

HARLEQUIN DUCK ASSESSMENT

Final – 29 December 1999

MAINE DEPARTMENT OF INLAND FISHERIES AND WILDLIFE
WILDLIFE DIVISION
RESOURCE ASSESSMENT SECTION
BIRD GROUP

by

MaryEllen R. Wickett

TABLE OF CONTENTS

	Page
INTRODUCTION.....	3
NATURAL HISTORY.....	4
Description.....	4
Distribution.....	6
Migration.....	8
Feeding	9
Breeding Biology	11
Survival and Longevity	14
MANAGEMENT	15
Regulatory Authority	15
Past Goals and Objectives	16
Past and Current Management.....	16
HABITAT ASSESSMENT.....	20
Past Habitat.....	20
Current Habitat	20
Habitat Projection	26
POPULATION ASSESSMENT.....	27
Past Populations.....	27
Current Population.....	28
Population Projections.....	32
Limiting Factors	33
USE AND DEMAND ASSESSMENT	36
SUMMARY AND CONCLUSIONS	38
LITERATURE CITED	40
APPENDIX I: Occurrence of Harlequin Ducks along coastal Maine, 1970-1999.....	45
APPENDIX II: Derivation of minimum estimate for wintering population of Harlequin ducks in Maine, February 1995	77

INTRODUCTION

Since 1968, the Maine Department of Inland Fisheries and Wildlife (MDIFW) has aggressively pursued development and refinement of wildlife species assessments and implementation of cost-effective comprehensive programs that support selected goals and objectives for the next 15 years. Assessments are based upon available information and the judgments of professional wildlife biologists responsible for individual species or groups of species. Precise data may not always be available or are too limited for meaningful statistical analysis; however, many trends and indications are sometimes clear and deserve management consideration.

The assessment has been organized to group information in a user-meaningful way. The Natural History section discusses biological characteristics of the species that are important to its management. The Management section contains history of regulations and regulatory authority, past management, past goals and objectives, and current management. The Habitat and Population sections address historic, current, and projected conditions for the species. The Use and Demand section addresses past, current, and projected use and demand of the species and its habitat. A Summary and Conclusions sections summarizes the major points of the assessment.

NATURAL HISTORY

Description

The Harlequin Duck (*Histrionicus histrionicus*) is the only species in its genus. Early nomenclature delineated 2 subspecies: Eastern and Western Harlequin Duck (Bent 1925, Palmer 1949); however, current nomenclature does not make this distinction (Bellrose 1980).

Harlequins (Fig. 1) are small, stocky, diving ducks, weighing 590-726 g



Figure 1. Harlequin Duck, drake and hen (sketch by Roger Tory Peterson in Nova Scotia Museum of Natural History (1999))

for males and 499-590 g for females and measuring 40.6-53.8 cm (\bar{x} =43.9 cm) in length for males and 37.1-43.7 cm (\bar{x} =40.1 cm) for females (Bellrose 1980). Harlequins have a narrow, short bill (culmen: M=25-28 mm, F=24-26 mm) (Delacour 1959, Johnsgard 1975) and relatively long tail (\bar{x} length: M=93 mm, F=82.3 mm) (Palmer 1976). Wingspread is 61.0-71.1 cm (\bar{x} :

M=67.3 cm, F=63.5 cm) (Palmer 1976, Terres 1980), with wing length ranging 18.8-20.3 cm (\bar{x} =19.6 cm) for males and 17.8-20.1 cm (\bar{x} =18.9 cm) for females (Bellrose 1980). Tarsus length ranges 34-39 mm for adult males and 33-36 mm for adult females (Phillips 1925). The bill, legs, and feet are bluish-gray in males, but paler and duller in females (Godfrey 1979, Bellrose 1980).

Harlequins are very buoyant on the water. They have a habit of jerking their head backward and forward while swimming, and their tail is often angled upward

(Phillips 1925, Palmer 1976). Harlequins fly swiftly, generally close to the water surface. When flying along mountain streams, they remain low, following the stream (Bent 1925, Johnsgard 1975). Harlequins swim and fly in small, compact groups. Even at various molting and wintering places where many birds may be present, they still tend to gather in small groups (<10 birds) (Palmer 1976, Bellrose 1980). The unwary nature of this species is notable. When disturbed, Harlequins tend to escape by swimming or diving, rather than flying (Palmer 1976). Mended breaks in bones have been noted in many collected specimens, likely a result of the birds' tendency to dive in turbulent water near ledges (Palmer 1949).

Harlequins are relatively silent birds outside the breeding season (Johnsgard 1975, Madge and Burn 1988). However, in courtship display, adult males make a high-pitched whistle or squeak that has been compared to the squeak of fighting mice, hence the vernacular name "sea-mouse" (Norton 1896). Females have a harsh, croaking call (Johnsgard 1975).

The winter and breeding plumage of adult males is glossy slate-blue, with black on the ventral region. White markings, outlined with black, include a large facial crescent between the eye and bill, circular spot on the lower rear ear-coverts, vertical stripes up the side of the neck and along the side of the breast, partial band around the base of the neck, partially white scapulars forming a narrow stripe between the back and folded wing, white and slate-gray tertials forming 3 broad white stripes near the tip of the folded wing, small spot on the flanks near the tail base, and a few spots on greater coverts and secondaries. Wings are dark, with glossy metallic blue secondaries. The sides of the male are chestnut, as is a stripe over the eye. Adult

males enter postnuptial molt in late June and remain in eclipse plumage until October. During this period, males resemble females, but their wings retain the colors of the nuptial plumage (Palmer 1976, Bellrose 1980, Madge and Burn 1988).

Females and immatures are primarily black-brown, with mottled gray breast and upper belly and dark wings. The white area below and in front of the eyes is sometimes divided by a dark line between the eye and bill. There is a distinct circular, white patch on the ear-coverts (Bellrose 1980, Madge and Burn 1988).

Immature males resemble females during their first autumn. Males attain adult features gradually during their first winter, but do not acquire the glossy purple-blue speculum of adults until their second year (Godfrey 1979, Bellrose 1980). Age- and sex-specific plumages and molting patterns are further detailed in Palmer (1976).

Female, immature male, and eclipse-plumaged male Harlequins resemble female Buffleheads, except that Harlequins have 2-3 white spots on the head rather than 1 on Buffleheads. The white spot behind the eye is circular for Harlequins and oblong in Buffleheads. In flight, Harlequins lack the white wing patch found in Buffleheads and White-winged Scoters. At a distance, both sexes of Harlequins appear black, like scoters. But Harlequins are not as heavy-bodied or long-billed as scoters, and when at rest, the longer and more wedge-shaped tails of Harlequins are raised and lowered like those of Ruddy Ducks (Bellrose 1980).

Distribution

Harlequin Ducks have a subarctic distribution, with 4 populations: Pacific, Greenland, Iceland, and eastern North America (Bellrose 1980).

In the eastern region of their breeding range, Harlequins are common in the southern half of Greenland and throughout Iceland, ranging near the coast to interior elevations (Palmer 1976, Bellrose 1980). The eastern North American population has a sparse and widely distributed breeding range, encompassing southeastern Baffin Island, southeastern Ungava Peninsula (around Ungava Bay), Quebec (inland from east coast of Hudson Bay), coastal Labrador, the north shore of the Gulf of St. Lawrence, and the Gaspé Peninsula (Palmer 1976, Bellrose 1980, Goudie 1991). Harlequins are rare in insular Newfoundland, probably limited to the Great Northern Peninsula (Goudie 1991).

The breeding range of the Pacific population includes northeast Siberia west to the Lena River, east to the Kamchatka Peninsula and Commander Islands, across the Bering Sea to the Aleutian Islands, interior Alaska, Yukon, British Columbia, southwestern Alberta, northern Washington, through Oregon to central California, northern Idaho, western Montana, and northwest Wyoming (Palmer 1976, Bellrose 1980).

The eastern North American population is widely dispersed in the winter, ranging from Newfoundland south to the mouth of the Chesapeake Bay (Va.), where a few ducks are reported annually (Palmer 1976, Montevecchi et al. 1995). Wintering Harlequins have been recorded as far south as South Carolina and Florida, with casual observations scattered inland (Phillips 1925, Delacour 1959, AOU 1983). However, the winter flocks of this population are concentrated in a few traditional areas (accounting for >80% of the wintering population) that include the eastern and southern coast of insular Newfoundland, around Anticosti Island, southeastern Nova Scotia,

Passamaquoddy Bay (N.B.), along the north shore of the Gulf of St. Lawrence, and in Penobscot Bay (Me.), with smaller concentrations south to Cape Cod (Mass.) and Sachuest Point (R.I.) (Goudie 1991, Montevecchi et al. 1995).

Harlequins in Iceland and Greenland are considered year-round residents, moving from inland rivers to adjacent marine coasts in the winter (Palmer 1976, Bellrose 1980). However, recent satellite tracking efforts have discovered Harlequins breeding in northern Quebec and Labrador and wintering in Greenland (Savard et al. 1999). The wintering range of the Pacific population encompasses the Commander and Aleutian Islands, Pribilof Islands, Alaskan coast south to central California, southeast portion of Russia (especially Kamchatka), Kuril Island, and Sakhalin Island to the Sea of Japan (AOU 1983, Goudie et al. 1994).

Migration

The Harlequin Duck is not a long-distance migrant (Palmer 1976). In many areas of its range, fall and spring migrations of Harlequins consist primarily of lateral movements from interior breeding grounds to wintering areas along adjacent sea coasts (Bellrose 1980).

The eastern North American population undergoes a more longitudinal migration. Harlequins travel southward along the Atlantic coast to their wintering areas during September-December. Birds first appear in small flocks at wintering areas in mid-September. Harlequins begin arriving in Maine 10 October-21 November (Palmer 1949, 1976).

In spring, Harlequins generally leave Maine for their northern breeding grounds 5-31 March; although birds have been observed in Maine as late as April to early May (Palmer 1949). Birds may not reach their breeding grounds until May-June (Bent 1925, Phillips 1925). Based on resightings of banded birds, Harlequins wintering at Isle au Haut, Maine have been sighted during spring and summer in the Gaspé Peninsula, northern Newfoundland, and Labrador (Harlequin Conservation Society 1999).

Feeding

Harlequins are daylight foragers. During summer, they feed primarily early in the morning and prior to sunset (Pool 1962 cited in Johnsgard 1975, Bengtson 1966 cited in Bellrose 1980). Harlequins feed in torrential mountain streams during the breeding season using several feeding methods: 1) wading in shallows along shore, prying among stones; 2) swimming with bill below surface, mandibles in constant motion similar to the feeding technique of Shovelers; 3) dabbling in shallow water to reach the stream bottom; and 4) diving to depths 0.9-1.5 m, then either walking on the stream bottom or swimming against the swift current while submerged, poking among stones (Michael and Michael 1922 cited in Palmer 1976, Bengtson 1966 cited in Bellrose 1980).

