 and November 2013.
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Status and Reasons for Designation

Status: Special Concern	Alpha-numeric code: Not applicable
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Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Population trend is unknown but likely increasing.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. Does not meet criterion; exceeds thresholds for extent of occurrence and area of occupancy.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Exceeds thresholds for population size.
Criterion D (Very Small or Restricted Total Population): Not applicable. Exceeds thresholds for population size, area of occupancy, and number of locations.
Criterion E (Quantitative Analysis): Not done.

PREFACE

Since the last status report was prepared in 2001, much has been learned about the life history and behaviour of Harlequin Ducks in eastern North America. There has also been increased conservation effort directed at the species. This updated status assessment of the eastern population upholds the view that there is merit in considering an Eastern North American Wintering Population and a Greenland Wintering Population for conservation management purposes. However, there continues to be insufficient evidence to support the assignment of two separate designatable units within eastern Canada.



COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS (2013)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.



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The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

on the

Harlequin Duck *Histrionicus histrionicus*

Eastern population

in Canada

2013

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

The Harlequin Duck (*Histrionicus histrionicus*) is a sea duck of the tribe Mergini, which includes waterfowl that spend considerable periods of their life history in marine habitats where they dive for food. The French name is Arlequin plongeur; the Inuktitut name is Satjugiame Kotsiutik; the Innu-Aimun name is Nutshipaustukueshish; the Beothuk name is Mammadronit; the Passamaquoddy name is Pitapsq. Colloquial English names in Atlantic Canada are lords and ladies, ladybird, white-eyed diver, and rock duck.

Historically, the Harlequin Duck had been separated into two subspecies: the Atlantic subspecies *H. histrionicus histrionicus* and the Pacific subspecies *H. histrionicus pacificus*, based on subtle differences in size and plumage (Brooks 1915). Although insufficient information is currently available to support subspecific distinction (Palmer 1976; Robertson *et al.* 2008), recent unpublished work by Scribner *et al.* (1998, 2000) has suggested that there are clear genetic differences between Pacific and eastern populations of Harlequin Ducks.

Morphological Description

The Harlequin Duck is a small duck ranging from 33 to 46 cm in length. Males average 650 g and are larger than females, which average about 450 g. The breeding plumage of the adult male is striking. Its body is slate-blue, lined with white and with chestnut-brown flanks. The head has a distinct round spot behind the eye, and a large white crescent in front of the eye that leads over top of the head bordered by black and chestnut. White bands and collars on the chest and neck are bordered with black lines. The female is brown with a mottled chest and a pale belly. The head has a small white spot above the eye and, similar to the male, a circular white spot near the ear. In front of the eye are variable white patches (Robertson and Goudie 1999). Male plumage varies during the annual moult when males often appear more female-like; likewise, immature males become progressively more adult-like during the winter-spring period (Smith *et al.* 1998; Robertson and Goudie 1999).

Female, juvenile and moulting male Harlequin Ducks are sometimes confused with female or moulting Surf Scoters (*Melanitta perspicillata*) and female Buffleheads (*Bucephala albeola*). The female Bufflehead has only one spot on its head while the Harlequin has two, sometimes three. The bill profile and size distinguish the Harlequin Duck from the Surf Scoter (see Robertson and Goudie 1999).

DISTRIBUTION

Global Range

Globally, Harlequin Ducks breed in eastern and western North America, southeastern Russia, Japan, Greenland, and Iceland (Robertson and Goudie 1999). The western and eastern North American populations are completely geographically disjunct (Figure 1). The western population breeds in Alaska south through Yukon, British Columbia, Washington, Oregon and Montana. It winters along the coast of the Pacific northwest.

In the east, the North American wintering population in coastal Greenland is shared with birds originating from both northeastern Canada and Greenland (Figure 1).

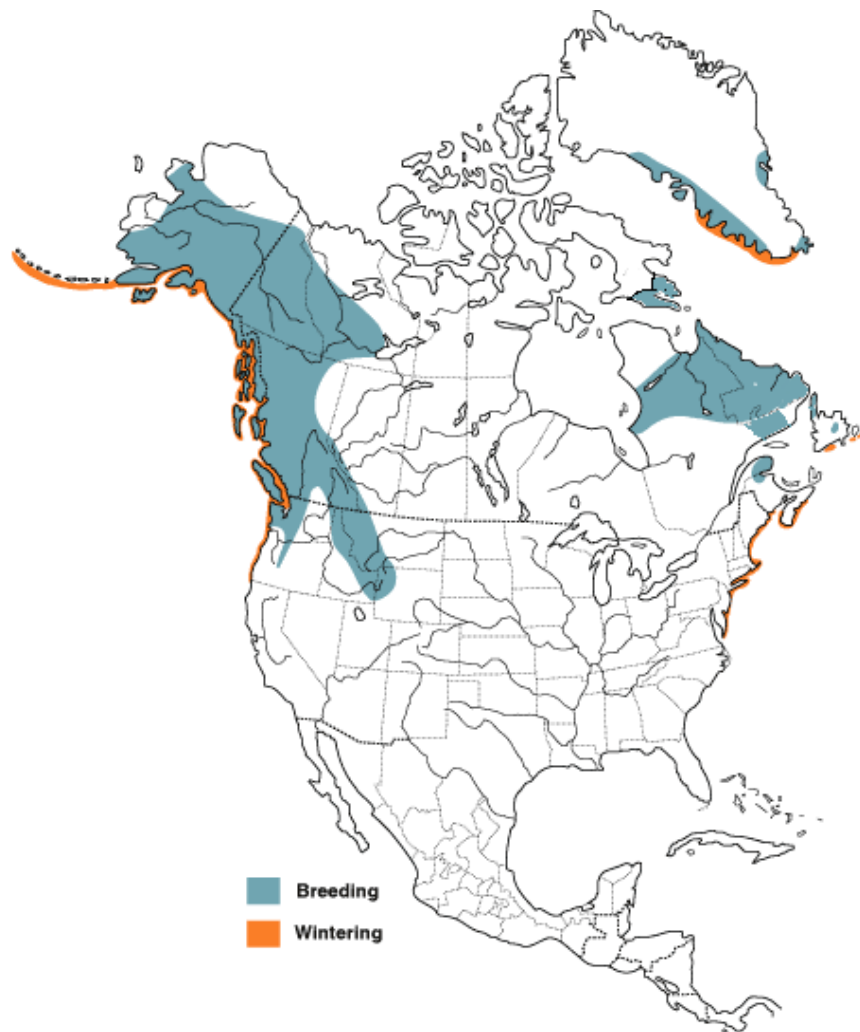


Figure 1. North American breeding and wintering range of the Harlequin Duck; adapted from Robertson and Goudie (1999).

Canadian Range

The relatively large population of Harlequin Ducks that occurs in western Canada breeds in Alberta and British Columbia. It is geographically disjunct and apparently genetically distinguishable from the population in eastern Canada (Scribner *et al.* 2000). The eastern population, which is the subject of this report, breeds in Newfoundland, Labrador, New Brunswick, Quebec, and Nunavut (Figure 2). In the east, Harlequin Ducks largely segregate into two populations on the wintering grounds: the Eastern North American Wintering Population (EWP) and the Greenland Wintering Population (GWP; see below and **Population Spatial Structure and Variability**).



Figure 2. Breeding and wintering range of Harlequin Ducks originating in eastern Canada. From Soulliere and Thomas (2009).

