Harlequin Duck (Histrionicus histrionicus) Conservation Assessment and Strategy for the U.S. Rocky Mountains

E. Frances Cassirer
Idaho Department of Fish and Game
Nongame and Endangered Wildlife Program
1540 Warner Ave
Lewiston, ID 83501

James D. Reichel
Montana Natural Heritage Program
1515 East Sixth Avenue
Helena, MT 59620

Richard L. Wallen
Office of Science and Resource Management
Grand Teton National Park
Moose, WY 83012-0170

Eric C. Atkinson
Hawk Mountain Sanctuary Association
RR 2, Box 191
Kempton, PA 19529

July 1996

EXECUTIVE SUMMARY

Harlequin ducks (Histrionicus histrionicus) are sea ducks that migrate to mountain streams to breed. The species is classified as a U. S. Forest Service sensitive species in the Northern, Rocky Mountain, and Pacific Northwest Regions, a state sensitive species in Oregon, a priority habitat species in Washington, and a species of special concern in Idaho, Montana, and Wyoming. Harlequin ducks are also classified as migratory waterfowl covered under general waterfowl or sea duck regulations throughout their range.

This Conservation Assessment and Strategy addresses the status and conservation of harlequin ducks in the Rocky Mountains of Idaho, Montana, and Wyoming. The **Conservation Assessment** summarizes available information on the ecology and population status of the harlequin duck in Idaho, Montana, and Wyoming, and identifies potential threats to the species' viability in this region. The **Conservation Strategy** identifies management actions and information needed in order to maintain viable populations and protect and maintain critical habitats to ensure that listing is not warranted, in accordance with the Endangered Species Act (ESA) of 1973, as amended.

The Conservation Assessment is based on inventory, monitoring, and research data collected in the U.S. Rocky Mountains since 1974. Approximately 300 pairs of harlequin ducks are estimated to breed in 57 breeding or probable breeding occurrences in the U.S. Rocky Mountains. A breeding occurrence is considered a single "breeding area", but may contain portions of several streams not separated by more than 10 km of unsuitable habitat, or 20 km of unoccupied, suitable habitat. Data gathered from marked individuals indicates a high degeree of fidelity to these breeding occurrences. The harlequin duck breeding occurrences identified in the U.S. Rocky Mountains are comprised of reaches on 128 streams. Over 90% of the harlequin duck breeding occurrences in the U.S. Rocky Mountains occur on federal lands, primarily managed by the U.S. Forest Service and National Park Service. However, approximately 25% of these do cross some privately-owned land. The remaining 7% (4 breeding occurrences) are located predominantly on state and privately-owned land.

Not all Rocky Mountain breeding occurrences have been located. Potential breeding habitat is identified as 2nd-order or larger streams containing reaches with average gradient of 1% - 7%, riffle habitat, clear water, gravel to boulder-sized substrate, and forested bank vegetation. Additional characteristics that may increase likelihood of use by harlequin ducks include: proximity to occupied habitat, overhanging bank vegetation, woody debris, loafing sites, absence of human activity, and inaccessibility.

Potential threats to harlequin ducks in the U.S. Rocky Mountains include activities that affect riparian habitats, water yield, water quality, and increase disturbance during the breeding season. Habitat conditions in migratory and coastal areas are also critical to conservation of harlequin ducks. Harlequin ducks breeding in the Rocky Mountains have been located off the coasts of Oregon, Washington, and British Columbia. Harvest in coastal areas, while apparently low, could also potentially affect harlequin ducks in the Rocky Mountains.

The Conservation Strategy emphasizes an adaptive approach for maintaining riparian and instream harlequin duck habitat. Guidelines are designed to maintain habitat quality by avoiding degradation from timber harvest, road construction and maintenance, mining, livestock grazing, water developments, and recreation. Guidelines include establishing stream buffers, maintaining instream flows and water quality, and reducing or not increasing human disturbance. Inventory and monitoring protocols are included for assessing the U.S. Rocky Mountain harlequin duck population size and trend and for individual project inventory and monitoring. Finally, areas where additional information is needed regarding basic ecology and management and methods to increase knowledge of management personnel and the public about harlequin ducks and their conservation are identified.

Table of Contents

List of Tables

List of Tables, cont'd.

List of Figures

ACKNOWLEDGMENTS

This document is based on the work of many dedicated individuals. Although too numerous to name, we appreciate the hard work of all those who helped collect the data used in this document. Craig Groves, formerly of the Idaho Conservation Data Center, and Dave Genter, Montana Natural Heritage Program initiated and maintained continued support for work on harlequin ducks in Idaho and Montana. Thanks to the U.S. Forest Service, National Park Service, National Geographic Society, Idaho Dep. of Fish and Game, and Wyoming Game and Fish Dep. for providing major funding for harlequin duck surveys and research in the U.S. Rocky Mountains.

Maps in this document were created by Cedron Jones of the Montana Natural Heritage Program. We thank Pete Clarkson, Dan Davis, Seth Diamond, Scott Robinson, Bill Ruediger, and Cyndi Smith for helping with the process of putting this together and providing comments on earlier drafts.

CONSERVATION ASSESSMENT

Taxonomy

Histrionicus is a monospecific genus in the tribe *Mergini* (sea ducks) (Johnsgard 1960). Disjunct populations occur in conjunction with the Atlantic and Pacific coastlines. No subspecies are currently recognized.

Management status

Due to low numbers, limited distribution, and localized population declines, harlequin ducks were classified by the U.S. Fish and Wildlife Service as a **C2 candidate** for threatened or endangered status throughout the United States in 1991(USDI 1991). The harlequin duck is a U. S. Forest Service **sensitive species** in the Northern, Rocky Mountain, and Pacific Northwest Regions, a state **sensitive species** in Oregon, a **priority habitat species** in Washington, and a **species of special concern** in Idaho, Montana, and Wyoming. Harlequin ducks are also classified as **migratory waterfowl** covered under general waterfowl or sea duck regulations in Washington, Oregon, California, British Columbia, and Alaska. Although harlequin ducks normally migrate to the coast prior to waterfowl hunting season in the Rocky Mountains, they are legally hunted and very occasionally taken in this area as well.

Range and Distribution

The harlequin duck winters and molts in coastal areas and migrates inland to breed along swiftly flowing mountain streams. Harlequin ducks are holarctic, but occur in disjunct populations associated with the Pacific and Atlantic coastlines in North America and Asia. The Rocky Mountains lie in the breeding range of the Pacific population in North America. This breeding range currently extends from Alaska, British Columbia, Washington, Oregon, and possibly northern California east to the eastern slopes of the continental divide in Alberta and Montana, and south to northwestern Wyoming and southeastern Idaho. Wintering occurs primarily in coastal areas of Alaska, British Columbia, Washington, Oregon, and northern California.

In the western United States outside Alaska, stream surveys and incidental reports have documented harlequin duck use on 347 second-order or larger streams, (Table 1). Number of streams used by harlequin ducks in western Canada and Alaska is unknown. Streams crossing state lines and equally divided between states were assigned to the upstream state. One hundred thirty-five streams where harlequin ducks have been observed during the breeding season in the U.S. Pacific outside Alaska occur in the Rocky Mountains (40%).

Table 1. Documented use of streams during the breeding season by harlequin ducks in the Pacific population in the coterminus United States, 1995.