Aquatic invertebrates are important components of the Harlequins' diet during the breeding season. Larvae, pupae, and adults of black flies (Simuliidae) (predominately), midges (Chironomidae), and caddisflies (Trichoptera) make up the principal summer food of Harlequins in Iceland (Bengtson 1966 cited in Johnsgard 1975, Bengtson and Ulfstrand 1971). Other summer foods include stoneflies (Plecoptera), mayflies

(Ephemeroptera), water boatmen (Corixidae), fish roe, and small freshwater crustaceans and mollusks (Bent 1925, Cottam 1939 cited in Bellrose 1980).

During winter, Harlequins usually forage in shallow marine water 2-3 m deep (Goudie 1991). They feed in traditionally used areas close to rocky shorelines or offshore rocky isles that are often awash or submerged at high tide or during heavy sea swells (Johnsgard 1975, Goudie and Ankney 1988, Montevecchi et al. 1995). Winter diets of Harlequins consist of higher energy (calories/unit dry weight) foods than those of larger-bodied sea ducks (e.g., Common Eider). The high metabolic demands of the Harlequin's small body size, however, may not be compensated solely by a diet of higher quality. Harlequins spend proportionately more time foraging (with little flexibility in adjusting activity budgets) and have more diverse diets than larger species (e.g., Black Scoter, Common Eider) that have lower energy demands per unit body mass (Goudie and Ankney 1986).

The winter diet of the Harlequin Duck in eastern North America may be similar throughout its range (Goudie 1991), with birds primarily consuming gammarid amphipods (mostly *Gammarellus angulosus* and *Calliopsius laeviusculus* with a few *Ishiocerus anguipes* and *Gammarus oceanicus*) and small gastropods (chink shells [*Lacuna vincta*]) (Goudie and Ankney 1986, Goudie 1991). Other food items include marine worms (*Lepidonotus* spp.), isopods (*Idotea baltica*), decapods (*Hyas araneus*), sea spiders, mollusks (*Ischnochiton ruber*, limpets [*Acmaea* spp.], chitons, periwinkles [*Littorina* spp.], bivalves [*Mytilus edulis*, *Lucina* spp., *Saxicava* spp.], gastropods [*Magarites helycinus*, *Thais* spp., *Buccinum* spp.]), echinoderms (*Strongylocentrotus droebachiensis*, *Ophiopholis aculeatua*, *Asterias* spp.), and clam worms (*Nereis* spp.)

(Cottam 1939 cited in Bellrose 1980, Palmer 1949, Goudie and Ankney 1986). Food availability influences distribution of Harlequin Ducks along the coast within and among years (Cassirer et al. 1993).

Breeding Biology

Harlequins reach sexual maturity at 2-3 years of age (Bent 1925, Bellrose 1980, Goudie 1991). Pair formation occurs primarily in late winter, while the birds are still in coastal waters (Johnsgard 1975, Palmer 1976). During spring, breeders (mostly paired) and prebreeders form large groups (some contain several hundred birds) and move toward river and stream mouths. In late April and May during ice out, the breeding population migrates inland to nest along fast, turbulent, oligotrophic rivers and streams in subarctic mountainous habitat (Bengtson and Ulfstrand 1971, Palmer 1976, Bellrose 1980). The few prebreeders that may go inland, soon join other prebreeders in molting areas on marine waters by May and June (Palmer 1976).

Harlequins tend to return to the same stream in successive years, often reoccupying the same loafing areas (Bengtson 1972 cited in Palmer 1976, Cassirer and Groves 1992). They are solitary nesters, but may nest in close proximity to conspecifics where food is plentiful (Palmer 1976). Mean breeding densities observed in Labrador and Idaho are much lower than those in Iceland (Labrador: 0.09 females/km river [highest density = 0.17 females/km river], Idaho: 0.15-0.20 pairs/km river, Iceland: 1.3 pairs/km river) (Bengtson 1972 cited in Johnsgard 1975, Goudie 1988, Cassirer et al. 1991, Goudie 1991, Cassirer and Groves 1992). Breeding densities ≤ 1 pair/km river are considered low (Goudie 1991).

Male territoriality appears centered around his mate (Bengtson 1972 cited in Johnsgard 1975, Inglis et al. 1989). However, where breeding densities are sparse on the periphery of the breeding area, pairs may occupy and defend a small section of the river (Bengtson 1966 cited in Bellrose 1980).

Productivity of Harlequins may be influenced largely by availability of suitable food during the breeding season (e.g., aquatic insect larvae) (Bengtson 1972 cited in Goudie 1991, Palmer 1976). The breeding distribution of Harlequins in northeastern North America appears closely related to that of black flies (Simuliidae) (Bengtson and Ulfstrand 1971, Goudie 1991). Availability of aquatic insect larvae may vary annually with variability in water temperature and water levels (Goudie 1991). Periodic low food abundance increases nonbreeding rates in Harlequins (frequency nonbreeding in adult females: Iceland 15->80%/yr, average 56%/yr during years low food availability). Females that do breed during summers of reduced food supplies produce fewer young (Bengtson and Ulfstrand 1971, Palmer 1976).

Harlequins are primarily ground nesters. In Iceland, most nests are located among dense vegetation under shrubby cover, with the remaining nests found in rocky hollows or among lava blocks. Nests are located very close to water, usually within 2-5 m of streams; although some nests have been located up to 25 m from the main stream (Bengtson 1966 cited in Bellrose 1980, Bengtson 1972 cited in Cassirer et al. 1993). Bengtson (1966 cited in Johnsgard 1975) partly attributed the species use of holes and crevices in Iceland to the lack of large, hollow trees. Harlequins occasionally have been observed nesting in tree cavities or on cliff faces in other locations (Bent 1925, Cassirer et al. 1993). Ground nests consist of a thin layer of grass, with occasional twigs, leaves,

and moss, lined with down (Knight 1908, Bengtson 1966 cited in Bellrose 1980, Cassirer et al. 1993). Nest sites often are occupied in consecutive years, leading Bengtson (1966 cited in Bellrose 1980) to conclude that the same hen returns in successive years to a particular nest site.

Egg-laying occurs mid-May through mid-July, with a peak in early June. The cream-colored eggs are laid at 2-4 day intervals. Clutch size ranges 3-9 eggs ($\bar{x}=5.7$ eggs) (Bengtson 1966 cited in Johnsgard 1975, Bengtson and Ulfstrand 1971, Bengtson 1972 cited in Palmer 1976).

Only the female incubates the eggs (Bent 1925, Inglis et al. 1989). She begins incubating before the clutch is complete, sitting tightly on the nest. Incubation period ranges 28-29 days (Bengtson 1966 cited in Johnsgard 1975). In Iceland, Bengtson (1972 cited in Palmer 1976) reported hatching began in early July, peaking 20-25 July, and continued approximately until 14 August. Hatching success was high (87%), with 5.3 eggs hatched/successful nest and 4.6 eggs hatched/all nests.

Shortly after the onset of incubation, males abandon their mates and leave breeding areas to congregate in favored foraging areas. After a few days, they depart to the sea for the postnuptial molt (Bengtson 1966 cited in Johnsgard 1975, Bellrose 1980). Because males leave soon after incubation begins, Harlequins typically do not re-nest. Females whose nests fail may also leave breeding grounds soon after males, heading for coastal molting areas (Palmer 1976).

After hatching, the hen leads her brood to a secluded part of the river. When young are half grown and feeding in the same manner as adults, the hen and her brood return to the main river. Several broods and their hens often become associated,

occasionally joined by hens unsuccessful in breeding (Bengtson 1966 cited in Johnsgard 1975, 1972 cited in Palmer 1976). In interior Iceland, hens and their broods do not arrive at sea until September, when young can fly. However, where Harlequins nest along streams nearer to the sea, some families may reach saltwater before the broods have fledged (Palmer 1976). Young Harlequins fledge 40-51 days after hatching (Bengtson 1966 cited in Johnsgard 1975, Cassirer and Groves 1992). Postbreeding females fly to traditional marine areas during fall for their molting period (Palmer 1976).

As an estimate of annual productivity for Harlequins, 1.5-2.2 young were reared per female in Iceland, with reproductive success strongly affected by food availability (Johnsgard 1975). During late July-early August in Labrador, Goudie (1991) estimated 1.04 broods/100 km river.

Survival and Longevity

Data are limited on age- and sex-specific survival rates for Harlequin Ducks. Duckling mortality is high during the first 2 weeks after hatching, after which mortality rate decreases. In Iceland, survival to fledging varied among years, ranging 40-75% (\bar{x} =55%) (Bengtson 1966 cited in Bellrose 1980, Bengtson 1972 cited in Palmer 1976). Data from Iceland indicate annual adult female survival rates of 65%; however, considering the reduced hazards of short migrations and closed harvest seasons, annual survival rate may be as high as 80-85% (Bengtson 1972 cited in Palmer 1976). Goudie et al. (1994) reported a longevity of 18 years for Harlequins.

MANAGEMENT

Regulatory Authority

Migratory sea ducks are protected by both federal and state legislation. The Lacey Act of 1900 prohibits interstate transportation of illegally killed game. The Migratory Bird Treaty Act of 1918 gives the federal government authority to regulate hunting of migratory game birds: listing which species can be legally hunted, restricting harvest to fall and winter seasons, and prohibiting market hunting. The U.S. Fish and Wildlife Service (USFWS) is responsible for establishing harvest regulations (e.g., season lengths, bag limits, and harvest methods), with input from state wildlife agencies coordinated through 4 Flyway Councils (Atlantic, Mississippi, Central, Pacific) (Robinson and Bolen 1984, Chandler 1985).

Two federal laws provide some protection for seabird habitat. Section 404 of the federal Clean Water Act of 1977, administered jointly by the Army Corps of Engineers (permit authority) and the Environmental Protection Agency, prohibits projects that violate water quality standards or involve toxic discharges; mitigation of unavoidable impacts is required. The Coastal Zone Management Act of 1972 establishes federal assistance to coastal states for coastal resource protection programs (Senner and Howe 1984).

In Maine, habitats of endangered and threatened wildlife may be designated as Significant Wildlife Habitat under the Natural Resources Protection Act (NRPA) of 1988, with regulatory oversight by the Maine Department of Environmental Protection. The Maine Department of Inland Fisheries and Wildlife (MDIFW) is responsible for defining

and mapping these habitats (high and moderate value waterfowl habitats, feeding and staging areas) for protection under this law.

The Harlequin Duck is classified as a Threatened species by MDIFW. Maine's Endangered Species Act of 1975 protects Endangered and Threatened wildlife species from take or harassment. A 1988 Amendment to the Act enables the Commissioner of Inland Fisheries and Wildlife to designate "Essential Habitat", critical for conserving Endangered and Threatened species, and to promulgate and enforce guidelines to protect these species.