Eastern Wintering Population (breeding and wintering)

The EWP consists entirely of birds originating from eastern Canada. The breeding range of the EWP includes central Labrador from Hamilton Inlet southward, parts of Newfoundland, and the upper reaches of rivers emptying into the Québec North Shore (Figure 2). It also includes Harlequin Ducks breeding on the Gaspé Peninsula of Québec (Brodeur *et al.* 2008; Savard *et al.* 2008), extending southward into northern New Brunswick (Boyne 2008). The Northern Peninsula of Newfoundland has an established breeding population (Gilliland *et al.* 2008), while a sighting of a female with a brood along the Bay du Nord River (south of Medonnegonix Lake) confirmed breeding of this species in southeastern Newfoundland (Thomas and Robert 2001; Figure 2).

The EWP winters in congregations in historically established sites along the coast of eastern North America from Newfoundland to Virginia (Mittelhauser 2000; Figure 2). Slightly more than half of the EWP winters in the United States, most notably in the Jericho Bay, Penobscot Bay, and the Isle au Haut regions of Maine. Generally smaller populations winter regularly along the south coast of Newfoundland, from Cape St. Mary's in the east to Ramea in the west. The Atlantic and Bay of Fundy coasts of Nova Scotia and New Brunswick also regularly have Harlequin Ducks in winter. A few also overwinter in southern Québec, particularly around Baie des Chaleurs on the south shore of the Gaspé Peninsula (Savard *et al.* 2008) and elsewhere along the St. Lawrence corridor and the Ottawa River (Thomas and Robert 2001). Over the past decade, increasing numbers are reported wintering in Saint-Pierre-et-Miquelon (Territory of France; B. Letournel, 2012, pers. comm.). Though still rare, increasing numbers of Harlequin Ducks (believed to belong to the EWP) have been reported in winter in the eastern Great Lakes.

Greenland Wintering Population (breeding and wintering)

In Greenland, Harlequin Ducks breed as far north as 72°30'N on the west coast, and at a few sites on the east coast up to about 66°N (Figure 1). In Canada, the breeding range of the GWP includes northern Labrador and north-central Québec (Morneau *et al.* 2008). Harlequin Ducks also breed at low densities in Nunavut in southern Baffin Island (Soper 1946; Mallory *et al.* 2001, 2004, 2008; Figure 2). It is presumed that Harlequin Ducks from these regions winter in southern Greenland (Mallory *et al.* 2008). All Harlequin Ducks breeding in Greenland are assumed to spend their winters along Greenland's southwest coast (Merkel *et al.* 2002; Boertmann 2003, 2008). While the GWP includes birds originating from both Canada and Greenland, there are no good estimates as to their relative proportions.

Moulting Distribution

After the nesting season, eastern Harlequin Ducks undergo a moult migration to offshore areas that are often well away from their breeding and wintering grounds. Moulting grounds of the EWP are typically well north of the wintering grounds, whereas they are at a similar latitude for the GWP. For the most part, EWP Harlequin Ducks moult along the coast of Newfoundland, central and southern Labrador, and Québec (Trimper *et al.* 2008; Figure 3).

In Labrador, notable sites include Tumbledown Dick Island, the Stag Islands, Gannet Islands, and St. Peter's Bay. In Newfoundland, the Grey Islands, Stearing Island, and Cape St. Mary's are also known moulting areas (Thomas 2008). The Québec coast has several moulting areas located at Bonaventure Island, Anticosti Island, the Newport-Port-Daniel area, and at Forillon National Park (Savard *et al.* 2008). Some female Harlequin Ducks from the EWP also moult at Isle au Haut, Maine (Mittelhauser, pers. comm.). Notwithstanding the above, at least some post-breeding males of the EWP initially migrate to moult southwest of Greenland, then move long distances to overwinter with females within the EWP range (Robert *et al.* 2008).

Similar to their winter distribution, post-breeding Harlequin Ducks from the GWP moult along the southwestern coast of Greenland (Mosbech *et al.* 1996; Boertmann 2003, 2008) and possibly Labrador.

Migratory Staging Areas

According to Soulliere and Thomas (2009), spring and autumn migrating Harlequin Ducks reportedly use coastal areas of Newfoundland and southern Labrador as a migratory stop-over. They are believed to stage in Labrador both prior to breeding and prior to moulting. Pre-breeding staging in the spring occurs primarily in coastal areas of Labrador from the area around Natuashish north to the Saglek Fiord. Birds breeding in Labrador that go on to moult in Greenland are thought to stage in northern coastal areas of Labrador before departing for Greenland. Key pre-moult staging areas include the Nain archipelago, and the coastal area from the Nachvak Fiord north to Cape Chidley. The tip of the Gaspé Peninsula is also a staging area for EWP Harlequin Ducks during spring migration (Brodeur *et al.* 1999; Robert *et al.* 2008; Savard *et al.* 2008). In the Gulf of St. Lawrence, the area around the Magdalen Islands is also used as a spring staging area (F. Shaffer pers. comm. 2013).

Extent of Occurrence and Area of Occupancy

Extent of occurrence (EO) for the Canadian breeding grounds cannot be calculated accurately at this time, because of uncertainties in delimiting range limits. However, EO would be $>20,000 \text{ km}^2$, based on a minimum convex polygon. An index of area of occupancy (IAO) for the breeding grounds, based on the $2 \text{ km} \times 2 \text{ km}$ square grid-method, is also not possible to calculate at this time. However, the population size and the widespread, scattered breeding sites across large areas suggest that the IAO values would be $>2000 \text{ km}^2$. Because of the Harlequin Duck's flocking behaviour during the winter, IAO calculated for the wintering grounds would be smaller than that for the breeding grounds, but would also be $>2000 \text{ km}^2$, based on the number of primary and secondary wintering locales in Canada and the US, plus Greenland.

Search Effort

There have been increased efforts to locate concentrations of Harlequin Ducks in recent decades. Based on aerial surveys for sea ducks, it is unlikely that new concentrations will be detected. Still, existing concentrations are relatively poorly monitored in eastern Canada. Efforts focused on the breeding range have been made by experienced observers using low-level helicopter coverage; while such surveys can cover expansive remote areas, they have not provided for statistical assessment of trends in numbers of breeding pairs (e.g., Trimper *et al.* 2008). The species is more readily monitored in winter when numbers are concentrated in discrete areas. For more information, see **Sampling Effort and Methods**.