State	Number of breeding streams or possible breeding streams where harlequin ducks have been observed	Number of harlequin duck breeding or probable breeding occurrences[1]
Washington	164	-
Oregon	39	-
Idaho	54	16
Montana	102	33
Wyoming	40	8
California	1	-
Total	400	-

[1] Data on harlequin duck breeding occurrences (defined below) not available outside the U.S. Rocky Mountains.

Within the U.S. Rocky Mountain area harlequin duck breeding streams can be divided into 2 subprovinces based on breeding ecology, habitat characteristics and geographic separation:

1. **Northern Columbia Basin** - northwestern Montana, including Glacier National Park and the Rocky Mountain Front, and Idaho north of the Salmon River.

2. **Intermountain** - southern Idaho north to and including the Salmon River, southwestern Montana and all of Wyoming including the Greater Yellowstone area.

Not all streams used by harlequin ducks during the breeding season are used for nesting or brood-rearing. Some streams where adult harlequins are observed may be used only during migration to and from breeding areas (these streams are not included in Table 1). In order to classify harlequin duck observations in a consistent manner, we propose the following criteria:

Harlequin duck breeding occurence:

Drainages or portions of drainages used by harlequin ducks where breeding is known, i.e. a brood or nest has been observed within the last 15 years. Comprised of contiguous stream reaches (and portions of lakes, reservoirs, or bays) used during the courtship, nesting, and

brood-rearing periods not separated by more than 10 km of unsuitable habitat or 20 km of unoccupied, suitable habitat.

Probable harlequin duck breeding occurrence:

Drainages or portions of drainages used by harlequin ducks where breeding is highly suspected, i.e. there have been at least 3 independent pair or female observations within the last 15 years. Comprised of contiguous stream reaches (and portions of lakes, reservoirs, or bays) used during the courtship, nesting, and brood-rearing periods not separated by more than 10 km of unsuitable habitat or 20 km of unoccupied, suitable habitat.

Breeding status unknown:

Drainages or portions of drainages with at least 1 harlequin duck observation but fewer than 3 independent pair or female observations during the breeding season within the last 15 years.

Breeding unlikely:

Observations of males during migration periods. The male migration periods are before 15 April and after 5 June in the Northern Columbia Basin and Rocky Mountain Front areas and before 1 May and after 20 June in the Intermountain region.

Observations of pairs outside the prenesting season. The prenesting season is from 15 April - 5 June in the Northern Columbia Basin and Rocky Mountain Front areas and 1 May - 20 June in the Intermountain area.

Incidental observations in unsuitable habitat such as ponds, or large, low gradient (<1%) rivers, not adjacent to known breeding sites, or observations on streams which have been identified as lacking breeding activity (e.g. migratory staging areas or stopovers).

Using these criteria, there are currently 48 known breeding occurrences (89 streams), 10 probable breeding occurrences (29 streams) and 81 streams where breeding status is unknown in the Rocky Mountains (Table 2, Fig. 2, Appendices A, B,and C, Table 1). Data are more complete for Idaho and Montana than for Wyoming. As of 1995,inventory had been conducted on approximately 5,640 km of stream (Idaho - 1,886 km; Wyoming - 792 km; Montana 2963 km). Wyoming distribution outside Yellowstone and Grand Teton National Parks is based 1 season of surveys (Laurion and Oakleaf 1995), and observations as well as historical observations and data in the Wyoming Game and Fish Department and Natural Heritage Program databases.

Table 2. **Number of occurrences (*streams*) where harlequin ducks have been observed in the Rocky Mountains.**

Area	Breeding	Probable breeding	Breeding status unknown
Northern Columbia Basin Northern Idaho/Northeastern Washington[1]	14 (*23*)	0 (*5*)	16 (*16*)
Northern Columbia Basin Northwestern Montana and Rocky Mountain Front[2]	24 (*47*)	7 (*17*)	26 (*27*)
Intermountain Southwestern Montana	1 (*1*)	1 (*1*)	6 (*9*)
Intermountain Southern Idaho[3]	1 (*1*)	1 (*1*)	8 (*8*)
Intermountain Wyoming[4]	7 (*17*)	1 (*5*)	21 (*21*)
Total	**47 (*89*)**	**10 (*29*)**	**77 (*81*)**

[1] One of these occurrences originates in northeastern Washington and flows into northern Idaho.
[2] One of these occurrences originates in Idaho and flows into Montana, one originates in British Columbia and flows into Montana, one originates in Montana and flows into Alberta, and one originates in Montana and flows into British Columbia.
[3] One of these occurrences originates in northwestern Wyoming and flows into southern Idaho.
[4] One of these occurrences originates in northwestern Wyoming and flows into southwestern Montana.

The majority of known and probable harlequin duck breeding streams in the Rocky Mountains occur on federal lands (Table 3). In Idaho, 89% of known and probable breeding occurrences and 93% (28 of 30) of known and probable breeding streams are on lands managed by the U.S. Forest Service, although at least 6 of these streams cross some private or corporate timber land. The two breeding occurrences not managed by the Forest Service are in watersheds managed primarily by the Idaho Department of Lands. In Montana, 76% (25 of 33) known and probable breeding occurrences are also primarily managed by the U.S. Forest Service, 5 (15%) are in Glacier National Park, and one each (3%) are on state, private, and mixed ownership (Glacier, Private, and Forest Service). At least 13 of these occurrences cross some private or corporate timber lands in stream reaches harlequins are known to use, and an additional 8 in stream reaches harlequins may use. The large number of occurrences in Montana which cross private lands show the importance of involving private landowners in management decisions; many occurrences could be jeopardized by changes in

Figure 1. Streams surveyed for Harlequin Ducks in Montana, Idaho, and Wyoming during the period 1985 - 1995.