Past Goals and Objectives

The Maine Department of Inland Fisheries and Wildlife has not established specific goals and objectives for Harlequin Duck management. The broad goal to maintain current abundance and distribution of coastal wildlife was adopted in the Coast of Maine Wildlife Management Area plan and is generally applied to Maine's seabird resource (Woodward and Hutchinson 1986, Woodward et al. 1991).

Past and Current Management

To date, a strategic management plan and management system have not been drafted by MDIFW for the Harlequin Duck. Current management of Harlequins in Maine consists primarily of closing harvest seasons, monitoring the wintering population, and assessing winter habitat.

Enactment of the Migratory Bird Treaty Act of 1918 was a crucial first step in regulating the harvest of Harlequins. With low population levels in eastern North

America (Vickery 1988), more protected measures eventually came into effect beginning in the 1980s. In 1985, Harlequins were listed as a Special Concern species in Maine, but still were hunted in Maine under regular duck season regulations with a season reduced to 40 days and a bag limit of 5 birds. In 1986, the daily bag limit was reduced to 4 ducks, and in 1988 season length was further reduced to 30 days with a 3 bird bag limit (MDIFW 1991). Harvest seasons were closed for Harlequin Ducks in 1987 in Newfoundland and Prince Edward Island, 1988 in Nova Scotia and New Brunswick (Can. Wildl. Serv. 1987), and 1989 in Maine (MDIFW 1991).

The eastern North American population of Harlequin Ducks was designated as endangered in eastern Canada by the Committee on the Status of Endangered Wildlife in Canada in 1990 (Goudie 1991). This designation prohibited harvesting of Harlequins by native people in Canada (previously permitted under the Migratory Bird Convention Act of 1917). Enforcement of harvest prohibitions continues to be difficult in Labrador and remote areas of insular Newfoundland (Montevecchi et al. 1995). Most wintering areas suitable for Harlequins in Canada are controlled through federal (Canadian) and provincial legislation (Goudie 1991).

Effective in 1990-91, there were no open seasons on Harlequin Ducks in Ontario, Quebec, the Atlantic Provinces, and eastern U.S. (Montevecchi et al. 1995). The U.S. identified the Harlequin Duck as a Federal Candidate, Category 2 species in 1991 (Cassirer et al. 1993), but this designation was eliminated in 1996. A 1995 petition to list the Harlequin Duck as endangered in the eastern U.S. was found not warranted in 1998 (U.S. Fish and Wildlife Service 1998).

A recovery plan for the Harlequin Duck in eastern North America was approved and published by the Recovery of Nationally Endangered Wildlife Committee in Canada on 7 April 1995. The goal of this recovery plan is to increase the eastern North American population of Harlequin Ducks to a level where its status can be down-listed to "vulnerable" ($\geq 3,000$ individuals by 2010) by implementing the following strategies: monitor wintering and breeding numbers and age classes to assess population size, structure, and trends; conduct scientific research to address critical gaps in knowledge of biology, ecology, and population genetics; model population dynamics to assess environmental and management effects; protect key habitats; enforce compliance with hunting prohibition; and promote public education. The Canadian Wildlife Service is the lead agency coordinating recovery actions for Harlequins, with cooperation and participation by provincial and U.S. (federal and state) wildlife agencies (Montevicchi et al. 1995).

In Maine, wintering areas are surveyed by MDIFW and individuals (e.g., Isle au Haut areas by G. Mittelhauser, Christmas Bird Counts coordinated by the National Audubon Society). A Harlequin Duck Management Team was named in 1998 to assist MDIFW with various facets of management of this population. This team is comprised of state, federal, and university staff with expertise in a variety of fields germane to management of Harlequin Ducks.

Maine's Oil Spill Response Plan identifies wintering areas of Harlequin Ducks as vulnerable to degradation from oil spills. These concentration areas have been mapped on Environmental Vulnerability Index maps maintained by the Department of Environmental Protection. Although these are considered high priority areas during

migration and wintering periods, protection will be difficult as they are located in exposed coastal areas where wind and wave action make effective control impractical.

Current studies financed by U.S. and Canadian sources are investigating Harlequin Duck genetics, migration, breeding and wintering distribution, and other life history characteristics. Glen Mittelhauser, University of Maine, is conducting research on Harlequin Ducks wintering in outer Penobscot Bay, Isle au Haut, and Jericho Bay, Maine. Agencies supporting this work are MDIFW, U.S. Fish and Wildlife Service - Petit Manan National Wildlife Refuge and Region Five Headquarters, Acadia National Park, the University of Maine, and the Maine Outdoor Heritage Program.

HABITAT ASSESSMENT

During winter, Harlequins only inhabit marine habitats, including traditionally used outer headlands and raised shoals. Harlequins forage in shallow marine water 2-3 m deep, using deeper waters primarily for resting, preening, and roosting (Goudie 1991). Two critical winter habitat factors include a rocky shoreline and predictable ice-free conditions (Vickery 1988).

Past Habitat

Since the late 1800s, Harlequins have wintered regularly at Isle au Haut and surrounding islands (Palmer 1949). However, historical records of Harlequin Ducks wintering at specific sites elsewhere along the Maine coast are limited (Table 1). Norton (1896) reported Harlequins were common along the eastern half of the coast of Maine during winter. By the early 1900s, a reduction in Harlequin presence during winter was reported by Knight (1908) in Hancock, Waldo, and Sagadahoc Counties. Harlequins occurred among islands in Washington County, Knox County, and were observed rarely in Cumberland County (Knight 1908).

Current Habitat

In Maine, Harlequin Ducks winter principally off the southern shore of Isle au Haut and adjacent islands in Penobscot and Jericho Bays and in the York County-Portland area (Table 2, Appendix I). Several additional wintering sites have been identified along the Maine coast since 1993 by Mittelhauser (1993, 1995) and

Table 1. Historical records of Harlequin Ducks wintering along coastal Maine, prior to 1970. Month of observation, if recorded, is noted as superscript.

Site Name	Island Reg. #	Harlequin Duck observations by decade								
		<1890	1890s	1900s	1910s	1920s	1930s	1940s	1950s	1960s
Pine Point, Scarborough				present ^{a;nov}						
Richmond I	55-579					present ^{a;oct}				
Isle au Haut	63-230	present ^a	present ^a	present ^a	present ^a	present ^a	present ^a	present ^a	approx 100 ^b	
Great Spoon I	63-287				50 ^{a;dec}		16 ^{a;mar}			
Blackhorse	63-294			6 ^{c;oct}						
Metinic I	63-584	present ^d								
Metinic Green I	63-585	numerous ^d	approx 8 ^{d;feb}							
Little Green I	63-654	present ^d	9 ^{d;feb}							
Large Green I	63-655		≥30 ^{d;feb}							
Green I Seal Ldgs	near 63-655		30-40 ^{d;feb}							
offshore Matinicus I and other islands in vicinity	near 63-903	present ^a								
Mt. Desert I	59-119									2 ^e
Swan's I	59-413	present ^a								
Deer Isle	59-730								5 ^{e;oct}	

^a(Palmer 1949).

^b(Hebard 1959 cited in Mittelhauser 1991).

^c(Jenney 1908).

^d(Norton 1896).

^e(Mittelhauser 1991).

Table 2. Ranges of Harlequin Ducks observed during December-March surveys (ground, aerial, boat) at sites where birds observed at least once. Asterisk indicates number of ducks based on partial survey of site. Sites currently tracked in Element Occurrence records^a are shaded.

Site Name	Island Reg. #	Range of Harlequin Ducks observed by decades		
		1970s	1980s	1990s
Smuttynose I	81-182			6-21 ^b
York Harbor			3 ^c	
York (CBC counts)		3-44 ^c	5-48 ^{c,d,e,f}	34-39 ^{g,h,i}
Cape Neddick, York		7 ^c	1-2 ^c	3 ^b
Bald Head, York/Ogunquit			6-24 ^c	2-16 ^{b,c}
Ogunquit				24-49 ^{j,k}
Moody Beach, Wells			2 ^c	
Biddeford Pool, Fortunes Rocks Beach		0-2 ^{c,d}	0-6 ^{c,d}	0 ^b
Wood I	81-015			3 ^b
Prouts Neck, Scarborough		5 ^c	1-12 ^{c,d}	0 ^b
Two Lights S.P., Cape Elizabeth				0-6 ^{b,c}
Richmond I	55-579			0-2 ^b
Portland		0-11 ^c	0-5 ^{c,e,f}	2-6 ^{g,i}
Ragged I	55-626			0-2 ^b
Indian Point, Georgetown		0-1 ^{c,d}	0-13 ^{c,d,e}	0 ^b
The Black Rocks	73-265 -266 -267 -268			1 ^b
Pemaquid Pt			2 ^c	0-3 ^{b,g,i}
Monhegan I	65-317		0-5 ^{c,e}	0-1 ^{b,g}
Owls Head to Rockland Harbor		1 ^c	2 ^c	
Stoddart I	63-113			1 ^c
Arey Ldgs	63-164 -165			0-2 ^{c,l}
Middle Ldg	63-167			0-1 ^{b,l}
Hay I	63-169 (-187)			0-8 ^{b,c,l,m}
Roberts Islands	63-174 -175			0-20 ^{b,c,l,m}
Brimstone I	63-176 (-172 -173 -177)			0-8 ^{b,c,l,m}
Little Brimstone I	63-179 (-178 -180 -181)			0-9 ^{b,c,l,m}
Buffalo Ledge	SW of 63-179			0-10 ^{b,c,l}

Table 2. Continued.