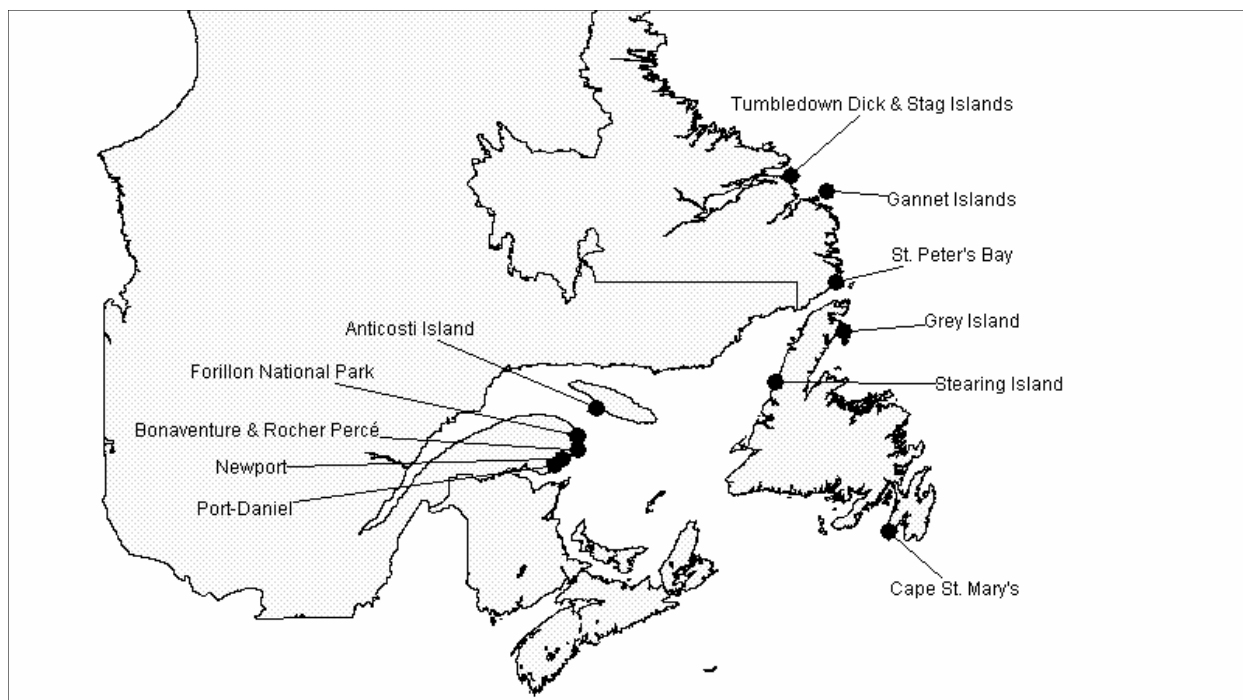


Figure 3. Key moulting areas for Harlequin Ducks in eastern North America (from Thomas and Robert 2001). The map does not include moulting areas in coastal Greenland.

Population Spatial Structure and Variability

Research shows that there is population structuring based on migration and movement patterns of Harlequin Ducks within eastern North America. Males captured and fitted with satellite transmitters in northern Labrador and northern Québec (i.e., from the GWP) migrated to northern Labrador and later on to Greenland, where they were presumed to have moulted and overwintered (Brodeur *et al.* 2002; Morneau *et al.* 2008). Males staging on the coast at Forillon National Park, Québec, and fitted with satellite transmitters, remained local, or migrated to Newfoundland and Labrador to breed and/or moult (Brodeur *et al.* 2002). EWP males captured in winter in Jericho Bay, Maine migrated north to breed in Gaspé Peninsula, Québec and the Hamilton Inlet region of Labrador. While some later moved to southwest Greenland to moult after the breeding season, these birds still returned to Maine to overwinter (Robert *et al.* 2008). Within the eastern population of Harlequin Ducks, results from preliminary genetic studies also point to genetic structuring, though it does not appear to be tied directly to wintering areas (Scribner *et al.* 1998, 2000; Scribner unpubl. data).

Philopatry to wintering areas is very high among Harlequin Ducks (Breault and Savard 1999; Mittelhauser 2000; Robertson *et al.* 1999, 2000). Even within local wintering sites, the birds show strong site tenacity to specific stretches of coast (Robertson *et al.* 1999). In addition, pair bonds are formed (or reunited) on the wintering grounds, and these pairs are maintained on the breeding grounds (Smith *et al.* 2000), resulting in long-term monogamy (Robertson and Goudie 1999; Cooke *et al.* 2000; Robertson *et al.* 2000). The separation during the winter period of the annual cycle when pairing occurs, coupled with distinct wintering sites and the philopatric nature of Harlequin Ducks to their wintering areas, means that the EWP and GWP remain largely demographically and genetically separated (see Esler 2000; Thomas and Robert 2001). However, even the small amount of intermixing that appears to occur between the EWP and the GWP means that the two populations are acting as a metapopulation (Thomas *et al.* 2008).

DESIGNATABLE UNITS

The previous status report concluded that there was insufficient evidence to demonstrate the existence of two designatable units (DUs) within eastern Canada (Thomas and Robert 2001). There is still no firm evidence to support the existence of more than one DU (e.g., see Brodeur *et al.* 2002; Thomas *et al.* 2008).

Within eastern North America, there are no biologically meaningful differences in morphology between GWP and EWP birds (Robertson *et al.* 2008). There is some genetic structuring (Scribner *et al.* 2000; K. Scribner unpublished data 2013). However, there is little evidence for genetic differentiation between Greenland and Maine wintering populations; results instead more accurately portray the existence of two management units (V. Friesen and K. Scribner pers. comm. 2013). Indeed, for conservation purposes, there is strong reason to consider the existence of two management units, corresponding to discrete wintering areas: namely the EWP and the GWP.

During the breeding season, results from banding and satellite telemetry indicate that a zone of overlap exists between these two subpopulations in central Labrador (Thomas *et al.* 2008), and presumably central Québec. At the present time, it is not possible to clearly map separation of the two management units during the breeding season.

Special Significance

Harlequin Ducks are unique among North American waterfowl, occupying clear, fast-flowing rivers and streams where they move with apparent ease in the turbulent waters. In terms of Aboriginal Traditional Knowledge, the Innu in Labrador know the species as *Nutshipaustukueshish*, meaning “one who loves the rapids.” In Kimmirut on Baffin Island, local hunters know the Harlequin Duck as *Turngaviaq*, and have contributed important information on its distribution and abundance (Mallory *et al.* 2001, 2008). Elsewhere, some Harlequin Ducks are periodically taken in subsistence hunts in Greenland, where they are used for traditional bird skin quilts (Boertmann 2008).

HABITAT

Habitat Requirements

Breeding Habitat

Harlequin Ducks prefer shallow, fast-flowing water with concentrations of aquatic invertebrates, and adjacent available shelter for nesting (Palmer 1976), but breeding and brood rearing habitat varies geographically. On some rivers, there is a tendency for females to nest near fast flowing waters, but successful breeders will move into slower waters to raise their broods (Kuchel 1977; Cassirer and Groves 1994). On other rivers, Harlequin Ducks raise their broods in the same area occupied before and during egg-laying (Robertson and Goudie 1999).

Nests are constructed primarily of down. Although some nests are located in tree cavities, most are placed on the ground near water, in a variety of situations—from mid-stream islands, up to 100 m from the river edge, to high (e.g., 30 to 40 m) above the water at the mouths of gorges and ravines (Robertson and Goudie 1999).

In Labrador, Harlequin Ducks in the Hebron Fjord used streams that were narrower and with a steeper shoreline slope than those not used. Occupied streams often have a higher pH with considerably more vegetation on the river islands and shoreline (Cassirer *et al.* 1993; Rodway 1998). In Newfoundland, Harlequin Ducks exploit rapids, riffles and runs, and are especially associated with boulder-strewn inlets and outlets of ponds. Large quantities of submerged and semi-submerged boulders provide increased surface area for attachment of larval insects, while movement of water through the boulders assures high rates of oxygenation, which is important to filter-feeding insects (Goudie and Gilliland 2008).

On the Gaspé Peninsula, Brodeur *et al.* (1998) found that Harlequin Duck broods used shallow rapids with cobble substrate and overhanging vegetation in mature forest. On the Port-Daniel and Sainte-Anne rivers, broods were observed on river stretches varying between 4 and 10 m, and 10 and 30 m wide, respectively (Brodeur *et al.* 1998). Some broods are reared in coastal habitats in northern Labrador (I. Goudie, pers. obs.).

Wintering Habitat

Harlequin Ducks overwinter in rocky outer marine coastlines, where the sea breaks against the shore (Goudie and Ankney 1988). Here, they feed over or near subtidal ledges, and close to shore near exposed headlands and archipelagos (Palmer 1949; Bengtson 1966; Goudie 1999; Robertson and Goudie 1999). They congregate on preferred rock shoals, and may form large groups in coastal areas rich in food concentrations (Robertson and Goudie 1999). The average distance from shore was $11 \text{ m} \pm 3 \text{ SD}$ in one study conducted in Newfoundland (Goudie and Ankney 1986), in water less than 10 m in depth (Robertson and Goudie 1999). Densities of Harlequin Ducks located in Jericho Bay, Maine were correlated with increased wave exposure, decreased intertidal gravel and boulder beach habitat, and an increased density of interstitial amphipods (Mittelhauser 2000).