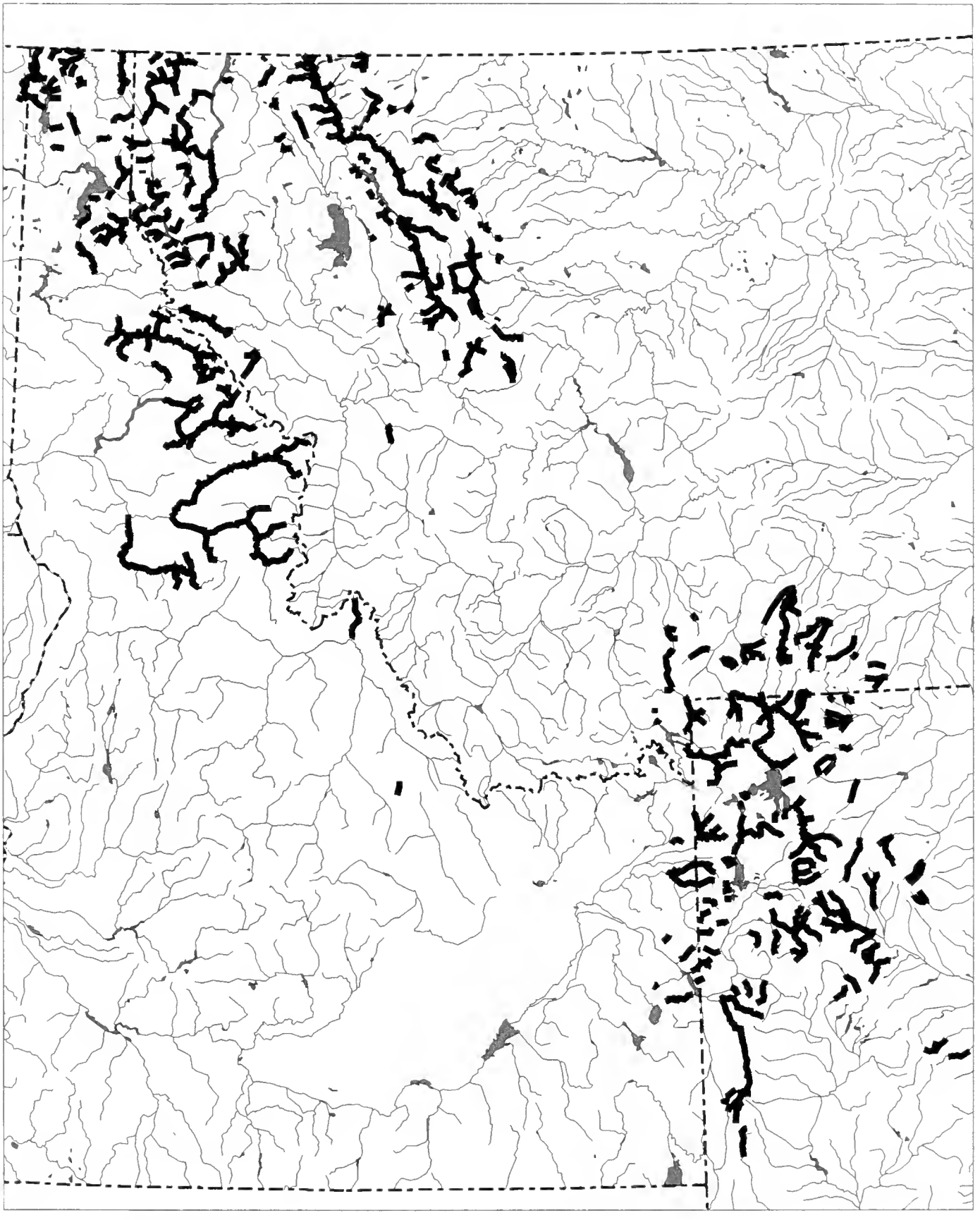
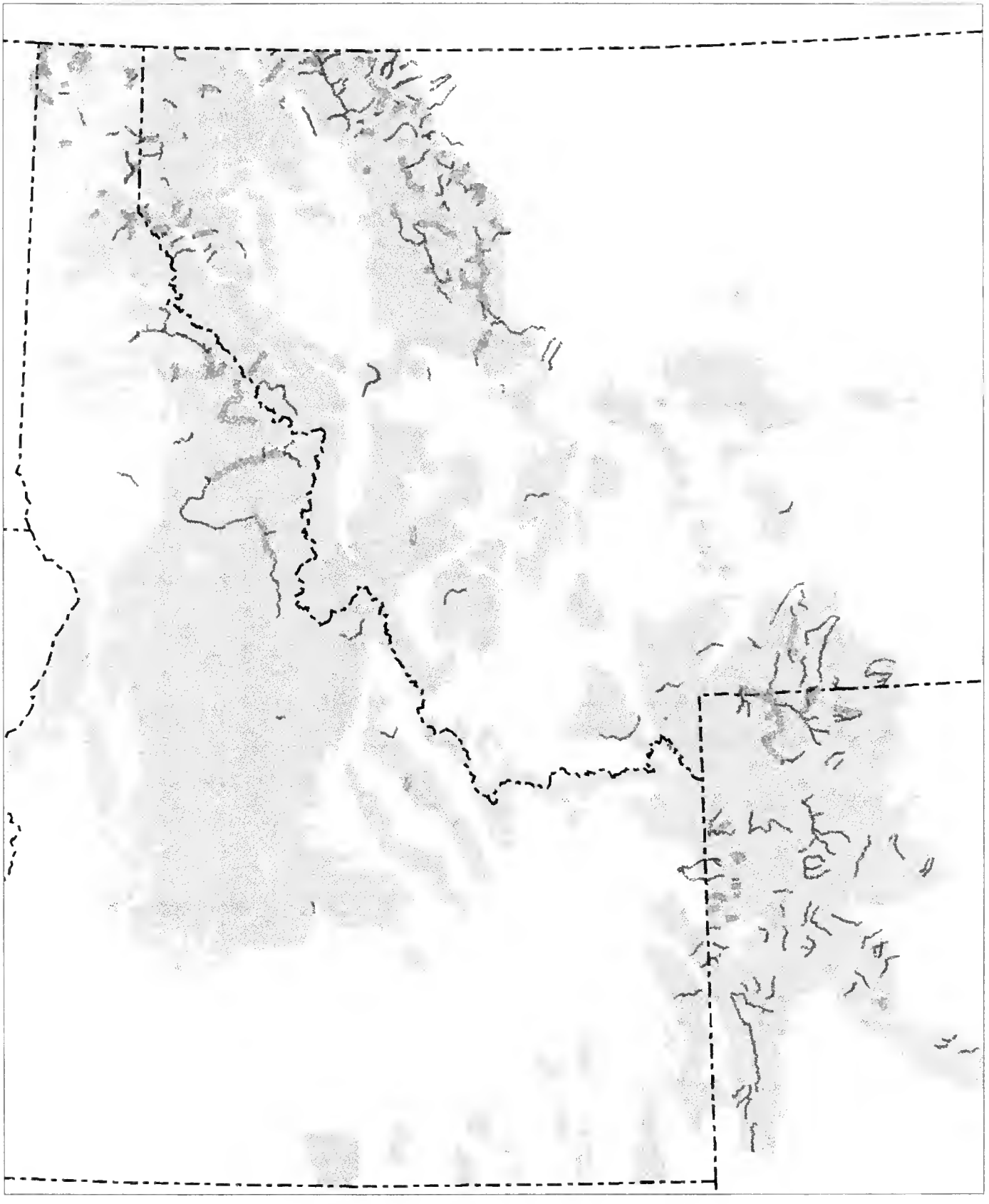


Figure 2. Breeding and probable breeding streams in Montana, Idaho and Wyoming



breeding
probable breeding
breeding status unknown
national forests/national parks

0 50
Scale in miles

July 19, 1996
Montana Natural Heritage Program

private land use. Portions of two occurrence in Glacier National Park are easily accessible by road, while the other three are in roadless areas. Over half (59%) of known and probable harlequin duck breeding streams in Idaho and Montana are on U.S. Forest Service Lands under multiple use management.

In Wyoming, 43% (3 of 8) breeding occurrences are managed by the National Park Service in Yellowstone and Grand Teton National Parks, 50% (4 of 8) are managed by the U.S. Forest Service, and 1 is managed by both the National Park Service and the U.S. Forest Service. The majority (62%) of known and probable breeding streams are managed by the National Park Service (Table 3). Suitable and occupied (breeding status unknown) habitat remains to be surveyed in Yellowstone National Park and on lands managed by the U.S. Forest Service and Bureau of Land Management in northwestern Wyoming (Appendix C).

Table 3. Primary land management status of known and probable harlequin duck breeding streams in the U.S. Rocky Mountains.