Site Name	Island Reg. #	Range of Harlequin Ducks observed by decades		
		1970s	1980s	1990s
Little Brimstone Ldg	S of 63-180			0-4 ^{c,l}
Holden Ldg (include Eastern Ldg)	63-182			0-10 ^{b,c}
Otter I and Ldg	63-183			0-10 ^{b,c,l,m}
Yellow Rock (include Lane Ldg)	63-184			0-2 ^{b,c,l}
Isle au Haut (southern end)	63-230	130-140 ^c	50-248 ^{b,c,n,o}	29-247 ^{b,c,l,m, p,q,r,s}
Great Spoon I & Ldg	63-287 (-290)		45-115 ^o	2-74 ^{b,c,l,m,p,q,r}
Little Spoon I	63-289		10-66 ^{b,o}	0-60 ^{b,c,l,m,p,q}
Roaring Bull Ledge	S of 63-230			0-1 ^b
The Brandies	63-234 -235			0-3 ^{b,p}
Saddleback Ldg	63-237			0-5 ^{b,c,m}
The Washers	E of 63-241			0-10 ^b
Big Brewster I	63-242			0-30 ^b
Southern Mark I	63-260			0-4 ^{b,c}
Fog Island	63-264 (-297)		6 ^c	0-12 ^b
N. Popplestone Ldg	63-261		0-4 ^c	0-24 ^{b,c,l,m,q}
S. Popplestone Ldg	63-265		13-20 ^c	0-30 ^{b,c,l,m,p,q}
Green Ledge	63-266		0-62 ^c	0-47 ^{b,c,l,m,q}
White Ledge	63-267 -298		0-13 ^c	0-30 ^{b,c,l,m,q}
Drunkard Ledge	SE of 63-267			2-20 ^b
Rich's Point (Isle au Haut)	63-230			0-1 ^b
Rich's Ledge	63-272 -273			0-15 ^{b,c,l,p,q}
York Ledges	63-274 -275 (-276)			0-20 ^{b,c,l,m,q}
York I	63-280			0-44 ^{b,c,m,q}
The Cowpen (& Ldg to S)	63-283 -284 (-285)		0-40 ^{b,o}	0-41 ^{b,c,l,m,p,q}
Halfway Rock	S of 63-285			0-15 ^{b,c}
Whitehorse	63-293		20-25 ^o	0-33 ^{b,c,l,m,p,q}
Blackhorse	63-294		0-10 ^o	0-22 ^{b,c,l,m,p,q}
Seal I	63-923			2 ^c
Spirit Ldg	59-001		60 ^o	0-81 ^{b,c,l,p,q}
Bald Rock	59-036			7 ^m

Table 2. Continued.

Site Name	Island Reg. #	Range of Harlequin Ducks observed by decades		
		1970s	1980s	1990s
Sally I	59-037			5-23 ^m
Inner Bar I	59-040			5-14 ^m
Outer Bar I	59-041			2-11 ^m
Western I	59-042			0-3 ^{l,m}
Cranberry Pt (Corea)				6-31 ^m
Big Black Ldg	59-046			0-2 ^{b,m}
Little Black Ldg	59-047			3 ^m
Schoodic I	59-062			1 ^m
Little Moose I	59-063	0-1 ^c	0-1 ^c	1 ^{c,l}
Mt. Desert I	59-119	1 ^{c*}	1-2 ^{c*}	0-4 ^{c*}
Egg Rock	59-301			2 ^c
Baker Islands	59-409 -473			0-12 ^{b,l,q}
Drum I	59-444			0-1 ^{c,l,p}
Long I (S coast)	59-451			1-9 ^c
Scrag I & Ldg	59-475 -476			0-4 ^{b,c,l,q}
Green I	59-477 -478			0-5 ^{b,c,l}
Brimstone I	59-479			0-16 ^{b,c,l,m,q}
Heron I & Ldg	59-480			0-25 ^{b,c,l,m}
Mason Ldg	59-481			0-37 ^{b,c,l,m,p,q}
Black Ldg	59-482			0-44 ^{b,c,l,m,p}
John's I Dry Ldg	59-484			0-10 ^{b,c,l}
Mt Desert Rock	59-561			4 ^l
Blue Hill		1 ^c		
Deer Isle	59-730	1 ^c		
Three Bush I	59-980			1 ^c
Marshall I	59-981			25 ^m
Boxam Ledge	SW of 59-981			0-15 ^b
Saddleback	59-999		2 ^o	0-45 ^{b,c,m,q}
Cross I	79-347			0-6 ^b
Outer Double Shot I	79-352			28 ^m
Libby Islands	79-359 -360			0-1 ^b
Moose/Crowley I	79-426		1-23 ^{c,d}	
Scabby Islands	79-553 -554 -588			0-2 ^b
Green I Ledge	79-571			2 ^b
The Brothers I	79-573 -585 -586			0-4 ^b
Egg Rock	79-605			0-4 ^b

Table 2. Continued.

Site Name	Island Reg. #	Range of Harlequin Ducks observed by decades		
		1970s	1980s	1990s
Green I Ledge	79-624			2 ^b
Big Nash I	79-626			0-10 ^{b,l}
Freeman Rock	79-676			6 ^l
Browney I	79-693			3 ^b
Fisherman I	79-694			0-6 ^b
Seal Rock	79-700			0-4 ^b
Petit Manan Point				2-4 ^{l,m}
The Castle	79-840			2-7 ^{l,m}
Bonney Chess Ldg	79-841			9 ^m
Little Ldg	79-842			0-4 ^{l,m}
Eastern I	79-843			14 ^m
Douglas Islands	79-916 -917 -918 -919 -921			0-2 ^{l,m}
Pond I(Majors Hd)	79-920			2 ^l
Jordans Delight	79-922			0-25 ^{b,l}
Black Ldg	79-923			0-3 ^b
Petit Manan I	79-933			2-8 ^{b,l,m}
Machias			4 ^c	
Quoddy Head S.P.				1 ^c
Eastport			5 ^c	

^aElement Occurrence records are part of the Biological and Conservation Data System (BCD) of the Natural Heritage Program. Maine Department of Inland Fisheries and Wildlife is responsible for maintaining the zoological portion of the BCD for Maine.

^bMaine Dep. Inland Fish. and Wildl. unpublished data.

^c(Mittelhauser 1991).

^d(Vickery 1988).

^e(Natl. Audubon Soc. 1989).

^f(Natl. Audubon Soc. 1990).

^g(Natl. Audubon Soc. 1991).

^h(Natl. Audubon Soc. 1992).

ⁱ(Natl. Audubon Soc. 1994).

^j(Nikula 1992).

^k(Nikula 1994).

^l(Mittelhauser 1993).

^m(Mittelhauser 1995).

ⁿ(Mactavish 1988).

^o(Mittelhauser 1989).

^p(Mittelhauser 1990).

^q(Mittelhauser 1992).

^r(Mittelhauser 1994a).

^s(Mittelhauser 1994b).

MDIFW (Appendix I). Concentrations of Harlequins have been observed from Schoodic Peninsula to Outer Double Shot Island (Cutler) late in the wintering season (Table 2, Appendix I).

Goudie (1991) does not believe the amount of habitat for Harlequin Ducks has been reduced along eastern North America; however, quality of winter habitat has been reduced due to increased human disturbance at formerly inaccessible, remote sites. Urchin fishing boats have been reported in most of the Harlequin wintering areas from Milbridge to Penobscot Bay; divers often work in areas where Harlequins feed. The effects of these fishing activities on wintering Harlequins are poorly understood (Mittelhauser 1993).

Habitat Projection

The wintering distribution of Harlequin Ducks in Maine continues to be refined with coast-wide surveys. Additional surveys will help to delineate Harlequin wintering habitat and identify additional principal wintering sites. The value of Harlequin habitat in Maine depends on continued habitat protection from human disturbance and degradation by oil pollution.

POPULATION ASSESSMENT

Past Populations

Harlequin Ducks wintering in eastern North America probably never were as numerous as other sea ducks. With limited historical information, it is difficult to estimate the size of the historic eastern North American population (Goudie 1989). However, many authors have concluded that Harlequins have been more abundant in this region in the past (Montevecchi et al. 1995). Goudie (1989) speculated that 5,000-10,000 was a reasonable estimate for the former population of Harlequin Ducks in eastern North America.

During the late 1800s to early 1900s, the Harlequin Duck population in eastern North America declined substantially; this decline was especially notable in Maine and Nova Scotia (Phillips 1925). The major depletion in the Harlequin population occurred before enactment of the Migratory Bird Treaty Act. Factors causing the decline are not fully known. However, with the noted tameness of Harlequins during winter, hunting more than any other factor has been linked to the decline of Harlequins in eastern North America (Goudie 1989).

Historic records of Harlequins wintering in Maine are limited (Table 1). At the end of the 19th century, Harlequins were common in Maine only along the eastern portion of the coast (Norton 1896). Knight (1908) estimated that <200 ducks wintered along the coast of Maine by the beginning of the 20th century, but this estimate may not have included birds wintering around the Isle au Haut area (Goudie 1989). Palmer (1949) reported that small flocks commonly wintered along the outer islands and ledges

eastward from western Penobscot Bay. Isle au Haut was the primary wintering area where Harlequins were reported to have wintered since before 1890.

Current Population

The eastern North American population of Harlequin Ducks was estimated at <1,000 individuals and possibly still declining when it was designated as endangered in eastern Canada in 1990. Based on population genetics and estimated population size, this population is at or below minimum viable population size (Goudie 1991, Montevicchi et al. 1995). More than half of the known eastern population of Harlequins winters along the New England coast (Goudie 1991).

It is difficult to survey for this species along the coast of Maine, where isolated winter habitats are difficult to access. Since 1970, Harlequins have been observed during periodic surveys along the Maine coast (Table 2). However, these surveys were not conducted to obtain a coastwide estimate of Harlequins wintering in Maine: 1) birds were observed December-March and numbers partially reflect migration periods, 2) limited areas have been regularly surveyed (e.g., Isle au Haut) but often without concurrent surveys of adjacent islands to account for daily and yearly changes in distribution, and 3) several survey methods have been used (ground, aerial, boat) confounding yearly comparisons.

The first attempt to systematically survey Harlequin Ducks to derive an estimate of Maine's wintering population was conducted during a 4-day period in February 1995 (Table 3). At least 655 Harlequins are estimated to winter along the coast of Maine, with 86% occurring around Isle au Haut and surrounding islands in Jericho and

Table 3. Harlequin Duck census along coastal Maine, February 1995. Time of observation is recorded in subscript for multiple observations per date. Sites currently listed in Element Occurrence^a records are shaded.

Site Name	Island Reg. #	Harlequin Ducks observed by date and method			
		8 Feb 1995			10-11 Feb 1995 ^b
		Ground ^c	Boat ^c	Aerial ^b	Aerial
Smuttynose I	81-182				21
Wood I	81-015				3
Richmond I	55-579				2
Ragged I	55-626				2
The Black Rocks	73-265 -266 -267 -268				1
Channel Rock (including Ldg)	63-168		0 ₀₈₅₅	0 ₀₉₄₅	
Middle Ldg	63-167			1 ₀₉₄₅	
Hay I	63-169 (-187)		0 ₀₉₂₀	0 ₀₉₄₅	
Roberts Islands	63-174 -175		0 ₀₉₀₀	1 ₀₉₄₅	
Brimstone I	63-176 (-172 -173 -177)		8 ₀₉₄₀	0 ₀₉₄₅	
Little Brimstone I	63-179 (-178 -180 -181)		2 ₀₉₃₅		
Buffalo Ledge	SW of 63-179			10 ₀₉₄₅	
Holden Ldg (include Eastern Ldg)	63-182			0 ₀₉₄₅	
Otter I and Ldg	63-183		0 ₀₉₀₅	2 ₀₉₄₅	
Yellow Rock (include Lane Ldg)	63-184			2 ₀₉₄₅	
Old Horse Ledge	W of 63-184			0 ₀₉₄₅	
Isle au Haut (southern end)	63-230	111 ₀₈₀₀ 137 ₀₈₃₀ 142 ₀₉₀₀ 115 ₀₉₃₀ 113 ₁₀₀₀ 133 ₁₀₃₀ 126 ₁₁₀₀ 105 ₁₁₃₀ 104 ₁₂₀₀ 109 ₁₂₃₀ 110 ₁₃₀₀ 136 ₁₃₃₀ 127 ₁₄₀₀ 105 ₁₄₃₀ 105 ₁₅₀₀	108 ₁₀₃₀	33(18 ^d) ₁₀₀₀ 45(5) ₁₁₀₅ 37(36) ₁₄₀₀	

Table 3. Continued.