Moulting and Migration Habitat

For moulting and staging, Harlequin Ducks generally select similar rocky coastal habitat as they do for wintering (Robertson and Goudie 1999). In the EWP, the moulting sites are outer coastal islands and headlands generally north of where the wintering concentrations occur, although for some sites, such as Cape St. Mary's, NL there are small numbers moulting where subsequently larger overwintering numbers gather (Thomas and Robert 2001).

Habitat Trends

Hydroelectric developments, forestry practices, and mining threaten the suitability of Harlequin Duck breeding habitat (Robertson and Goudie 1999; Soulliere and Thomas 2009). However, the extent of these changes has not been quantified and no trends are available. The Gulf Stream may be extending farther north along the eastern seaboard in recent decades, affecting the quality of colder coastal habitats preferred by Harlequin Ducks. For additional information, see **Threats and Limiting Factors**.

BIOLOGY

Diet

On the breeding grounds, Harlequin Ducks primarily eat freshwater aquatic invertebrates, such as chironomids (Robertson and Goudie 1999), whereas on marine habitat they consume subtidal and intertidal aquatic invertebrates (Goudie and Ankney 1986). Cottam (1939) assessed the diet of 63 adult Harlequin Ducks captured throughout the year in North America (mostly western birds), and provided the following estimates: crustaceans (57.1%), molluscs (24.7%), insects (10.2%), echinoderms (2.4%), and fish (2.4%). During the non-breeding season, Harlequin Ducks feed mostly on marine crustaceans (Decapoda, Amphipoda, Isopoda, Cirrledia) and molluscs (Gastropoda, Polyplacophora, Bivalvia), and complement their diet with a variety of other marine prey, such as fish, fish eggs, insects, echinoderms, and sea cucumbers (Robertson and Goudie 1999).

Robert and Cloutier (2001) collected 42 fecal samples from Harlequin Ducks captured on breeding rivers of northern Québec, Labrador, and Newfoundland, and determined that chironomidae was the most important food item consumed when considering volume of prey types. Chironomidae was also the most numerous taxon collected in benthic samples on the Torrent River in northern Newfoundland (Goudie and Gilliland 2008).

Harlequin Ducks make extensive use of inundated shorelines of lakes with an abundance of larval Ephemeroptera (mayflies) in spring habitat in central Labrador (Goudie and Jones 1999, 2001), and have been observed feeding on emerging caddisflies on small lakes and ponds in northern Newfoundland (Goudie and Gilliland 2008).

Life Cycle and Reproduction

Harlequin Ducks are similar to other species of sea ducks in that they have delayed sexual maturity, low annual production, variable breeding success, and a long lifespan (Goudie *et al.* 1994b). Although females have been observed to breed as early as 1 year of age, breeding success tends to be low until at least 5 years of age. Similarly, male Harlequin Ducks are able to acquire mates at 2 years of age, but often do not mate until ≥ 3 years old.

Harlequin Ducks raise one brood per season (Robertson and Goudie 1999). Mean clutch size varies somewhat across their range: Iceland mean: 5.7 eggs (Bengtson 1972); south-central Alaska mean: 6.1 ± 0.9 SD ($n = 7$; Crowley 1999); and Oregon mean: 5.2 ± 1.2 SD ($n = 21$; Bruner 1997). There are little available data on eastern North American clutch sizes. Brodeur *et al.* (1998) reported two nests containing 4 eggs, and one containing 7 eggs on the Gaspé Peninsula, Québec.

The proportion of females that successfully fledge broods varies annually, and in some years there may be widespread reproductive failure (Reichel *et al.* 1997; Goudie and Jones 2005). Goudie and Jones (2005) proposed that it is failed nesting and not breeding deferment that results in years of very low productivity. Some rivers may experience relatively high levels of reproductive success and hence act as source populations for larger geographic regions (Goudie and Gililand 2008).

Female Harlequin Ducks leave breeding areas with their broods, and lead them to the moulting/wintering grounds. It is not until they arrive at the moulting/wintering area that the family group separates (Regehr *et al.* 2001).

Philopatry to wintering areas is high (Robertson *et al.* 2000). Pair bonding occurs on the wintering grounds. Courtship begins in October, and there is long-term monogamy as pairs reunite during winter and return to breed in specific stretches of rivers (Robertson and Goudie 1999). On the breeding grounds, the paired male and/or female chase or attack conspecifics that approach in the vicinity of feeding and resting sites (Bengtson 1966; Inglis *et al.* 1989; Squires *et al.* 2007).

Demographic Rates

Annual survival rates have been estimated for Harlequin Ducks around North America (e.g., Cooke *et al.* 2000; Mittelhauser 2008; Thomas and Robertson 2008). Because these estimates of 'apparent survival' are based on mark-resighting, they are confounded by unknown levels of emigration (Lebreton *et al.* 1992). Local movements of Harlequin Ducks may also be substantial (Regehr 2003). Hence, there is a tendency to underestimate true survival rates. Further complications relate to band wear and/or loss (Goudie *et al.* in prep.).

Annual survivorship estimates based on radiotelemetry are likely more robust than those from mark-resighting, but such data are currently scarce. For the western population, Esler *et al.* (2000) estimated survivorship of 0.837 ± 0.029 SE for adult females in unoiled areas of Prince William Sound, Alaska.

In the east, Goudie (2002, 2003, 2004) banded over 100 Harlequin Ducks in central Labrador. Based on resightings, apparent survival rates for adult females were 0.795 ± 0.065 SE (Fig River) and 0.857 ± 0.132 SE (Crooked River). For adult males, the rates were 0.874 ± 0.089 SE (Fig River) and 0.571 ± 0.187 SE (Crooked River; Goudie and Jones 2003). Survivorship of local females (recruitment) for the Fig River was 0.876 ± 0.212 SE. The Fig River estimate of female recruitment, if applicable to the larger population scale, has the potential to considerably alter population modelling outputs.

Another study that highlighted survival was completed on the largest known EWP moult site—the Gannet Islands, Labrador (Thomas and Robertson 2008). Apparent survival was estimated for 113 male Harlequin Ducks (second-year, $N = 30$; adult, $N = 83$). Second-year male apparent survival rates were considerably lower (0.466 ± 0.118 ; 95% PLI: 0.256 - 0.689) than adult rates (0.744 ± 0.045 ; 0.647 - 0.822), likely due to increased dispersal of young birds.

The apparent annual survival rates based on mark-resighting on the breeding range and in moulting areas are both much higher than rates reported from mark-resighting programs on the winter range (0.66 ± 0.04 SE for fall-captured adult females in Maine; Mittelhauser 2008). This estimate appears low, and if correct, cannot sustain the numbers detected in Maine during winter (L. Tudor, pers. comm.). The relatively low apparent mean survival rates reported for Maine (Mittelhauser 2008) could be confounded by emigration.

Thomas and Robert (2001) concluded that it is not possible to provide a rigorous estimate of recruitment and sustainable reproductive rates. Often the power of mark-resighting studies lies more in the ability to model apparent survival with environmental covariates than to produce rigorous estimates of vital rates. For example, Jones *et al.* (2002) demonstrated statistical support for apparent survival of seabirds tracking the Pacific decadal oscillation. Likewise, the relatively low apparent survival rates demonstrated for male Harlequin Ducks moulting at the Gannet Islands, Labrador (Thompson and Robertson 2008; see above) likely reflect lower philopatry to moult sites in the eastern Canadian population (see Brodeur *et al.* 2008) (where moulting and wintering do not overlap) than in the population in western Canada (Robertson and Goudie 1999).