State	U.S. Forest Service					Nat'l Park	State Lands	Private	Mixed ownership
	Wilderness	Roadless	Wild and/or scenic	NRA	Multiple use				
Idaho	1	4	5(1)[1]	0	18	0	2	0	0
Montana	5	2	(2)[1]	1	17	5	1	1	1
Wyoming	2	2	0	0	3	13	0	0	0
Total	8	8	5	1	38	18	3	1	1

()[1] Streams are in designated wilderness.

Population size and trend

Population size

Minimum harlequin duck breeding population size in the pacific U.S. outside Alaska is approximately 523 pairs. Thirty-eight percent (198 pairs) breed in the Rocky Mountains (Table 4).

Trend

Although historical information is lacking for most areas, both breeding and wintering distribution may be declining in the Pacific population. Harlequin ducks have disappeared both from peripheral areas where they were formerly present but rare, and from centrally located areas where

they were once relatively common. Reductions in the Pacific breeding distribution have been documented primarily in the eastern and southern parts of the range (Cassirer et al. 1993). Harlequin ducks appear to no longer use at least 10 streams in the Rocky Mountains which previously (as recently as 1987) had a record of use (Table 5) . However, pair numbers on most breeding streams that have been surveyed for 3 or more years appear to be stable (Appendix D).

Table 4. Estimated United States harlequin duck breeding population in the Pacific Northwest and Rocky Mountains (Cassirer et al. 1993, Thompson et al. 1993).

State	Minimum no. breeding pairs[1]	Estimated total number of breeding pairs[2]
Washington	275	-
Oregon	50	-
Idaho	48	70
Montana	110	159
Wyoming	40	58
Total	523	287

1 Maximum number observed during surveys.

2 Assuming 69% observability under optimum survey conditions (Cassirer and Groves 1994). Data not available outside the Rocky Mountains.

Table 5. Rocky Mountain streams previously used by harlequin ducks where no use has been documented since 1988. Number in parentheses is number of surveys 1989 - 1994.

State	Historical consistent use documented	Historical occasional breeding documented	Historical occasional pair use documented
Idaho	Kelly Creek and N. Fork Clearwater River below Kelly Creek **(3)**[1]	Smith Creek (Kootenai River) **(3)**[1]	Orogrande Creek (N. Fork Clearwater River) **(4)**[1]
Montana	Kootenai Falls area of Kootenai River (11)[1]	Otatso Creek	Bighorn River Canyon Jocko River Sweet Water Creek
Wyoming			Shell Creek Canyon

Life history and habitat use

Wintering and nonbreeding ecology

Harlequin ducks winter along northern coastlines, usually near reefs, rocky islands, and cobble beaches. Coastal numbers are greatest from October through March or April (Campbell et al. 1990, Byrd et al. 1992), although nonbreeding and immature individuals may remain on the ocean year-round. Pair bonds are likely formed in coastal areas. Banding efforts suggest that individuals exhibit fidelity to both molting and wintering areas (Goudie, Breault, unpubl. data, pers. comm).

Distribution of harlequin ducks along the coast shifts within and among years (Schirato and Sharpe 1992), partially due to food availability (Chadwick 1992). Marine foods include crustaceans, gastropods, and other invertebrates (Vermeer 1983, Goudie and Ankney 1986, Gaines and Fitzner 1987), and roe (Vermeer 1983, Chadwick 1992).

Sex ratios on wintering areas are biased towards males in most areas (British Columbia 60% males, 40% females or apparent females, Campbell et al. 1990, Chadwick 1992; Amchitka and Shemya Islands, Alaska 53-56% males, Byrd et al. 1992). Summering ratios of males in some areas of coastal British Columbia increase to 95% (Campbell et al. 1990). However, in some areas females and juveniles predominate (Adak Island, Alaska 46% males, Byrd et al. 1992; Maine 48% males, 52% apparent females, Mittelhauser 1991).

Migration

Harlequin ducks migrate from the coast to breeding areas from March through June and return to the coast from June through September. Little is known about migration routes, although they are thought to follow stream corridors, particularly where breeding streams are relatively close to coastal wintering sites (Bengtson 1966, Dzinbal 1982). Birds evidently fly to Rocky Mountain breeding areas east of the continental divide. Migration to these areas probably involves a combination of swimming and flight, and may be influenced by distance from wintering areas, as well as weather and snow conditions encountered enroute. There appear to be some locations along travel corridors in the Rocky Mountains where harlequin ducks stop regularly during spring migration. Few birds are observed during return migration to the coast in summer and fall, therefore this migration is thought to be relatively rapis (Wallen 1987, 1991).

Harlequin ducks marked on breeding streams in northern Idaho (4 ducks), northwestern Montana (12 ducks), and northwestern Wyoming (2 ducks) have been reobserved along Oregon, northwestern Washington, and southern British Columbia coastlines July - March (Wallen 1991, unpubl. data; Cassirer and Groves 1992, 1994, unpubl. data; Reichel and Genter 1994, 1995, unpubl. data).

Breeding ecology

Both pairs and bachelor drakes migrate to breeding areas. Unpaired hens are uncommon on the breeding grounds during spring. Spring sex ratios on breeding streams average 55-64% males (Bengtson 1972, Kuchel 1977, Inglis et al. 1989). Harlequin ducks maintain a multi-year pair bond, and both pairs and bachelor drakes exhibit strong fidelity to breeding streams (Kuchel 1977, Wallen 1987, Cassirer and Groves 1991, Reichel and Genter 1995).

Breeding chronology tends to be delayed in areas with later snowmelt: harlequin ducks in the northern Columbia Basin breed approximately 2 weeks earlier than in the higher elevation Intermountain area (Wallen 1987, Cassirer and Groves 1990). Egg laying and incubation generally occur during May and June. At the start of incubation, the drakes return to the coast, eliminating the possibility of renesting. During late June and early July nonbreeding, possibly immature, hens appear on the streams and remain until after hatching occurs in June and July. Nonbreeding and unsuccessful hens migrate to the coast in July. Successful hens remain on the streams with the ducklings, although up to 40% abandon their broods before fledging (Wallen 1987, Cassirer and Groves 1991). Ducklings return to the coast in the summer and fall after fledging. Males do not attain full breeding plumage until after their second winter and in general harlequin ducks do not breed until after their first year.

Breeding habitat

The harlequin is the only duck in the northern hemisphere to breed almost exclusively along swiftly flowing mountain streams. Within their breeding range, harlequin ducks nest only along a select number of clear streams with rocky substrates. Stream channels range from braided to straight, with an abundance of riffle and rapid habitats. Some use of mountain lakes and lake outlets has been documented in the Canadian Rockies (Clarkson 1992), Montana (Ashley 1994, Reichel and Genter, unpubl. data) and Iceland (Bengtson 1972). Bank vegetation is highly variable, from moorland in Iceland, spruce forest and willow thickets in Labrador, willow shrub or pole or immature-sized lodgepole pine (*Pinus contorta*), Engelmann spruce (*Picea engelmanii*), and Douglas-fir (*Pseudotsuga menziesii*) forest in Wyoming, Montana, and southern Idaho (Wallen 1987, Atkinson and Atkinson 1990, Diamond and Finnegan 1993), to mature or old-growth western redcedar (*Thuja plicata*) - western hemlock (*Tsuga heterophylla*) in the Pacific northwest (Cassirer and Groves 1991).