Site Name	Island Reg. #	Harlequin Ducks observed by date and method			
		8 Feb 1995			10-11 Feb 1995 ^b
		Ground ^c	Boat ^c	Aerial ^b	Aerial
Great Spoon I & Ldg	63-287 (-290)		56 ₁₂₀₅	6 ₁₀₄₅ 31 ₁₄₃₀	
Little Spoon I	63-289		53 ₁₂₃₅	60 ₁₀₄₅ 4 ₁₄₃₀	
The Brandies	63-234 -235			3 ₀₉₄₅	
Saddleback Ldg	63-237		5 ₀₉₅₅	0 ₀₉₄₅	
Southern Mark I	63-260			0 ₁₀₄₅ 0 ₁₄₃₀	
Fog Island	63-264 (-297)			0 ₁₀₄₅ 2 ₁₄₃₀	
N. Popplestone Ldg	63-261		24 ₁₃₃₀	0 ₁₀₄₅ 0 ₁₄₃₀	
S. Popplestone Ldg	63-265		3 ₁₃₂₅	22 ₁₀₄₅ 8 ₁₄₃₀	
Green Ledge	63-266		47 ₁₃₂₀	8 ₁₀₄₅ 11 ₁₄₃₀	
White Ledge	63-267 -298		0 ₁₃₁₅	7 ₁₀₄₅ 5 ₁₄₃₀	
Drunkard Ledge	SE of 63-267			2 ₁₀₄₅	
Rich's Ledge	63-272 -273			0 ₁₀₄₅ 0 ₁₄₃₀	
York Ledges	63-274 -275 (-276)		6 ₁₃₀₅	12 ₁₀₄₅ 0 ₁₄₃₀	
York I	63-280		21 ₁₃₀₀		
The Cowpen (& Ldg to S)	63-283 -284 (-285)		23 ₁₂₄₅	32 ₁₀₄₅ 3 ₁₄₃₀	
Whitehorse	63-293		21 ₁₁₅₅	0 ₁₀₄₅ 5 ₁₄₃₀	
Blackhorse	63-294		10 ₁₁₅₀	0 ₁₀₄₅ 11 ₁₄₃₀	
Spirit Ldg	59-001			12 ₁₀₄₅	
Baker Islands	59-409 -473			0 ₁₀₄₅	
Scrag I & Ldg	59-475 -476			4 ₁₀₄₅	
Green I	59-477 -478			0 ₁₀₄₅	
Brimstone I	59-479		14 ₁₄₃₀	0 ₁₀₄₅	
Heron I & Ldg	59-480		13 ₁₄₂₀	8 ₁₀₄₅	
Mason Ldg	59-481		0 ₁₄₁₅	10 ₁₀₄₅	
Black Ldg	59-482		15 ₁₄₄₅	5 ₁₀₄₅	
John's I	59-483			0 ₁₀₄₅	
John's I Dry Ldg	59-484			0 ₁₀₄₅	

Table 3. Continued.

Marshall I	59-981		25 ₁₃₅₀		
Saddleback	59-999		6 ₁₃₄₅	0 ₁₀₄₅	
Green I Ledge	79-571				2
Big Nash I	79-626				4
Browney I	79-693				3
Fisherman I	79-694				6
Petit Manan I	79-933				3

^aElement Occurrence records are part of the Biological and Conservation Data System (BCD) of the Natural Heritage Program. Maine Department of Inland Fisheries and Wildlife is responsible for maintaining the zoological portion of the BCD for Maine.

^bMaine Dep. Inland Fish. and Wildl. unpublished data.

^c(Mittelhauser 1995).

^dnumbers in parentheses are Harlequins not visible to ground observers.

Penobscot Bays (Appendix II). On 31 March 1998, 950 Harlequins were counted in Jericho Bay west to Vinalhaven Island during a boat survey (MDIFW unpublished data). Even with the possible overlap of wintering and migration periods, these numbers verify the importance of the outer Penobscot Bay-Isle au Haut-Jericho Bay region to wintering Harlequin Ducks. Based on this survey, the eastern North American population is >1,000 individuals. However, this relatively low population level combined with seasonal concentrations of a large portion of this population at a limited number of sites results in a very tenuous viability for the eastern North American population of Harlequin Ducks.

Population Projections

An estimate of the statewide wintering population of Harlequin Ducks is available only for February 1995; therefore, data are not available to project population trends. However, a recent survey (31 March 1998) during the wintering/migration periods indicates a possible increasing trend. With continued coastwide annual surveys during the winter, MDIFW will be better able to ascertain the status of Maine's wintering population of Harlequin Ducks.

Population viability for Harlequins is maintained only by high rates of adult survival (Goudie 1991). Population modeling using data from Iceland (Goudie et al. 1994) determined that population stability occurs when adult annual survival rate approximates 85%, which is the value Bengtson (1972 cited in Palmer 1976) speculated as possible for adult females. An increasing population (9.3%/yr) was simulated when adult survival rates approximated 95%.

Limiting Factors

The Harlequin Duck is restricted to breeding habitat along turbulent rivers; thus, Harlequins probably were never abundant in eastern North America (Montevecchi et al. 1995). Annual productivity is often low due to reproductive factors (delayed maturity, small clutch size) and the influence of fluctuating levels of critical food resources (i.e., aquatic insect larvae) on production of young (Goudie 1991). There is no indication that predation is a significant limiting factor of Harlequins in eastern North America (Goudie 1991, Montevecchi et al. 1995).

Winter habitat is restricted to traditionally used rocky shorelines or exposed outcroppings that are consistently ice-free (Vickery 1988, Goudie 1991). Harlequin distribution is currently restricted to the most remote and inaccessible of these winter sites (Goudie 1991). With its relatively small size and high energy demands compared to larger sea ducks, Harlequins may have little flexibility in adjusting their winter activity budgets. Food may be considered a limited resource in winter because these obligatory diurnal feeders spend a large proportion of the day feeding (Goudie and Ankney 1986).

With its extremely small population size and use of traditional areas, Harlequins are particularly vulnerable to human-related activities (Goudie 1991). Principle threats on breeding and staging areas include habitat loss due to hydroelectric developments (James Bay I and Upper Churchill River hydroelectric projects and potential loss in the James Bay II project), disturbance from low-level flying by the military, habitat degradation from forestry and resource extraction industries, increased disturbance from adventure tourism, black fly control programs (e.g., around Churchill Falls

hydroelectric project), and incidental harvest by native people. Harlequins are at risk on wintering grounds and staging areas from illegal hunting. Other threats on wintering areas include habitat degradation from the effects of fishing and seaweed harvesting activities and increasing human disturbance associated with increased ease of access to remote areas (Goudie 1991, Montevecchi et al. 1995)

Winter habitats are threatened by the potential of oil spills and chronic oil pollution. Goudie (1991) notes that oil contamination occurs annually during the winter in southeastern Newfoundland and may be one of the principle factors contributing to the decline of wintering Harlequins in that area. Harlequins also are susceptible to oiling while flightless during the postbreeding molt (Montevecchi et al. 1995).

Historically, in some areas of its eastern range (especially in Iceland and Greenland), declines in Harlequin populations have been attributed to hunting (legal and illegal) and egg collection for aviculture and food (Phillips 1925, Palmer 1949, Goudie 1991). The Harlequins' relative tameness compared to other sea ducks (Norton 1896, Bent 1925, Palmer 1949) and use of nearshore winter habitats (Goudie and Ankney 1988) increases its vulnerability to hunters (Montevecchi et al. 1995). With its low fecundity level, Harlequins are unable to sustain moderate rates of harvest (>3-5% of initial adult population) (Goudie 1991, Goudie et al. 1994).

Even though hunting seasons for Harlequins have been closed in Maine since 1989-90 and eastern Canada since 1990-91, these ducks continue to be at risk from illegal hunting. Because females and juveniles are hard to distinguish from legally-hunted waterfowl (e.g., scoters), they may be shot incidentally on wintering areas (Goudie 1991, Montevecchi et al. 1995). Additionally, in remote northern regions of its

breeding range where hunting season closures may be difficult to enforce, Harlequins continue to be at risk during spring hunting (Montevecchi et al. 1995).

USE AND DEMAND ASSESSMENT

Prior to 1989, Harlequin Ducks were legally hunted in Maine during the regular duck hunting season. Males have been especially sought as trophy birds (Montevecchi et al. 1995). However, in the mid-1980s, MDIFW noted this resource potentially could be overexploited because of the Harlequin's restricted winter range in Maine. In the 1985 MDIFW Waterfowl Assessment, Corr (1985) discussed the possibility of regulating sport harvest of Harlequins in localized areas to ensure unique populations were not jeopardized by hunting or habitat alteration. As the precarious status of the eastern North American population of Harlequin Ducks became evident based on its low population size and winter range limited to a few traditional sites (Goudie 1989), harvest seasons for Harlequin Ducks were closed throughout eastern North America (Montevecchi et al. 1995).

The demand to conserve rare fauna and the ecosystems they depend upon, especially species listed as Threatened or Endangered, is declared in Maine's Endangered Species Act. Accordingly, MDIFW is entrusted with preserving the diversity of wildlife in the state. Harlequin Ducks contribute to the biological diversity of Maine, and their presence adds to the ecological value of Maine's marine ecosystem. Protecting populations and gaining ecological understanding of species (e.g., Harlequin Duck) are essential to effective ecosystem management and to preserving Maine's natural heritage.

As the popularity of photography, nature study and appreciation, and awareness of Maine's wildlife resource grows, the demand for observation and photographic use of

rare species (e.g., Harlequin Duck) will increase. Boyle et al. (1990) estimated 90% of the state's adult population participate in nonconsumptive use of wildlife. Members of 35% of households in Maine made trips annually to view wildlife and >80% valued the opportunity to view wildlife in Maine.

This high public demand for nonconsumptive use of wildlife is of considerable value to Maine's economy. A minimum estimate of the value of nonconsumptive use of wildlife in Maine is \$55.4 million annually (Boyle et al. 1990), comparable to the economic contribution by resident hunters.