There is little information on the lifespan of Harlequin Ducks. Longevity can be expected to exceed 10 years, and is likely in the range of 15 to 20 years (Robertson and Goudie 1999). One estimate of generation time for the species would use: $1/\text{adult mortality} + \text{age at first reproduction}$. Annual survival rates of Harlequin Ducks in the Strait of Georgia, BC are regarded as the best overall assessment for this species based on mark-resighting (males: 0.869 ± 0.011 SE; females: 0.796 ± 0.019 SE; Goudie *et al.* in prep.). With a combined male/female average adult survival rate of 0.83, and assuming age at first reproduction is 3-5 years (see above), generation time would be 9-12 years. A 10-year generation time seems appropriate for a species characterized by delayed sexual maturity, low annual fertility and a long lifespan.

Behaviour and Adaptability

Aspects of the behaviour of Harlequin Ducks increase their susceptibility to disturbance, hunting, and catastrophic events because the birds exploit near-shore sites and are relatively tame. Harlequin Ducks are also highly social, and tend to show high site fidelity, especially in the non-breeding season (Robertson *et al.* 1999; Robertson and Goudie 1999).

Interspecific Interactions

Outside the breeding season, Harlequin Ducks frequently intermingle with (and potentially compete with) groups of larger species of sea ducks, namely, Common Eiders, Surf Scoters, and Black Scoters (*Melanitta nigra*) in eastern North America (Goudie and Ankney 1988). Large gull species (*Larus* spp.) are known to harass and steal food from Harlequin Ducks (Robertson and Goudie 1999). In eastern North America, fish may act as competitors for invertebrates on the breeding grounds (Robertson and Goudie 1999).

Raptors and mustelids take adults and ducklings. Robertson and Goudie (1999) suggested that predation may be an important source of female and duckling mortality, and likely explains differences in male and female survival rates.

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

Numbers of Harlequin Ducks are difficult to measure during the breeding season due to their dispersed nature in remote areas of the northern boreal and subarctic regions. Due to their gregarious nature during the winter months, winter counts are the best available measure of population status and trend.

To date, the majority of survey efforts targeting Harlequin Ducks during the breeding season have been carried out in Labrador using a variety of methods, including aerial and ground-based counts (see Trimper *et al.* 2008). During the period from 1987-2008 in Labrador, over 800 helicopter survey hours were carried out, on at least 111 river systems/sections during the breeding season (Trimper *et al.* 2008). Thomas (2005, 2006) also launched an ambitious aerial survey to monitor Harlequin Ducks inside and outside the low-level flight training area at Goose Bay, Labrador, which included the Great Northern Peninsula of Newfoundland as a control.

Targeted surveys in Atlantic Canada have been used to assess the wintering population there, but survey effort and type have been inconsistent over time (Table 1). These targeted surveys also need more scientific rigour in order to demonstrate repeatability and allow for calculation of confidence intervals. Surveys of wintering Harlequin Ducks have also been conducted annually at Saint-Pierre-et-Miquelon since 1990 (B. Letournel, pers. comm. 2012).

The primary database for assessing population trend comes from the Christmas Bird Count (CBC). CBCs are conducted on one day each winter within defined “count circles” that are 24 km in diameter. Knowledge of which sites were surveyed in a given year is important for interpreting CBC results. For instance, key wintering sites (e.g., Cape St. Mary’s, NL in 2010, 2011) for Harlequin Ducks were not surveyed in some years. The issue of whether CBCs should be adjusted for observer effort (e.g., birds per party hour) has been debated for this species. The general consensus has been that for species such as the Harlequin Duck, the number of observers is not correlated to the number of birds counted, because in winter, sea ducks are highly visible and concentrated in discrete and predictable sites. Generally, these areas are known by birders and adequately covered on CBCs regardless of the overall number of observers taking part in the count. The number of counts that are actually conducted is more important. This is because the number of count circles that have been surveyed has been increasing fairly steadily over the past several decades. To account for this, CBC count data in this status report have been re-expressed as the mean number of birds counted per CBC circle on which Harlequin Ducks were recorded.

Abundance

Greenland Wintering Population

Winter counts of Harlequin Ducks have never been conducted in Greenland, so little information is available about the size of the Greenland Wintering Population. Outside the winter period, about 5000-10,000 birds (predominantly adult males) moult along the southwest coast of Greenland after the breeding season (Boertmann and Mosbech 2002). However, it is not known what proportion of these birds originates from Canada (Boertmann 2008).

Lacking any better data, Thomas and Robert (2001) estimated that 4000-10,000 mature individuals from the GWP breed in Canada. This now seems like a rather high estimate, as Trimper *et al.* (2008) later estimated only 395 pairs (about 800 birds) breeding in all of Labrador (of which about 150 are most likely associated with the EWP not the GWP). Based on Mallory *et al.* (2008), no more than 100 pairs likely breed in Nunavut (southern Baffin Island). Data are scant for northern Québec, but information contained within Savard *et al.* (2008) suggests that the population there consists of somewhere around 2000 pairs. From the above, it is estimated that there are about 2300 pairs of Harlequin Ducks (4600 mature individuals) within the GWP in Canada, which is at the lower end of the estimate provided earlier by Thomas and Robert (2001).

Eastern Wintering population

The entire EWP wintering population originates from breeding areas in Canada, slightly more than half of which overwinters in the eastern United States. Historically (late 1800s), numbers of Harlequin Ducks wintering in eastern North America probably did not exceed 10,000 individuals (Goudie 1989, 1991; Robertson and Goudie 1999). Based on recent survey coverage, about 3075-3300 birds are currently estimated to occur (Table 2). This includes immatures. Assuming that adults comprise about 85% of the wintering population (Roberts 2008), then the EWP would consist of 3226-3420 mature individuals (Table 2). This is up from the estimate of 1800 provided by Mittelhauser *et al.* (2002), and is consistent with a modest population increase (see **Fluctuations and Trends** below).

Fluctuations and Trends

Trends in Wintering Numbers

There are no data to assess trends in Harlequin Ducks in winter in Greenland. In eastern North America, analysis of CBC data indicates a 5.6% average annual increase ($P < 0.001$) in numbers of wintering birds since 1970 (Figure 4). Based on a generation time of 10 years, the trend has averaged about 5% per year ($P = 0.02$) over the 3 generations spanning the period from 1981 to 2011, which is equivalent to an increase of about 350% overall. Although surveys have not been consistent in terms of coverage or methodology, targeted winter counts of Harlequin Ducks in Canada also point to a general increase (Table 1). Overall, there has been an improvement in numbers since cessation of hunting in 1990. However, the rate of increase appears to have been slowing down in recent years (see Figure 4).

In Maine, Mittelhauser (2012, pers. comm.) reported that numbers of wintering Harlequin Ducks appear to be remaining constant in the Isle au Haut region, but that they are declining south of there. Low apparent annual survival rates of Harlequin Ducks estimated for Maine in winter (Mittelhauser 2008) could be attributable to a high rate of emigration if some of the birds are shifting distribution (e.g., shifting north). Such was the case for Iceland, where a pattern of decreasing numbers of Harlequin Ducks wintering in southern coastal areas was noted, whereas numbers increased farther north in association with warmer winters (Gardarsson and Einarsson 2008).

Trends in Breeding Numbers

According to Thomas and Robert (2001), an attempt was made to determine the population trend of breeding Harlequin Ducks in Labrador based upon short-term data summarized in Jaques Whitford Environment Limited (1999). Of the 24 rivers selected for analysis, the annual percentage change was +1.61%, and the 10-year percentage change was +17.4%. However, the increase was not statistically significant ($p = 0.7616$), and the power of the test was low ($< 20\%$).