Harlequin ducks usually nest close to streams on streambanks or islands, but nesting habits are highly variable. Nests may be on the ground in dense vegetation, in rocky cavities, piles of woody debris, undercut streambanks, or in cliff cavities above the stream, or hollow trees or snags in the adjacent forest. Nests are extremely well-hidden, and are often, although not always, upstream of pair activity areas (Bengtson 1972, Cassirer et al. 1993).

Gradient, water quality, substrate, and bank vegetation are useful indicators of potential harlequin duck breeding habitat. The following characteristics are typical of harlequin duck breeding streams in the Rocky Mountains:

1. Stream size second-order or greater.
2. Reaches on the stream with average gradient between 1% and 7%, with some areas of shallow water (riffles).
3. Clear water.
4. Rocky, gravel to boulder-size substrate.
5. Forested bank vegetation.

Some factors that may increase likelihood of use by harlequin ducks include:

1. Proximity to occupied habitat
2. Hiding cover along the stream; including overhanging shrub vegetation, logjams, undercut streambanks, woody debris and instream loafing sites (boulders or gravel bars adjacent to

swiftly-flowing water.

3. Absence of human disturbance such as boating, fishing, and residences.
4. Lack of access by road or trail.

Lists of some potential breeding streams in the Rocky Mountains based these parameters are contained in Appendices A, B and C, Table 3.

Productivity

On average, 12 - 56% of paired females on a breeding stream successfully produce ducklings to fledging in a given year (Bengtson and Ulfstrand 1971, Kuchel 1977, Wallen 1987, Cassirer and Groves 1991). Duckling survival to fledging ranges from 45-80%. Brood size at fledging averages 2.6 - 4.5 (Bengtson 1972, Kuchel 1977, Dzinbal 1982, Wallen 1987, Cassirer and Groves 1991, Reichel and Genter 1995). Recruitment rate is unknown. In an increasing population in Iceland, productivity measured over a 15 year period varied from 0.1 to 3.3 ducklings fledged per hen annually, and averaged 1.1 ducklings per hen per year. (Gardarsson and Einarsson 1991). Productivity is highly variable from year to year and appears to be influenced by magnitude and timing of stream runoff (Kuchel 1977, Cassirer and Groves 1994, Diamond and Finnegan 1993, Reichel and Genter 1994) and food availability (Bengtson and Ulfstrand 1971, Gardarsson and Einarsson 1991). Harlequin ducks feed mainly on benthic invertebrates (Pool 1962, Bengston and Ulfstrand 1971) and roe (Dzinbal 1982) on breeding areas. Lack of productivity is due both to nonbreeding and failed breeding by paired hens (Bengtson and Ulfstrand 1971, Dzinbal 1982, Cassirer and Groves 1991).

Return rates

Return rates of banded or nasal-marked adults to breeding streams were 63% in Idaho (n = 31), 40% in Wyoming (n = 54), and 67% in Montana (n = 12, Kuchel 1977)), 57% (n = 30, Reichel and Genter 1995) and 54% (n = 7, Ashley 1994) in Montana. Some ducklings eventually return to their natal streams to breed (Kuchel 1977, Wallen 1991). Return rate of juveniles appears to be low, but is not well documented. At least 5 females of 103 ducklings banded in Grand Teton National Park 1987-1990 have returned and nested successfully (Wallen 1991). In Montana, 11 of 67 ducklings banded returned to their natal stream as two-year-olds; all were females and at least 1 nested successfully while 8 did not (Kuchel 1976, Ashley 1994, Reichel and Genter 1995).

Conservation Genetics

No information is available on population genetics in harlequin ducks. The extent of genetic variation between the Atlantic and Pacific populations, or across the Pacific breeding range is unknown. Harlequin ducks exhibit a high degree of fidelity to breeding areas, but probably pair on wintering areas where genetic mixing may occur. The degree of similarity among breeding streams is important in understanding both the extent of pair formation and mixing on wintering areas, and the genetic uniqueness of harlequins using different breeding streams or areas. Additional information is needed in order to understand implications for conservation and/or potential reintroduction efforts.

Summary of threats

Harlequin duck population regulation appears to be a complex mechanism affected by a number of factors. Potential human-caused threats to population viability in the Rocky Mountains include both habitat degradation and direct mortality in breeding and wintering areas.

A. Presence of threatened destruction, modification, or curtailment of the species habitat or range.

A1. Riparian habitats

Harlequin ducks use diverse riparian habitats for nesting, feeding, to provide security, and as escape cover. Streambank and/or channel alteration may reduce the quality of these habitats by eliminating or reducing both cover and food supply.

Management considerations: channelizaton, damming, livestock grazing, brush removal, timber harvest, gravel extraction, logjam removal, dredging, bank rip-rap, and road construction.

A2. Water yield levels

Harlequin duck productivity is inversely related to spring streamflows, particularly during the nesting and brood-rearing periods in June and July (Kuchel 1977, Diamond and Finnegan 1993, Reichel and Genter 1994, Cassirer and Groves 1994). High flow events during this period can reduce or eliminate productivity.

Harlequin ducks are closely tied to streams for feeding and protection from predators. Hens with broods usually travel downstream from nesting areas during the brood-rearing period prior to fledging. Dewatering of feeding and brood-rearing areas during the breeding period will render these habitats unavailable to harlequin ducks and will likely directly negatively impact productivity.

Management considerations: hydropower development, stream diversion or damming, timber harvest, and road construction.

A3. Water quality

Sedimentation may fill interstitial habitat in and adjacent to streams (Roby et al. 1977) and reduce the density of the harlequin duck food supply (macroinvertebrates) and alter species composition. Sedimentation may also reduce the ability of harlequin ducks to find prey. Toxic chemical pollution can also directly impact the harlequin duck food supply.

Management considerations: road construction, timber harvest, livestock grazing, toxic chemical spills, mining activities.

A4. Habitat security

Harlequin ducks can be displaced by instream river use (Clarkson 1992, Hunt 1993), particularly on narrow streams. Instream recreational activities may be more disruptive when conducted during the prenesting and early brood-rearing season (May-July) than when conducted later in the breeding cycle (August and September). Human activities along the banks may also displace birds and indirectly impact reproduction (Wallen 1987).

Management considerations: boating use, angler use, hiking, camping, and land management activities in and along streams during the breeding season.

A5. Migration, molting, and wintering conditions

Harlequin ducks breeding in the Rocky Mountains migrate to northern Pacific coastlines to molt and winter. Habitat conditions in these areas are critical to maintaining breeding subpopulations in Idaho, Montana, and Wyoming. Potential direct threats to harlequin duck survival include oil spills and other contamination in breeding and wintering areas. Besides being an immediate mortality factor, residual oil may eliminate reproduction by chronically recontaminating birds (Patten 1993).

Management considerations: oil and other pollution, encroachment of shoreline development and commercial activities on wintering or molting areas.

Overutilization for commercial, recreational, or educational purposes.

B1. Overharvest

Overharvest of remnant populations on wintering areas likely occurred and may be continuing to occur in the Atlantic. This long-lived species has a relatively low reproductive rate as well as delayed reproduction and probably cannot withstand significant increases in adult mortality. This is compounded by use of near shore habitats that makes the species relatively vulnerable to hunting from shore. Currently there is little evidence of significant hunting pressure on the Pacific population outside localized areas in Alaska. However, sea duck hunting is gaining popularity on the west coast and the species occurs in such low numbers in the Rocky Mountains that it could be easily affected by minimal coastal hunting pressure.