Increasing numbers of citizens desire to preserve the greatest diversity of species possible, at state, national, and global levels (Kellert 1980). This desire is based on increasing public perception of scientific, utilitarian, and cultural values of biological diversity, as well as ethical arguments for conserving plant and animal species. At the state level, public support for preserving wildlife diversity in Maine is present and reflected in state legislation protecting Endangered and Threatened wildlife and their habitats.

SUMMARY AND CONCLUSIONS

By the end of the 19th century, the eastern North American population of Harlequin Ducks was declining. This decline was especially noted in Maine's wintering population, with the species remaining common at only a few traditional sites along the eastern portion of Maine's coast.

Maine supports a significant portion of the eastern North American population of Harlequin Ducks during winter. However prior to 1995, a statewide estimate of Maine's wintering population of Harlequins was not available. In an initial attempt to quantify Maine's wintering population, at least 655 Harlequins were estimated wintering in Maine in February 1995; 86% occurred around Isle au Haut and surrounding islands in Jericho and Penobscot Bays.

Harlequins can be censused practically while flocks concentrate in traditional winter areas. There is a need to conduct regular surveys of Maine's coast during winter using a standardized methodology, with the objectives of more thoroughly delineating the coastwide distribution of Harlequin Ducks in Maine, monitoring population levels, and determining population trends.

Harlequin Duck winter habitat is restricted to traditionally used rocky shorelines or exposed outcroppings that are consistently ice-free. These marine habitats are vulnerable to contamination by pollutants (i.e., oil) and disturbance by humans. Stability of Harlequin Duck populations is maintained through high adult survival (Goudie et al. 1994). Continued winter surveys will aid in delineating areas in Maine used by Harlequins during winter or migration and identifying primary areas of use that need

protection from disturbance or degradation by oil pollution. The Harlequin Duck is classified as a Threatened species in Maine.

LITERATURE CITED

- American Ornithologists' Union (AOU). 1983. Check-list of North American birds. 6th ed. American Ornithologists' Union, Washington, D.C.
- Bellrose, F. C. 1980. Ducks, geese, and swans of North America. 3rd ed. Stackpole Books, Harrisburg, PA. 540pp.
- Bengtson, S-A. 1966. Field studies of the Harlequin Duck in Iceland. Wildfowl Trust Ann. Rep. 17:79-94.
- _____. 1972. Breeding ecology of the Harlequin Duck (*Histrionicus histrionicus*) (L.) in Iceland. *Ornis Scandinavica*. 3:1-19.
- _____, and S. Ulfstrand. 1971. Food resources and breeding frequency of the Harlequin Duck (*Histrionicus histrionicus*) in Iceland. *Oikos* 22:235-239.
- Bent, A. C. 1925. Life histories of North American wild fowl. Part 2. U.S. Nat. Mus. Bull. 130, Washington D.C.
- Boyle, K. J., S. D. Reiling, M. Teisl, and M. L. Phillips. 1990. A study of the impact of game and non-game species on Maine's economy. Dep. Agric. and Resour. Econ., Univ. Maine, Orono. 119pp.
- Canadian Wildlife Service. 1987. The Harlequin Duck - help protect it. Environment Canada. 3pp lfilet.
- Cassirer, E. F., and C. R. Groves. 1992. Ecology of Harlequin Ducks in northern Idaho. Prog. Rep. Idaho Dep. Fish Game. Study No. 4202-1-7-2. 73pp.
- _____, _____, and R. L. Wallen. 1991. Distribution and population status of Harlequin Ducks in Idaho. *Wilson Bull.* 103:723-725.
- _____, G. Schirato, F. Sharpe, C. R. Groves, and R. N. Anderson. 1993. Cavity nesting by Harlequin Ducks in the Pacific Northwest. *Wilson Bull.* 105:691-694.
- Chandler, W. J. 1985. Migratory bird protection and management. Pages 27-70 in R. L. Di Silvestro, ed. Audubon Wildlife Report 1985. Natl. Audubon Soc., N.Y.
- Corr, P. 1985. Waterfowl Assessment. Game bird species assessments and strategic plans. Me. Dep. Inland Fish. and Wildl., Bangor.
- Cottam, C. 1939. Food habits of North American diving ducks. U.S. Dep. Agric. Tech. Bull. 643. 140pp.

- Delacour, J. 1959. The waterfowl of the world. Vol. 3. Arco Publish. Co., Inc., NY. 270pp.
- Forster, R. A. 1988. The autumn migration - August 1 to November 30, 1987: Northeastern Maritime region. *Am. Bird* 42:231-238.
- Godfrey, W. E. 1979. The birds of Canada. National Mus. of Canada, Ottawa. 428pp.
- Goudie, R. I. 1988. Aerial surveys of Harlequin Ducks in northern Labrador, 23-28 July 1988. *Can. Wildl. Serv.*, St. John's, Newfoundland. 14pp.
- _____. 1989. Historical status of Harlequin Ducks wintering in eastern North America - a reappraisal. *Wilson Bull.* 101:112-114.
- _____. 1991. The status of the Harlequin Duck (*Histrionicus histrionicus*) in eastern North America. *Can. Wildl. Serv.* 60pp + 38 pp (Appendices).
- _____, and C. D. Ankney. 1986. Body size, activity budgets, and diets of sea ducks wintering in Newfoundland. *Ecology* 67:1475-1482.
- _____, and _____. 1988. Patterns of habitat use by sea ducks wintering in southeastern Newfoundland. *Ornis Scand.* 19:249-256.
- _____, S. Brault, B. Conant, A. V. Kondratyev, M. R. Petersen, and K. Vermeer. 1994. The status of sea ducks in the North Pacific Rim: toward their conservation and management. *North American Natural Resources Conf.* 27pp.
- Harlequin Conservation Society. 1999. *Histrionics*. Harlequin Conservation Society Newsletter 2(1):1-10.
- Hebard, F. V. 1959. Water birds of Penobscot Bay. *Portland Soc. Nat. Hist.* Portland, ME. 36pp.
- Inglis, I. R., J. Lazarus, and R. Torrance. 1989. The pre-nesting behavior and time budget of the Harlequin Duck *Histrionicus histrionicus*. *Wildfowl* 40:55-73.
- Jenney, C. F. 1908. Harlequin Ducks on Maine coast. *J. Maine. Ornithol. Soc.* 10:114.
- Johnsgard, P. A. 1975. Waterfowl of North America. Indiana University Press, Bloomington. 575pp.
- Kellert, S. R. 1980. Public attitudes toward critical wildlife and natural habitat issues. U. S. Gov. Printing Off., Washington, D. C.
- Knight, O. W. 1908. The birds of Maine. Charles H. Glass Co., Bangor, ME. 693pp.

- Mactavish, B. 1988. The spring season - March 1 to May 31, 1988: Northeastern Maritime region. *Am. Bird* 42:407-410.
- Madge, S., and H. Burn. 1988. *Waterfowl, an identification guide to the ducks, geese and swans of the world.* Houghton Mifflin Co., Boston. 298pp.
- Maine Dep. Inland Fish. and Wildl. (MDIFW). 1991. *Waterfowl assessment and strategic plan. Planning for Maine's Inland Fish and Wildlife 1991-1996. Vol. 1: Wildlife. Part 2: Species assessments and strategic plan updates.* Augusta, ME. 259pp.
- Michael, C. W., and E. Michael. 1922. An adventure with a pair of Harlequin Ducks. *Auk* 38:14-23.
- Mittelhauser, G. H. 1989. The ecology and distribution of the Harlequin Duck (*Histrionicus histrionicus*) wintering off Isle au Haut, Maine. B. A. Thesis. Coll. of the Atlantic, Bar Harbor, ME. 69pp.
- _____. 1990. Survey of Harlequin Ducks along the Isle au Haut shoreline and adjacent offshore islands, 1989-90. Unpubl. rep. to the National Park Service. 28pp.
- _____. 1991. Harlequin Ducks at Acadia National Park and coastal Maine 1988-1991. *Island Res. Cent., Coll. of the Atlantic, Bar Harbor, ME.* Unpubl. rep. 67pp.
- _____. 1992. Harlequin research in Maine, 1992. *Proc. Harlequin Duck Symposium. Northwest Section of The Wildlife Society, Moscow, Id.* pp 10-13.
- _____. 1993. Status of Maine Harlequin Ducks - 1993. Endangered and nongame grant rep. submitted to Me. Dep. Inland Fish. and Wildl., Bangor. 37pp.
- _____. 1994a. Proposal: Harlequin research 1994. Submitted to Me. Dept. Inland Fish. and Wildl. 4pp.
- _____. 1994b. Harlequin ducks wintering at Isle au Haut, Maine - 1994 progress report. Unpubl. rep. submitted to Acadia National Park, Bar Harbor, ME. 22pp.
- _____. 1995. Harlequins on the coast of Maine - 1995 progress report. Unpubl. rep. submitted to Me. Dep. Inland Fish. and Wildl. 27pp.
- Montevecchi, W. A., A. Bourget, J. Brazil, R. I. Goudie, A. E. Hutchinson, B. C. Johnson, P. Kehoe, P. Laporte, M. A. McCollough, R. Milton, N. Seymour. 1995. National recovery plan for the Harlequin Duck in eastern North America. Rep. 12. Recovery of Nationally Endangered Wildl. Committee. 30pp.

- National Audubon Society. 1989. The 89th Christmas bird count - December 1988 to January 1989. *Am. Birds* 43:607-1220.
- _____. 1990. The 90th Christmas bird count - December 1989 to January 1990. *Am. Birds* 44:547-1043.
- _____. 1991. The 91st Christmas bird count - December 15, 1990 to January 2, 1991. *Am. Birds* 45:551-1022.
- _____. 1992. The 92nd Christmas bird count - December 14, 1991 to January 2, 1992. *Am. Birds* 46:538-1024.
- _____. 1994. The 94th Christmas bird count - December 17, 1993 to January 3, 1994. *Natl. Audubon Soc. Field Notes* 48:383-886.
- Nikula, B. 1992. The winter 1991-1992 season: New England region. *Am. Birds* 46:235-239.
- _____. 1994. The regional reports. Winter season - December 1, 1993 to February 28, 1994: New England region. *Natl. Audubon Soc. Field Notes* 48:181-185.
- Norton, A. H. 1896. Recent observations on *Histrionicus histrionicus* in Maine. *Auk* 13:229-234.
- Nova Scotia Museum of Natural History. 1999. Birds of Nova Scotia. <http://museum.ednet.ns.ca/mnh/nature/nsbirds/bns0070.htm>, bns0070.jpg. 19Aug99.
- Palmer, R. S. 1949. Maine birds. *Bull. Mus. Comp. Zool.* Vol. 102. Harvard College, Cambridge, MA. 656pp.
- _____. 1976. Handbook of North American birds. Vol. 3. Waterfowl. Part 2. Yale Univ. Press, New Haven, CT. 560pp.
- Phillips, J. C. 1925. A natural history of the ducks. Vol. 3. Houghton Mifflin Co., Boston. 383pp.
- Pool, W. 1962. Feeding habits of the Harlequin Duck. *Wildfowl Trust Ann. Rep.* 13:126-129.
- Robinson, W. L., and E. G. Bolen. 1984. Wildlife ecology and management. Macmillan Publishing Co., NY. 478pp.
- Savard, J.-P., M. Robert, S. Brodeur, and G. Fitzgérald. 1999. Satellite tracking of Barrow's Goldeneye and Harlequin Ducks in eastern North America. *Waterfowl* 2000 12(1):14.