Likewise, helicopter-based surveys on 43 rivers in Labrador and northern Newfoundland in spring indicated modest increases in numbers of indicated pairs over the short-term period from 2005 to 2009 (Jones and Goudie 2008, 2009). However, repeatability of surveys was low.

Population Viability Analysis

A rudimentary population viability analysis (PVA) was presented by Thomas and Robert (2001) for the EWP. Based on this analysis, the risk of extinction at that time was estimated to be 32% after 50 years. However, the PVA model was preliminary and further work is needed to adequately assess extinction risk (Thomas and Robert 2001), particularly in light of more recent information that shows an increasing population.

Rescue Effect

Within eastern North America, rescue by immigration is most plausible from Greenland. However, data on both immigration rates and population trends from there are almost wholly lacking, so it is difficult to attach any level of probability to rescue.

Table 1. Summary of counts of birds recorded during targeted winter surveys conducted at key Harlequin Duck wintering sites in Atlantic Canada from 2001 to 2013. All surveys were conducted between mid-February and mid- to late March.

Site	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010 ¹	2011	2012	2013 ⁴
Eastern Shore Islands Wildlife Mgt Area, NS	265 ²	355 ²			651 ²	389 ²				409			342
Prospect, NS	8 ²	57 ²								87			192
Little Port L'Hebert, NS	32 ³	126 ²	78 ³			219 ²		93 ²					224
Digby Neck, NS	28 ³	48 ²	86 ²		118 ²	108 ²	57 ²	45 ²					
Port George, NS					7 ³	12 ³	14 ³	13 ³		21 ³			
Point Lepreau, NB	0	6 ³			11		12			16			
Machias Seal Island, NB	14 ³	17 ³		19 ³	20 ³					51 ³			
White Head Island, NB	68 ³	69 ²	130 ²	126 ²	139 ²	113	139		219	97		225	98
The Wolves, NB	38 ²	50 ²	46 ²	54 ²	32 ²	70	79			44			
Kent Island, NB		9 ²	4	14 ²	5 ²	5	10		5	0	16		28
Cape St. Mary's, NL	83 ²				242 ²	218 ²		263 ²		399 ²	464 ²		636 ²

1 - All 2010 surveys conducted from helicopter except for Port George, Machias Seal Island, and Cape St. Mary's

2 - Boat survey

3 - Ground survey

4 - From Environment Canada (2013a)

Table 2. Estimated numbers of Harlequin Ducks wintering in eastern North America.

Region	Population Estimate
Eastern United States	1575-1800 ¹
Bay of Fundy (NB)	17 ²
The Wolves (NB)	69 ²
Grand Manan/Machias Seal Island (NB)	199 ²
Bay of Fundy (NS)	47 ²
Digby Neck (NS)	295 ²
Eastern Shores Wildlife Management Area (NS)	342 ²
Prospect (NS)	192 ²

Region	Population Estimate
Little Port L-Herbert (NS)	224 ²
Cape Breton Island (NS)	28 ²
Avalon Peninsula (NL)	24 ²
Cape St. Mary's (NL)	636 ²
Saint-Pierre-et-Miquelon, France	150 ³
Total	3798-4023 (3226-3420 adults⁴)

¹ From Mittelhauser (2008).

² From Environment Canada (2013a).

³ Reported by Bruno Letourneau (pers. comm., 2012).

⁴ Winter counts include both young-of-the-year and mature adults; a factor of 0.85 was used to estimate the size of the population of mature individuals.

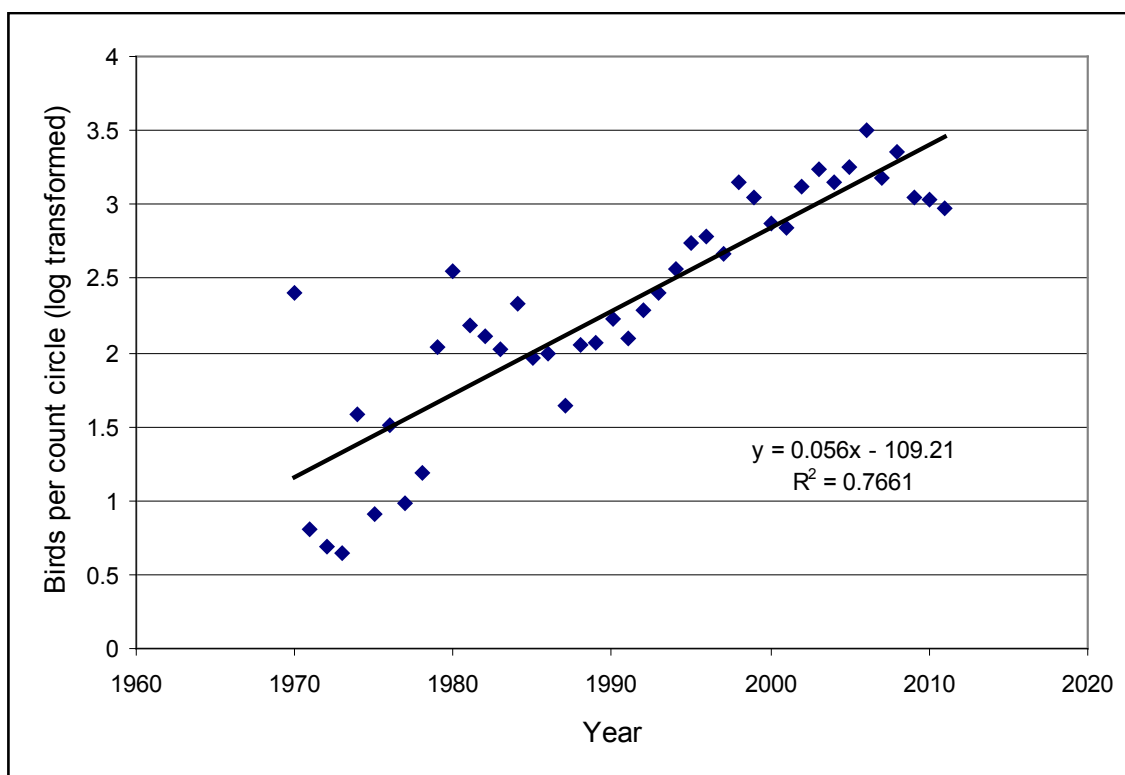


Figure 4. Trends in numbers of Harlequin Ducks wintering in eastern North America (Canada, United States and Saint-Pierre-et-Miquelon), based on Christmas Bird Count data, 1970-2011. Values are expressed as birds per count circle (\log_e) to account for the increasing number of counts being conducted over time.

THREATS AND LIMITING FACTORS

In terms of limiting factors, Harlequin Ducks have delayed sexual maturity, low annual production, variable breeding success, and a relatively long lifespan. Stability of populations of sea ducks is dependent on high adult survival. Populations are especially vulnerable to factors that reduce adult survival, even by relatively small amounts (~3%), thereby greatly extending the time necessary for the population to recover from declines (Goudie *et al.* 1994b). Much of the following material is based on a threat assessment conducted by Soulliere and Thomas (2009) on Harlequin Ducks in eastern North America.

Pollution

Oil and Chemical Pollution

Oil pollution is a major concern for Harlequin Ducks in eastern North America due to their concentration in groups in coastal areas in the vicinity of extensive tanker and container vessel traffic. A large oil spill or chronic oil releases (bilge flushings, etc.) could severely impact populations at key moulting or wintering sites, such as Cape St. Mary's, Newfoundland or Isle au Haut, Maine.