Management considerations: migratory waterfowl harvest regulations.

C. Predation and disease.

There is currently no evidence of excessive levels of predation and disease on harlequin ducks.

D. Other natural or manmade factors affecting the species continued existence.

No other natural or manmade factors are known to be affecting the species.

E. Inadequacy of existing federal regulations.

Federal migratory bird harvest regulations covering harlequin ducks are based on monitoring and harvest data that may be inadequate to detect impacts on the Rocky Mountain subpopulation (see overharvest).

CONSERVATION STRATEGY

Introduction

The intent of this Conservation Strategy is to prevent declines in current population levels of the harlequin duck (Histrionicus histrionicus) in the Rocky Mountain breeding range of Idaho, Montana, and Wyoming. The primary goal is to maintain viable populations along with protection and maintenance of critical habitats to ensure that listing is not warranted, in accordance with the Endangered Species Act (ESA) of 1973 as amended. Establishment of management guidelines is complicated by a limited knowledge base and by the fact that harlequin ducks exhibit significant variation in some aspects of breeding ecology and behavior throughout their range. A monitoring program should be developed for all occupied areas affected by proposed management activities and this strategy should be updated as necessary to reflect current knowledge.

This Conservation Strategy focuses on the harlequin duck, but will also benefit other riparian and aquatic-dependent species, including Federal and State special status species such as bull trout (Salvelinus confluentus) and westslope cutthroat (Oncorhyncus clarki lewisi). Likewise, management for these fish species will benefit harlequin ducks.

Standards and guidelines

Standards and guidelines apply to habitat along occupied harlequin duck breeding streams, including breeding streams, probable breeding streams, and streams of unknown breeding status (Appendix A,B,C, Tables 1 and 2). Management guidelines are intended to protect habitat components (security, cover, food), necessary for harlequin ducks to complete their life cycle. The following standards and guidelines should be followed unless cumulative effects watershed analysis and site specific analyses by a qualified biologist addressing harlequin duck habitat parameters indicate that habitat function can be maintained using alternative methods.

Timber management

Timber management guidelines are specifically intended to: avoid disturbance of breeding birds, (TM-1) and maintain security cover and nesting habitat (TM-2, TM-3). The goal of timber management guideline TM-4 is to avoid increasing spring and summer stream flows which can reduce harlequin duck productivity by washing away nests and/or ducklings. Finally, guidelines TM-3 and TM-5 are intended to prevent increases in sedimentation which could impact the harlequin duck's food supply (aquatic insects) and foraging ability.

TM-1. Active logging and road construction activities (such as harvest, skidding, grading, blasting, excavation, etc.) within 2 sight distances[1] of riparian zones should be conducted outside the

---

[1] Sight distance is a measure of hiding cover often defined as the distance at which 90% or more of an adult animal is hidden from view (Thomas et al. 1976, Lyon and Christenson 1992). **In this conservation strategy sight distance is defined as the distance at which the green line vegetation or riparian area is obscured from view prior to leafout.** Two sight distances is double this distance.

harlequin duck breeding season. The breeding season is 15 April - 5 September in the Northern Columbia Basin and 1 May - 20 September in the Intermountain.

TM-2. Maintain overstory and understory cover within 2 sight distances or 100m from the greenline vegetation.

TM-3. Maintain riparian vegetative structure and function, and snags, and woody debris along the stream within 2 site-potential tree lengths from the stream.

TM-4. Manage timber harvest and road construction in uplands to maintain the natural stream flow regime. Avoid increasing peak flows during snowmelt and rain events, reducing summer flows and increasing bedload movement.

TM-5 Avoid increasing sediment delivery to streams during the breeding season in order to maintain substrate condition and turbidity levels necessary for maintaining the harlequin duck benthic invertebrate food supply and suitable feeding conditions.

Roads management

Road management guidelines are intended to avoid disturbance of breeding birds, reduce human access to breeding streams, maintain security cover and nesting habitat, and prevent increases in sedimentation which could impact the harlequin duck food supply (aquatic insects) and foraging ability. In addition, road management guidelines are intended to avoid increasing spring and summer stream flows which can reduce harlequin duck productivity by washing away nests and/or ducklings.

RM-1. For planned roads:

a. Avoid placing new roads up drainage bottoms, concentrate road systems on mid-slopes or ridges.

b. Locate roads in areas not visible from the stream, at least 2 sight distances away from the stream and where stream access is not increased.

c. Restrict frequency of stream crossings and where feasible bridge streams instead of using culverts. Avoid crossing streams at stream junctions because these areas are often frequently used by harlequin ducks..

d. Conduct stream crossing construction activities outside the harlequin duck breeding season.

RM-2. For existing roads:

a. Do not construct new pullouts or parking areas within 2 sight distances or 100m of the greenline vegetation, or where stream accessiblity would be increased.

b. Move roads away from the stream where feasible when reconstructing or upgrading existing roads.

c. When reconstructing or upgrading roads eliminate parking areas and pullouts that increase access to streams.

d. Obliterate and stabilize roads no longer required for timber activities.

e. Evaluate and eliminate potential impacts of road maintenance activities on water quality and stream habitat.

Fire/Fuels management

The fire/fuels management guideline is intended to avoid disturbing harlequin ducks during the breeding period and impacting riparian nesting habitat and security cover.

FM-1. Where possible, locate incident bases, camps, helibases, staging areas, helispots and other centers for incident activities greater than 300 ft from the stream, unless they can be constructed consistent with achieving the conservation strategy goal.

Grazing management

Grazing management guidelines are intended to maintain water quality, temperatures, and quantity necessary to sustain the harlequin duck food supply (aquatic insects) and provide the clear water conditions needed for foraging, and to maintain vegetation along streambanks (especially shrubs) for nesting habitat and security cover. In addition they are designed to avoid disturbance of nesting birds or broods.

GM-1 Eliminate impacts that are inconsistent with attainment of conservation strategy goals by managing grazing (length and timing of grazing season, stocking levels, location and development of water sources) to maintain riparian vegetation and stream bank stability in excellent condition, including:

a. Ensuring that available water will sustain the naturally occurring aquatic ecosystem.

b. Locating livestock watering facilities at least 300 ft from the stream or outside riparian areas.

c. Removing water developments which are inconsistent with conservation strategy goals, and restore these areas.

GM-2 Conduct livestock trailing, bedding, watering, salting, loading, and other handling efforts outside harlequin duck breeding areas and/or breeding season.

Water management

Water management guidelines WM-1 and WM-2 focus on maintaining adequate water levels in the

stream to allow adults and ducklings to move through continous habitat during the breeding season. They also are intended to maintain habitat for the harlequin duck food supply, aquatic insects, minimize disturbance, and prevent increases in spring and summer flows that can negatively impact productivity by washing away nests and/or ducklings. Water management guideline WM-3 is intended to prevent sedimentation that can negatively affect the harlequin duck food supply and their foraging ability, and to prevent disturbance of ducks during the breeding season.