Senner, S. E., and M. A. Howe. 1984. Conservation of nearctic shorebirds. *Behav. Mar. Organ.* 5:379-421.

Terres, J. K. 1980. *The Audubon Society encyclopedia of North American birds.* Alfred A. Knopf, NY. 1109pp.

U.S. Fish and Wildlife Service. 1998. *Federal Register* 63(88):25177-25178.

Vickery, P. D. 1988. Distribution and population status of Harlequin ducks (*Histrionicus histrionicus*) wintering in eastern North America. *Wilson Bull* 100(1):119-126.

Woodward, S., and A. E. Hutchinson. 1986. Management plan for the Coast of Maine Wildlife Management Area, Regions A, B, C. Maine Dep. Inland Fish. and Wildl., Augusta, ME. 29pp.

_____, _____, and R. B. Allen. 1991. Management plan for the Coast of Maine Wildlife Management Area, Regions A, B, C. Maine Dep. Inland Fish. and Wildl., Augusta, ME. 29pp.

Appendix I. Occurrence of Harlequin Ducks along coastal Maine, 1970-1999. Surveys were conducted January-March, December (unless noted otherwise as month code^a listed in cell). Presence during year indicated with solid circle; absence indicated with open square. Blank entry indicates no surveys recorded for area in given year. Asterisk indicates absence based on partial survey of area. Presence/absence records based on ≥ 1 census (ground, aerial, boat, or combination) for given year. Sites and observations currently listed in Element Occurrence records^b are shaded.

Site Name	Island Reg. #	Presence or absence of Harlequin Ducks by year (Jan-Mar, Dec)															
		1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Smuttynose I	81-182																
Seapoint Beach, Kittery																	
York Harbor																	
York (CBC counts)			• d	• d	• d	• d	• d	• d	• d	• d	• d	• d	• d	• d	• e	• d	• d
York Nubble		• d;oc															
Cape Neddick, York					• d							• d	• d	• d			
Bald Head, York/Ogunquit																	
Ogunquit																	
Moody Beach, Wells																	
Cape Porpoise Harbor Islands																	
Biddeford Pool, Fortunes Rocks Beach											• d,e	□ e	□ e	• d	• e	• d,e	
Wood I	81-015																
Stratton I	81-002																
Bluff I	81-001																
Prouts Neck, Scarborough											• d;+ap	• d	• d	• d	• d	• d	• e
Two Lights S.P., Cape Elizabeth															• d;no		

Appendix I. Continued

Site Name	Island Reg. #	Presence or absence of Harlequin Ducks by year (Jan-Mar, Dec)													
		1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Smuttynose I	81-182										• c		• c		
Seapoint Beach, Kittery					• d;oc										
York Harbor				• d											
York (CBC counts)		• d	• d	• f	• g	• h	• i		• j						
York Nubble															
Cape Neddick, York			• d	• d;no							• c		□ c		
Bald Head, York/Ogunquit			• d;no	• d	• d	• d					• c		• c		
Ogunquit								• j		• l					
Moody Beach, Wells				• d											
Cape Porpoise Harbor Islands											□ c		□ c		
Biddeford Pool, Fortunes Rocks Beach				• d							□ c		□ c		
Wood I	81-015										• c		□ c		
Stratton I	81-002										□ c		□ c		
Bluff I	81-001										□ c		□ c		
Prouts Neck, Scarborough				• m; +my,jn	• d						□ c		□ c		
Two Lights S.P., Cape Elizabeth					• d;oc	• d					□ c		□ c		

Appendix I. Continued

Site Name	Island Reg. #	Presence or absence of Harlequin Ducks by year (Jan-Mar, Dec)													
		1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Turnip I	55-427												<input type="checkbox"/> c		
Jaquish I	55-430												<input type="checkbox"/> c		
Richmond I	55-579												<input type="checkbox"/> c		
Portland		<input type="checkbox"/> d	• d	• f	• g	• h	• i		• j						
Ragged I	55-626												• c	<input type="checkbox"/> c	
White Bull I	55-628												<input type="checkbox"/> c	<input type="checkbox"/> c	
Mark I	55-630												<input type="checkbox"/> c	<input type="checkbox"/> c	
Bald Head to Small Point, Phippsburg													<input type="checkbox"/> c	<input type="checkbox"/> c	
Indian Point, Georgetown		• d	• d;+no	• d,f; +oc	• d								<input type="checkbox"/> c		
The Black Rocks	73-265 -266 -267 -268												• c		
Fox I	73-285												<input type="checkbox"/> c	<input type="checkbox"/> c	

Appendix I. Continued

Site Name	Island Reg. #	Presence or absence of Harlequin Ducks by year (Jan-Mar, Dec)													
		1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Smith I	63-126						<input type="checkbox"/> d								
Green I	63-127 -129						<input type="checkbox"/> d								
House Ldg	63-128						<input type="checkbox"/> d								
Mitten Ldg	63-131						<input type="checkbox"/> d								
Narrows I(seaside)	63-132						<input type="checkbox"/> d								
Clam Ledges	63-133 -134						<input type="checkbox"/> d								
Green Ldg (including Griffin & Halibut Ldg)	63-135						<input type="checkbox"/> d								
Sheep I	63-136						<input type="checkbox"/> d								
Wreck Ldg	W of 63-136						<input type="checkbox"/> d								
Bunker Ldg (off S. Vinalhaven)									<input type="checkbox"/> n						
Round Rock	63-141						<input type="checkbox"/> d								
Folly Ledge	63-163						<input type="checkbox"/> d								
Arey Ldgs	63-164 -165						<input checked="" type="checkbox"/> d		<input type="checkbox"/> n						

Appendix I. Continued

Site Name	Island Reg. #	Presence or absence of Harlequin Ducks by year (Jan-Mar, Dec)													
		1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Carvers I	63-166 -186						□ d		□ n	□ c	□ c		□ c	□ c	□ c
Channel Rock (including Ldg)	63-168						□ d		□ n	□ c; +no	□ c,o				□ c
Middle Ldg	63-167						• d		□ n	□ c	• c				□ c
Hay I	63-169 (-187)								• n	□ c; +no	□ c,o		• c	□ c	□ c
Diamond Rock	63-171						□ d				□ c		□ c	□ c	□ c
Roberts Islands	63-174 -175						• d		□ n	• c	• c,o		□ c	□ c	• c
Heel Tap	Betwn 63-175 63-184						□ d								
Brimstone I	63-176 (-172 -173 -177)						• d,n; +no		• n	□ c; +no	• c,o		□ c	□ c	□ c
Little Brimstone I	63-179 (-178 -180 -181)						• d		• n	□ c; +no	• c,o		□ c	□ c	□ c
Buffalo Ledge	SW of 63-179						• d		□ n	• c	• c		□ c	□ c	
Little Brimstone Ldg	S of 63-180						• d		• n						

Appendix I. Continued

Site Name	Island Reg. #	Presence or absence of Harlequin Ducks by year (Jan-Mar, Dec)													
		1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Holden Ldg (include Eastern Ldg)	63-182						□ d			□ c	• c		□ c	□ c	• c
Otter I and Ldg	63-183						• d		• n	□ c;+no	• c,o		• c	□ c	□ c
Yellow Rock (include Lane Ldg)	63-184						□ d		□ n	□ c;+no	• c				
Old Horse Ledge	W of 63-184										□ c				
Nathan I	63-213				□ p										
Pell I	63-215				□ p										
Flake I	63-216 -217				□ p										
Kimball I	63-221				□ p										
Isle au Haut (southern end)	63-230	• c	• q;no	• p,d,m	• p,r; +no	• s,r,d; +my,o c	• d	• s	• t,n	• u,c; +no	• c,o		• c	• c	• c
Great Spoon I & Ldg	63-287 (-290)				• p	• r	• d	• s	• t,n	• c;+no	• c,o		• c	• c	• c
Little Spoon I	63-289	• c			• p	• r	• d	• s	• n	• c;+no	• c,o		□ c	• c	• c
Roaring Bull Ledge	S of 63-230										• c				□ c

Appendix I. Continued

Site Name	Island Reg. #	Presence or absence of Harlequin Ducks by year (Jan-Mar, Dec)													
		1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
The Brandies	63-234 -235				□ p	□ r				□ c	• c		• c	• c	□ c
Saddleback Ldg	63-237						□ d			□ c	• c,o		□ c	□ c	□ c
The Washers	E of 63-241									• c	• c		• c	□ c	• c
Big Brewster I	63-242									• c;no	• c		□ c	□ c	• c
Southern Mark I	63-260						• d				□ c				
Fog Island	63-264 (-297)				• d					• c	• c		□ c	• c	• c
N. Popplestone Ldg	63-261	• c			• d	• r,d,n +my	• d	• s	• n	• c	• c,o		• c	□ c	• c
S. Popplestone Ldg	63-265				• d		• d	• s	• n		• c,o		• c	• c	• c
Green Ledge	63-266	• c			• d	• d	• d	• s	• n	• c; +no	• c,o		• c	□ c	• c
White Ledge	63-267 -298				• d	• d	• d	• s	• n		• c,o		□ c	• c	• c
Drunkard Ledge	SE of 63-267									• c	• c				
Wheat I	63-268				□ p										
Rich's Point (Isle au Haut)	63-230									□ c; +no	• c		□ c	□ c	□ c
Rich's Ledge	63-272 -273					• r	• d	□ s	□ n		□ c				

Appendix I. Continued

Site Name	Island Reg. #	Presence or absence of Harlequin Ducks by year (Jan-Mar, Dec)													
		1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
York Ledges	63-274 -275 (-276)						• d	• s	• n		• c,o		• c	• c	□ c
York I	63-280						• d	• s		• c	• c,o				
Torrey Ledge	E of 63-280									□ c					
The Cowpen (& Ldg to S)	63-283 -284 (-285)	• c			• p	• r,d; +my	• d	• s	• n	• c;+no	• c,o		• c	• c	• c
Halfway Rock	S of 63-285						• d				• c		• c	□ c	
Whitehorse	63-293				• p	• r,n; +my	• d	□ s	• n	□ c; +no	• c,o		□ c	□ c	□ c
Blackhorse	63-294				• p,t	• r	• d	□ s	• t,n	□ c; +no	• c,o		□ c	• c	□ c
Metinic I	63-584								□ n		□ c				
Metinic Green I	63-585								□ n						
The Nubble	63-586								□ n						
Hog I	63-588								□ n						
Two Bush I & Ldg	63-653								□ n						
Little Green I	63-654								□ n		□ c				