Oil pollution can depress survival in Harlequin Ducks, both through direct mortality and indirectly through long-term contamination of the food chain (Esler *et al.* 2000). Lock *et al.* (1994) modelled the areas of Atlantic Canada with the greatest potential for oil spills, and it was subsequently found that these areas correspond with known Harlequin Duck moulting and wintering sites (Thomas and Robert 2001). Newfoundland lies on a major shipping route between Europe and North America. The proportion of oiled seabirds (all species) increased from 1984 to 1997, and chemical assays of oiled bird corpses determined that 90% of the oil was the type used by large ocean-going vessels (Wiese and Ryan 1999; Wiese and Ryan 2003).

While chronic oil pollution off the southeastern coast of Newfoundland has declined significantly since at least the early 2000s, the densities of oiled birds still exceed those reported elsewhere in the world (Wilhelm *et al.* 2009). Chronic oil pollution has also declined in Nova Scotia (Lucas *et al.* 2012). Despite laudable declines in the rate of chronic oiling in recent decades, catastrophic oil spills still present a significant threat, if only because of the high amount of shipping traffic that occurs along the eastern seaboard.

New opportunities for oil exploration have been identified in Greenland, and there is much interest in the Fylla Area of western Greenland, which corresponds with known Harlequin Duck moulting and wintering habitat (Mosbech *et al.* 1996; Boertmann 2008). Even so, shipping activity and oiling may not pose a serious threat in Greenland because of lower traffic than in the eastern seaboard of North America. Oil tankers in coastal Greenland are also double-hulled, which further reduces risk (Thomas and Robert 2001).

Acidification of Streams

Acidification of streams that are occupied by Harlequin Ducks reduces the abundance and diversity of invertebrate prey. Soulliere and Thomas (2009) concluded that this poses a moderate threat and one that is likely declining in severity owing to reductions in emissions responsible for acid precipitation.

Heavy Metals and Other Toxins

The bioaccumulation of heavy metals (e.g., mercury) is generally a concern for sea ducks (Henny *et al.* 1995), but there is no information on heavy metal buildup in Harlequin Ducks. The most serious source of heavy metal contamination stems from mining, but this is likely of greatest concern only in localized rivers and streams (Soulliere and Thomas 2009).

Habitat Loss or Degradation

Hydroelectric Development

Hydroelectric projects are a potential threat to Harlequin Duck breeding habitat when rivers and streams are inundated or their flows are changed. Harlequin Ducks in the EWP may have been negatively affected by large-scale habitat loss associated with hydroelectric development of the Upper Churchill River in Labrador, and other rivers in south-central Newfoundland. Innu elders reported declines in numbers subsequent to hydroelectric development associated with the Smallwood Reservoir in central Labrador (Ryan 1994; Thomas 2001). Extensive hydroelectric projects in northern Québec in the early 1970s likely also affected numbers of birds contained within the GWP. The area associated with the proposed Hydro-Québec Great Whale project (presently on hold) supports hundreds of breeding pairs (Morneau *et al.* 2008; Savard *et al.* 2008).

Industrial Forestry

Forestry practices can impinge on the breeding success of Harlequin Ducks (Cassirer *et al.* 1993). In south-central British Columbia, Freeman and Goudie (1998) reported higher breeding densities of Harlequin Ducks in unharvested sections of streams and rivers than in harvested areas. Logging activities not only remove suitable riparian breeding habitat, but increased logging activity in upstream areas can increase siltation, which negatively impacts invertebrate populations (Breault and Savard 1991; Crowley and Patten 1996). Female Harlequin Ducks may abandon such areas (Smith 1996b). Best management practices can reduce impacts of forestry; in British Columbia, 100 m no-cut buffers are maintained along streams supporting breeding Harlequin Ducks (Cassirer *et al.* 1993). In Atlantic Canada, however, provincial regulations for adequate width of vegetative buffering of streams against forestry operations are not considered to be sufficient (Soulliere and Thomas 2009).

Southern breeding areas of the EWP are more heavily impacted by industrial forestry practices than those located farther north, and are not relevant for the GWP.

Mining

Mining activities can negatively affect Harlequin Ducks through habitat loss or declines in invertebrate populations (Robertson and Goudie 1999). For example, a nickel mine in northern Labrador displaced pairs from one of the most productive Harlequin Duck breeding areas in the assessment region (Voisey's Bay Environmental Assessment Panel 1999). Mining is most likely a localized threat, but it has the potential to increase.

Hunting and Other Sources of Mortality

Historically, hunting was the factor that most likely led to low numbers evidenced prior to 1990 along the eastern seaboard (Goudie 1991; Mittelhauser *et al.* 2002). Because of the Harlequin Duck's long lifespan and low reproductive capacity, even low levels of hunting mortality (especially when it involves adult females) can have serious implications for populations. Mortality due to hunting has been greatly reduced, owing to a hunting ban in eastern Canada (with the exception of Nunavut) and the eastern United States since 1990, and a ban in Greenland since the 1960s. Despite the ban, a low level of mortality of Harlequin Ducks continues to occur, mostly the result of incidental take, whereby hunters mistake this species for another (Thomas and Robert 2001). Efforts to address these issues are ongoing with hunter education initiatives (Soulliere and Thomas 2009).

Harlequin Ducks have also been shot by subsistence hunters in central Labrador (Thomas and Robert 2001) and in Nunavut (Soulliere and Thomas 2009). Hunting is still permitted in Nunavut, though the numbers taken are small. In Greenland, Harlequin Ducks are sometimes observed for sale at local community markets (S. Gilliland pers. comm.). Boertmann (2008) reported that some individuals are periodically taken in subsistence hunts along the western Qaqortoq District of Greenland, where they are used for traditional bird skin quilts.

Harlequin Duck behaviour likely contributes to their susceptibility to being accidentally killed by hunters, because they are relatively tame and use coastal habitats near shore (i.e., within shooting range). Also, Harlequin Ducks are regularly observed mixed among larger groups of hunted species like Common Eiders, Surf Scoters and Black Scoters, increasing the possibility of accidental shooting.

Entanglement or entrapment with gill-nets and other fishing gear may pose a threat to Harlequin Ducks in nearshore areas (Smith 1996a; Robertson and Goudie 1999). While there is little direct evidence for this, Savard (1988) suggested that it may be important in areas where extensive inshore fishing overlaps with non-breeding concentrations of Harlequin Ducks. Harlequin Ducks may also consume lead weights and plastic fishing gear (Robertson and Goudie 1999). Overall, this threat is likely low to moderate.

Human Disturbance

Breeding Harlequin Ducks are reportedly tolerant of moderate human disturbance (Savard 1988; Clarkson 1994; Brodeur *et al.* 1998). However, human activities along riparian areas may adversely impact breeding success (Wallen 1987). Once disturbed from the nest, it may take several hours for the female to return (Robertson and Goudie 1999), and chronically disturbed areas may eventually be abandoned (Cassirer and Groves 1991; Clarkson 1994; Hunt 1998). Still, most breeding sites are in remote regions away from human activity.

Harlequin Ducks flush from areas in response to oncoming boats, but this depends on the size of the craft, the size of the river and water levels (Smith 1996a; Hunt 1998). Boat traffic is minimal along the breeding rivers of Labrador and northern Québec. However, non-breeding aggregations of Harlequin Ducks will flush from coastal areas if approached too closely by boats (Robertson and Goudie 1999), which can disrupt feeding.

Goudie and Jones (2004) reported a dose-response effect of noise from military jets on behaviour of Harlequin Ducks in central Labrador. Further analyses demonstrated residual behavioural effects lasting up to 2 hours following overflights generating noise greater than 85 dBA (Goudie 2006). In recent years, the level of low-level military jet training in Labrador has been diminishing.