WM-1. For hydroelectric and other water development proposals, maintain instream flows and habitat conditions (including connectivity to facilitate brood movements) suitable for achieving the conservation strategy goal. Coordinate this process with the appropriate state agencies.

WM-2. Hydroelectric facilities will be located, operated, and maintained to eliminate adverse effects that are inconsistent with attainment of the conservation strategy goals.

WM-3. Schedule instream projects involving excavation or other disturbances outside the harlequin duck breeding season unless they can be designed to be compatible with acheiving the conservation strategy goal.

Minerals management

Minerals management guidelines are intended to maintain the long term water quality and quantity necessary for sustaining the harlequin duck food supply, aquatic insects, and the clear water necessary for foraging. They are also designed to protect riparian nesting habitat and security cover, and to avoid human disturbance during the breeding season. Guideline MM-3 focuses on maintaining sufficient water in the stream to allow adults and ducklings to move through continous habitat during the breeding season.

MM-1 Require an approved plan of operations, reclamation plan, and reclamation bond for any mineral operation that could affect achievment of conservation strategy goals. Reclamation plans will contain measurable attainment and bond release criteria for each reclamation activity.

MM-2 Locate structures, support facilities, and roads compatible with maintaining habitat necessary to acheive conservation strategy goals. When a road is no longer required for mineral activities, it will be obliterated and stabilized.

MM-3 Maintain minimum yearound water flows in the stream channel consistent with flows occuring the absence of the facility development.

MM-4 Prohibit solid and sanitary waste facilities within riparian areas that are inconsistent with acheiving conservation strategy goals. If no practical alternative exists to locating mine waste (waste rock, spent ore, tailings) facilities within riparian areas, and releases can be prevented and stability can be ensured, then:

a. Analyze the waste material using the best conventional sampling methods and analytical techniques to determine its chemical and physical stability characteristics.

b. Locate and design the facilities using best conventional techniques to ensure mass stability, prevent the release of acid or toxic materials, and attainment conservation strategy goals. If the best conventional technology is inconsistent with attainment of conservation strategy goals, prohibit such facilities within the riparian area, or 300 ft from the stream.

c. Monitor waste and waste facilities to confirm predictions of chemical and physical stablity, and make adjustments to operations as needed.

d. Reclaim waste facilities after operations to assure chemical and physical stability necessary for acheiving conservation strategy goals.

e. Require reclamation bonds to ensure long-term chemical, physical, hydrological, and biological stability of mine waste facilities.

MM-5 For leasable minerals, prohibit surface occupancy within 300 ft of the stream, unless they can be conducted in a manner compatible with acheiving conservation strategy goals. Adjust the operating plans of any existing contracts to eliminate impacts that are inconsistent with attainment of conservation strategy goals.

MM-6 Sand and gravel mining in riparian areas should not be conducted unless it can be done in a manner consistent with acheiving conservation strategy goals.

MM-7 Develop inspection and monitoring requirements for mineral activities. Evaluate the results of inspection and monitoring to modify mineral plans, leases, or permits as needed, to eliminate impacts that are inconsistent with attainment of conservation strategy goals.

Recreation management

Recreation management guidelines RE-1 through 4 are intended to avoid disturbance of harlequin ducks by boaters during the breeding season. This can be especially detrimental on smaller streams where it is difficult for harlequin ducks maintain a comfortable distance between themselves and the boats without being displaced up- or downstream. Recreation management guidelines RE-5 through RE-7 are intended to reduce or avoid increases in disturbance by other recreational activities in and along the stream during the harlequin duck breeding season. RE-5 and RE-6 are also intended to maintain nesting and security habitat in riparian areas.

RE-1. Discourage expansion of boating activities on occupied or potential harlequin duck breeding streams or stream reaches currently receiving low or no boating use. Control access through methods such as not plowing access roads during the breeding season or where necessary, closing roads that would provide boater access to remote streams. Implement seasonal boating closures where use cannot be managed through access restrictions.

RE-2. Prohibit commercial boating permits, boating competitions, and instructional schools in areas currently without them; this should include transportation of private boating parties and/or their equipment at the beginning or end of their trip by commercial outfitters.

RE-3. Do not expand commercial boating and fishing outfitter permits during the harlequin duck breeding season (Northern Columbia Basin: 15 April - 5 September, Intermountain: 1 May - 20 September) on harlequin duck breeding streams, including fishing derbies, transportation of private boating parties and/or their equipment at the beginning or end of their trip by commercial outfitters.

RE-4. Prohibit motorized boating activity, including jet skis on occupied harlequin duck streams. Where these activities are already established, relocation should be considered.

RE-5. Locate new trails or reconstructed trails greater than 2 sight distances or 300 ft from the stream and avoid increasing stream access.

RE-6. Do not construct new campgrounds or expand existing campgrounds along the streambank. Do not designate new horse or fishing camps within 300 ft. of the stream, and where feasible move existing sites, especially those used during the harlequin duck breeding season.

RE-7. Manage fishing pressure to achieve the conservation strategy goal including maintaining late-season (July) openers.

Information and education

The information and education guidelines are intended to provide accurate, informative, and entertaining materials to the public to explain the life history and habitat needs of harlequin ducks. They are also aimed at assisting administrators, land managers, biologists, and other field personnel with the implementation of this conservation strategy.

IE-1. Create brochures, posters, and multi-media presentations on harlequin duck ecology and conservation for dissemination to user groups and the general public.

IE-2. Conduct interagency workshops on harlequin duck ecology and implementation of the conservation strategy for managers and field biologists in Idaho, Montana, and Wyoming.

IE-3. Encourage recreation and wildlife field personnel to incorporate information on harlequin duck ecology and conservation in public contacts as appropriate.

Inventory

Inventory should be conducted on all potential harlequin duck breeding streams identified as "breeding status unknown" in this strategy. Surveys should be conducted at least once for pairs during the prenesting season within the next 5 years (by the year 2000). Inventory should also be initiated on all streams with potentially suitable habitat (see conservation assessment) in areas that may be affected by management activites. Inventory protocol is described in Appendix E.

Monitoring and adaptive management

It is particularly important to monitor populations in a managed landscape to assess various impacts of land management activities, to evaluate the success of this conservation strategy, and to allow for adaptive management. Within the Rocky Mountains, monitoring is designed in the context of the 2 subprovinces identified in the conservation assessment:

1. **Northern Columbia Basin** - northwestern Montana, including Glacier National Park, the Rocky Mountain Front, and Idaho north of the Salmon River.

2. **Intermountain** - southern Idaho north to the and including the Salmon River, southwestern Montana, and all of Wyoming including the Greater Yellowstone area.

In each area monitoring consists of 1) annual pair and brood monitoring on selected accessible, consistently used breeding streams streams; and 2) rotational sampling on all other breeding streams (Skalski 1995). Monitoring will document pair abundance, trend, and productivity. A monitoring protocol is included in Appendix E.

A monitoring program should also be developed to address proposed management activities that could potentially negatively or positively impact harlequin duck abundance and productivity. Monitoring should be of sufficient duration to evaluate long term or chronic affects. This should include collection of baseline data as well as project implementation, habitat response, and wildlife response monitoring. This monitoring information is imperative for evaluation of management activities and implementation of adaptive management.

Copies of all inventory and monitoring data should be deposited at the state or Natural Heritage Program. Data will be summarized in an annual report by the Rocky Mountain Harlequin Duck working group which will include at least one member from each of the involved states.