Appendix I. Continued

Site Name	Island Reg. #	Presence or absence of Harlequin Ducks by year (Jan-Mar, Dec)													
		1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Large Green I	63-655								□ n		□ c				
Green I Seal Ldgs	near 63-655								□ n						
Eastern Egg Rock	63-860										□ c				
Little Egg Rock	63-873										□ c				
Shark I	63-875										□ c				
Matinicus I	63-903						□ d				□ c				
Wooden Ball I & Western Ldg	63-917 -918 -919						□ d		□ n*		□ c				
Seal I	63-923						• d				□ c				
Ragged I	63-930						□ d*		□ n*		□ c				
Malcom Ldg	63-938						□ d								
Matinicus Rock	63-940 -941						□ d		□ n		□ c				
Spirit Ldg	59-001				• p	• r	• d	• s	• n	• c; +no	• c		□ c	• c	• c
Bald Rock	59-036								• n;ap		• o				
Sally I	59-037										• o				
Sheep I	59-039								□ n						
Inner Bar I	59-040								□ n;ap		• o				
Outer Bar I	59-041								• n;ap		• o				

Appendix I. Continued

Site Name	Island Reg. #	Presence or absence of Harlequin Ducks by year (Jan-Mar, Dec)													
		1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Islands at mouth of Gouldsboro & Dryer Bays											□ c		• c		• c
Western I	59-042								□ n		• o				
Cranberry Pt(Corea)									□ n;ap		• o				
Big Black Ldg	59-046								□ n;ap		• o		• c		□ c
Little Black Ldg	59-047										• o				
Schoodic Peninsula									• n;ap						
Spruce Pt (Schoodic Peninsula area)									□ n						
Rolling I	59-060								□ n						
Schoodic I	59-062								• n;ap		• o		□ c		□ c
Little Moose I	59-063	□ d		• d	• d;my	• d			• n;ap	• j	□ c				
Pond I	59-064								□ n;ap						
Mt. Desert I	59-119							• d							
Egg Rock	59-301							• d							
High Sheriff I	59-397 -399							□ d							
Baker Islands	59-409 -473								• s	• n		□ c			

Appendix I. Continued

Site Name	Island Reg. #	Presence or absence of Harlequin Ducks by year (Jan-Mar, Dec)													
		1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Deer Isle	59-730														
Halibut Rocks	59-979 -991						□ d								
Three Bush I	59-980						• d								
Marshall I	59-981										• o		□ c	□ c	
Boxam Ledge	SW of 59-981									• c			□ c		
Saddleback	59-999				• p	• d;my	• d	• s		• c;no	• c,o		□ c	• c	• c
Cape Wash I	79-297										□ c				□ c
Old Man I	79-313										□ c		□ c		□ c
Cross I	79-347										□ c		□ c		• c
Double Head Shot Islands	79-351 -353										□ c		□ c		□ c
Outer Double Shot I	79-352										• o				
Libby Islands	79-359 -360										□ c		• c		□ c
Moose/Crowley I	79-426	• d													
Mark I	79-493									□ n					
Seguin I (E side)	79-496									□ n					
The Nipple	79-499									□ n					
Head Harbor I (E & S side)	79-500									□ n					

Appendix I. Continued

Site Name	Island Reg. #	Presence or absence of Harlequin Ducks by year (Jan-Mar, Dec)													
		1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Great Wass I	79-512								<input type="checkbox"/> n		<input type="checkbox"/> c		<input type="checkbox"/> c		<input type="checkbox"/> c
Ram I	79-552										<input type="checkbox"/> c		<input type="checkbox"/> c		<input type="checkbox"/> c
Scabby Islands	79-553 -554 -588										<input type="checkbox"/> c		• c		<input type="checkbox"/> c
Green I Ledge	79-571										• c				
Green I	79-572												<input type="checkbox"/> c		
Pulpit Rock	79-576										<input type="checkbox"/> c		<input type="checkbox"/> c		
The Brothers I	79-573 -585 -586 -587												<input type="checkbox"/> c		• c
Egg Rock	79-605								<input type="checkbox"/> n		<input type="checkbox"/> c		<input type="checkbox"/> c		• c
Seaduck Rock	79-607								<input type="checkbox"/> n						
Batson Ledges	79-613								<input type="checkbox"/> n						
Outer Sand I	79-617								<input type="checkbox"/> n						
Stanley Ledge	79-618								<input type="checkbox"/> n						
Flat I & Ldgs	79-621								<input type="checkbox"/> n						
Black Rock	79-622								<input type="checkbox"/> n						
Green I Ledge	79-624										• c				
Big Nash I	79-626								<input type="checkbox"/> n		• c		• c		<input type="checkbox"/> c
Nash I	79-627								<input type="checkbox"/> n		<input type="checkbox"/> c				<input type="checkbox"/> c

Appendix I. Continued

Site Name	Island Reg. #	Presence or absence of Harlequin Ducks by year (Jan-Mar, Dec)													
		1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Ladle Ledges	79-633 -634 -636								□ n						
Man I	79-655								□ n						
Steele Harbor I (SE shore)	79-660								□ n						
Knight I (S end)	79-669								□ n						
Mistake I (S end)	79-673								□ n						
Channel Rock	79-674								□ n		□ c		□ c		
Black Ledge	w of 79-674										□ c		□ c		
Freeman Rock	79-676								• n		□ c		□ c		□ c
Browney I	79-693										• c				
Fisherman I	79-694										• c		□ c		
Crumple I	79-696								□ n		□ c		□ c		□ c
Curllew Rock(S shore)	79-697								□ n						
Seal Rock	79-700								□ n		□ c		□ c		• c
Bois Bubert I	79-824								□ n		□ c				
Petit Manan Point								• n	□ n;ap		• o				
The Castle	79-840								• n		• o				

Appendix I. Continued

Site Name	Island Reg. #	Presence or absence of Harlequin Ducks by year (Jan-Mar, Dec)													
		1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Bonney Chess Ldg	79-841								□ n;ap		• o				
Little Ldg	79-842								□ n		• o				
Eastern I	79-843								• n;ap		• o				
Pot Rock	79-902								□ n						
Flint I	79-903								□ n						
Shipstern I	79-906								□ n						
Tommy I	79-908 -934								□ n						
Trafton I	79-909								□ n						
Pond I	79-912										□ c		□ c		
Douglas Islands	79-916 -917 -918 -919 -921								□ n		• o		□ c		
Pond I (Majors Hd)	79-920								• n						
Jordans Delight	79-922								• n		□ c		• c		• c
Black Ldg	79-923								□ n		□ c		□ c		• c
Green I & Ldgs	79-929 -930 -931 -932								□ n				□ c		□ c

Appendix I. Continued

Site Name	Island Reg. #	Presence or absence of Harlequin Ducks by year (Jan-Mar, Dec)															
		1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Petit Manan I	79-933																
Egg Rock	79-935 -927																
Machias																	
Quoddy Head S.P.																	
Eastport		□ d	□ d	□ d	□ d	□ d	□ d	□ d	□ d			• d;+ap				□ d	□ d

Site Name	Island Reg. #	Presence or absence of Harlequin Ducks by year (Jan-Mar, Dec)															
		1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999		
Petit Manan I	79-933				• d;ap	• d; +ap, my			• n		• c,o						
Egg Rock	79-935 -927								□ n								
Machias				• d													
Quoddy Head S.P.						• d											
Eastport		□ d	□ d	□ d	□ d												

^aTwo letter codes for months (for observations outside of Jan-Mar,Dec range). Month code indicates presence/absence based only on month listed. However, if month code is preceded by +, presence/absence is based on survey in listed month in addition to Jan-Mar,Dec range.

ap	April	jl	July	oc	October
my	May	au	August	no	November
jn	June	se	September		

Appendix I. Continued

^bElement Occurrence records are part of the Biological and Conservation Data System (BCD) of the Natural Heritage Program. Maine Department of Inland Fisheries and Wildlife is responsible for maintaining the zoological portion of the BCD for Maine.

- | | | | |
|---|--|---|-----------------------|
| c | Maine Dep. Inland Fish. and Wildl. unpublished data. | m | (Mactavish 1988). |
| d | (Mittelhauser 1991). | n | (Mittelhauser 1993). |
| e | (Vickery 1988). | o | (Mittelhauser 1995). |
| f | (Natl. Audubon Soc. 1989). | p | (Mittelhauser 1989). |
| g | (Natl. Audubon Soc. 1990). | q | (Forster 1988). |
| h | (Natl. Audubon Soc. 1991). | r | (Mittelhauser 1990). |
| i | (Natl. Audubon Soc. 1992). | s | (Mittelhauser 1992). |
| j | (Natl. Audubon Soc. 1994). | t | (Mittelhauser 1994a). |
| k | (Nikula 1992). | u | (Mittelhauser 1994b). |
| l | (Nikula 1994). | | |

APPENDIX II. Derivation of minimum estimate for wintering population of Harlequin Ducks in Maine, February 1995.

Area Censused	Date	No. Harlequins observed	Correction factor ^a	No. Harlequin Ducks estimated wintering in area
Isle au Haut	8 Feb 1995	133 ^b		133
Islands near Isle au Haut in Penobscot and Jericho Bays	8 Feb 1995	214 ^c	2	428
York-Cumberland-Sagadahoc Counties and Milbridge-Beals area	10-11 Feb 1995	47 ^d	2	94
Min. estimate of Maine's 1995 wintering population of Harlequin Ducks				655 ^e

^aCorrection factor for aerial census of Harlequin Ducks in Maine:

Islands in Penobscot and Jericho Bays: aerial census = 0.60(boat census) (Mittelhauser 1995)
 southern shore Isle au Haut: boat census = 0.81(ground census) (1030 hr census; Mittelhauser 1995)

Therefore, aerial census observes approximately 49% [0.60(0.81*ground census) or 0.49(ground census)] of birds observed from ground

Or, 2(aerial count) { birds present.

^bShore-based survey of southern shoreline of Isle au Haut, 1030 hr (Mittelhauser 1995).

^cMe. Dep. Inland Fish. and Wildl. aerial census of islands, 0930-1100 hr. Table 3 lists census by islands; number ducks observed includes 7 Harlequins located along east coast of Isle au Haut, outside of shore-based survey area.

^dMe. Dep. Inland Fish and Wildl. aerial census. Table 3 lists census by site.

^eMinimum estimate because only surveyed known or suspected wintering sites along the Maine coast.