Coastal Development

Commercial harvests of algae and sea urchins could alter Harlequin Duck coastal habitat, while crustacean fishers could impact food resources. Aquaculture is also a growing industry along the coasts of Maine and Atlantic Canada and the associated increased boat traffic could lead to disturbance of wintering and moulting birds. While it is not presently having an adverse impact, it could worsen in the future (Soullier and Thomas 2009).

Climate Change

Soulliere and Thomas (2009) noted that climate change may lead to changes in temperature, salinity and alkalinity in freshwater and marine ecosystems, as well as changes in river flows. Such changes would likely affect the distribution, abundance and phenology of invertebrate food supplies that Harlequin Ducks rely on. With climate change, a northward extension and warming of the Gulf Stream could also radically change inshore marine ecosystems along coastal New England and the Maritime provinces. However, the severity of the threat posed by climate change to Harlequin Ducks is hard to assess at this time.

Number of Locations

For the EWP, the majority of the birds overwintering in eastern Canada occur in 11 main areas, but there are also over 100 other less important wintering sites known in Canada (see Soulliere and Thomas 2009). At least a dozen other important wintering concentrations occur in the US (Mittelhauser 2008), plus a few more in Saint-Pierre-et-Miquelon. The number of discrete wintering locations for the GWP is unknown, but it too would be more than 10. Hence, the total number of wintering locations for the eastern population of Harlequin Duck is greater than 100. These locations are coastal areas and are individually vulnerable to oil spills (e.g., Wiese and Ryan 1999, 2003), which is the most plausible and likely threat.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

In Canada, Harlequin Ducks are protected under the *Migratory Birds Convention Act* of 1916 and its amending protocol. A ban on hunting is in effect for Harlequin Ducks along the entire Atlantic Flyway, with the exception of Nunavut (Environment Canada 2013b). The eastern population of the Harlequin Duck is presently designated as a species of Special Concern under the *Species at Risk Act*, and a management plan is in place for eastern Canada (Environment Canada 2007). Under provincial legislation, the species is listed as Endangered under the New Brunswick and Nova Scotia *Endangered Species Acts*, and Vulnerable under the *Newfoundland and Labrador Endangered Species Act*. It is listed as Vulnerable under Québec's *Loi sur les espèces menacées ou vulnérables* (RLRQ, c E-12.01). It is designated as Threatened in Maine. No hunting is permitted in Saint-Pierre-et-Miquelon (Territory of France), and efforts are under way to add Harlequin Duck to the territory's endangered species list.

Non-Legal Status and Ranks

The IUCN Red List category is "Least Concern." The global ranking given by NatureServe is G4 (apparently secure, last assessed in 1996; NatureServe 2012). Harlequin Ducks have also been ranked in each province and state where they occur in eastern North America (Table 3). In Canada, the General Status rank is "Sensitive" (CESCC 2010).

Table 3. Ranks assigned to the eastern population of the Harlequin Duck in North America (NatureServe 2012).

Region	Rank*
Global	G4
United States	N4B, N4N (breeding, non-breeding)
Canada	N4B, N3N (breeding, non-breeding)
Labrador	S4B (breeding)
Newfoundland	SNR (non-breeding)
New Brunswick	S1B, S1N (breeding, non-breeding)
Nova Scotia	S2N (non-breeding)
Québec	S3
Nunavut	SNRB (breeding, non-breeding)
Ontario	SNA (non-breeding)

Region	Rank*
Maine	S2S3N (non-breeding)
Massachusetts	S2N (non-breeding)
Rhode Island	S1N (non-breeding)
New Jersey	SNA (non-breeding)
Virginia	SNA (non-breeding)
Maryland	S1N (non-breeding)
New York	SNA (non-breeding)

* G = is a global status rank; S = rank assigned to a province or state; N = is a national status rank. S1 indicates that a species is critically imperilled because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines, making it especially vulnerable to extirpation; S2 indicates that a species is imperilled because of rarity or other factors making it very vulnerable to extirpation, usually with 6 to 20 occurrences or few individuals remaining (i.e., 1000 to 3000); S3 indicates that a species is vulnerable because it is rare or uncommon, or found only in a restricted range, or because of other factors making it vulnerable to extirpation; S4 indicates a species is uncommon but not rare; some are cause for long-term concern due to population declines or other factors; S5 indicates that a species is secure because it is common, widespread, and abundant. SNA = non-breeding; rank not applicable (species not a suitable target for conservation activities). SNRB = rank not yet assessed (breeding or non-breeding).

Habitat Protection and Ownership

In eastern Canada, much of the Harlequin Duck's breeding habitat occurs on public or Crown land and very little is privately owned. Several areas that hold moulting and/or staging birds have protection in the form of parks or reserves. However, such sites are not protected against some threats like oil spills.

In Newfoundland, Gros Morne National Park supports a small population of breeding Harlequin Ducks. A small number breed within the Bay du Nord Wilderness Reserve. Cape St. Mary's Ecological Reserve in southeastern Newfoundland is protected under the *Wilderness and Ecological Reserves Act*, and supports more than 200 wintering birds as well as a small moulting population. In Labrador, large concentrations of moulting Harlequin Ducks occur in the Gannet Islands Ecological Reserve and in Torngat Mountains National Park. In Québec, Forillon National Park and Parc national de l'Île-Bonaventure-et-du-Rocher-Percé host about 150 moulting Harlequin Ducks. A few pairs also breed in Parc national de la Gaspésie. Birds also nest within the boundaries of Réserve faunique de Port-Daniel, though such reserves are subject to forest exploitation. Within the Maritime provinces, Nova Scotia's Eastern Shore Wildlife Management Area is one of the major wintering sites for Harlequin Ducks, where several hundred birds currently concentrate. Port Joli Migratory Bird Sanctuary and Kejimikujik National Park Seaside Adjunct also host a few individuals. In the Bay of Fundy, no hunting of any kind is permitted around The Wolves, which supports a sizable wintering population of Harlequin Ducks. Other sites (e.g., Kent Island, Machais Seal Island, Point Lepreau, Southern Wolf Island) have restricted access.

In the United States, the Sachuest Point National Wildlife Refuge and Acadia National Park are located on the periphery of the Harlequin Duck wintering locale in Rhode Island and Maine, respectively, but there is no associated marine component to either location. The largest wintering population in eastern North America is located near Acadia National Park, Maine, but occurrences of Harlequin Ducks within the actual boundary of the park are limited (Mittelhauser 2008).

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BIOGRAPHICAL SUMMARY OF REPORT WRITER

Robert Ian Goudie, Ph.D. received a B.Sc. and doctorate from Memorial University of Newfoundland and an M.Sc. from University of Western Ontario on avian ecology and behaviour. He is an experienced scientist in wildlife demography, ecology, and behaviour who has worked extensively throughout Newfoundland and Labrador and western Canada where his published studies are extensively cited. As a consulting scientist he continues his expertise in environment research and conservation including conceptualizing, conducting, and reviewing environmental assessment studies, and conducting scientific literature reviews. In recent years he has worked extensively with monitoring globally rare lichens as indicators of environmental health for old growth boreal forests. Through involvement with environmental non-government conservation groups, Dr. Goudie applies his love of Nature to his native Newfoundland roots. Over the past three years he has coordinated forest issues for the Newfoundland and Labrador Chapter of the Canadian Parks and Wilderness Society where he is currently promoting ecosystem-based planning and the application of the Canadian Boreal Forest Agreement to our province. He is considered very knowledgeable in ecological land classification, wildlife conservation, resource management, and Aboriginal resource use.