Research Needs

Many basic questions about harlequin duck ecology remain to be answered. Answers to the following research questions are important for prioritizing and developing appropriate management techniques:

<u>What are the critical habitat components limiting harlequin duck breeding and wintering populations?</u>

Harlequin ducks use a wide variety of habitats during the breeding season, from old growth forest to tundra. Habitats used and not used over a wide range of breeding areas should be compiled to identify common habitat components in order to better define habitat requirements. Effects of altering both breeding and wintering habitat should be documented as management activities occur and possibilities for mitigation and habitat restoration investigated.

<u>How and why do productivity and survival change over time and among areas, and what are the relative impacts of these changes on populations?</u>

Long term studies to are needed to determine demographic parameters necessary for understanding and modelling population dynamics. These include: productivity, age-related survival, recruitment, age(s) at first breeding and/or first successful breeding, age(s) of last breeding, life expectancy and causes and timing (seasonal and age-related) of mortality.

What are the impacts of human disturbance on breeding and wintering harlequin ducks?

Several independent studies have documented the sensitivity of harlequin ducks to human disturbance during the breeding season, however behavior varies among individuals and breeding areas. Effects of human disturbance on behavior, productivity, and survival in breeding and wintering areas should continue to be examined.

Are distinct metapopulations (such as a Rocky Mountain breeding population) identifiable within the Pacific range of harlequin ducks?

Harlequin ducks exhibit a fairly high degree of ecological and behavioral variability, such differences in habitat use and timing of breeding activities, across their range. Some subpopulations migrate hundreds of miles to montane breeding areas, while others breed on coastal streams. Yet although they are philopatric to breeding areas, mixing occurs on molting and wintering areas. Pair-bonding may occur in both breeding and wintering areas. The degree of genetic differences among and within wintering and breeding subpopulations would allow assessment of the extent of mixing and would help determine the appropriate management unit.

What are the characteristics of harlequin duck migration? How well defined are migratory staging areas and migration corridors? What is the extent and nature of monements in coastal and inland areas?

Movement, migration, and dispersal patterns within and between breeding and wintering areas are little known. Investigatation through radiotelemetry, banding, and other techniques is needed to better understand these patterns.

Literature Cited

Ashley, J. 1992. A summary of documented harlequin duck observations in Glacier National Park, 1874-1992.

_____ 1994a. 1992-1993 Harlequin duck monitoring and inventory results in Glacier National Park, Montana. USDI National Park Serv., West Glacier, MT. 57 pp.

_____ 1994b. Progress report: Harlequin duck inventory and monitoring in Glacier National Park, Montana. USDI National Park Serv., West Glacier, MT. 10 pp.

Atkinson, E. C. and M. L. Atkinson. 1990. Distribution and status of harlequin ducks (Histrionicus histrionicus) on the Targhee National Forest. Idaho Dep. of Fish and Game, Nongame and endangered wildlife prog. 25 pp.

_____ . 1991. Distribution and status of harlequin ducks and common loons on the Targhee National Forest. Idaho Dep. of Fish and Game, Nongame and endangered wildlife prog. 27 pp.

Bengtson, S. A. 1966. Field studies on 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 Scand. 3:1-19.

_____ and S. Ulfstrand. 1971. Food resources and breeding frequency of the harlequin duck Histrionicus histrionicus in Iceland. Oikos 22:235-239.

Byrd, G. V., Williams, J. C., and A. Durand. 1992. The status of harlequin ducks in the Aleutian Islands, Alaska. Pp. 14-32 in Proceedings, Harlequin duck symposium, April 23-24, 1992, Moscow, ID.

Campbell, W., Dawe, N. K., McTaggart-Cowan, I., Cooper, J. M., Kaiser, G. W. and M. C. E. McNall. 1990. The birds of British Columbia. Royal British Columbia Museum, Victoria, B. C.

Carlson, J. C. 1990. Results of harlequin duck (Histrionicus histrionicus) surveys in 1990 on the Flathead National forest, Montana. Mont. Not. Heritage Prog., Helena, MT. 32 pp.

Cassirer, E. F. and Craig R. Groves. 1991. Harlequin duck ecology in Idaho: 1987-1990. Idaho Dep. of Fish and Game, Nongame and endangered wildlife Prog. 93 pp.

_____ and _____. 1992. Ecology of harlequin ducks in northern Idaho: progress report 1991. Idaho Dep. of Fish and Game, Nongame and endangered wildlife program. 73 pp.

_____ and _____. 1994. Ecology of harlequin ducks in northern Idaho. Idaho Dep. of Fish and Game, Nongame and endangered wildlife program. 51pp.

_____, Schirato, G., Sharpe, F., Groves, C. R., and R. N. Anderson. 1993. Cavity nesting by harlequin ducks in the PacificNorthwest. Wilson Bull. 105:691-694.

_____. 1995a. Harlequin duck monitoring on the Moyie River and other tributaries to the Kootenai River in northern Idaho subsequent to natural gas pipeline construction. Idaho Dep. of Fish and Game, Nongame and endangered wildlife prog. 11pp.

_____. 1995b. Harlequin duck monitoring in northern Idaho, 1995. Idaho Dep. of Fish and Game Nongame and endang. wildlife prog. 19pp.

Clarkson, P. 1992. A preliminary investigation into the status and distribution of harlequin ducks in Jasper National Park. 65 pp.

Diamond, S. and P. Finnegan. 1993. Harlequin duck ecology on Montana's Rocky Mountain Front. U.S.D.A. Forest Service, Lewis and Clark N. F., Choteau, MT. 73pp.

Dzinbal, K. A. 1982. Ecology of harlequin ducks in Prince William Sound, Alaska during summer. M. S. Thesis, Oregon State Univ., Corvallis. 89 pp.

Fairman, L. M., C. Jones, and D. L. Genter. 1989. Survey results for Harlequin Ducks (Histrionicus histrionicus) on the Kootenai National Forest and Flathead National Forest, Montana. Mont. Nat. Heritage Prog., Helena. 20 pp.

Fairman, L. and G. Miller. 1990. Results of the 1990 survey for harlequin ducks (Histrionicus histrionicus) on the Kootenai National Forest, Montana and parts of the Lolo National Forest, Montana. Mont. Nat. Heritage Prog., Helena, MT. 41 pp.

Gangemi, J. T. 1991. Results of harlequin duck (Histrionicus histrionicus) surveys on the non-wilderness portion of the Flathead National Forest, Montana. Mont. Nat. Heritage Prog., Helena. 29 pp.

Gardarsson, A. and A. Einarsson. 1991. Responses of breeding duck populations to changes in food supply. Paper presented at Aquatic birds in the trophic web of lakes, Sackville, New Brunswick, April 19-22, 1991. 37pp.

Hunt, W. A. 1993. Jasper National Park harlequin duck projects, 1992: Maligne Valley pilot projects. Canadian Parks Service, Jasper National Park. 58 pp.

Inglis, I. R., Lazarus, J., and R. Torrance. 1989. The pre-nesting behavior and time budget of the harlequin duck (Histrionicus histrionicus). Wildfowl 40:55-73.

Johnsgard, P. A. 1960. Classification and evolutionary relationships of the sea ducks. Condor. 62:426-433.

Johnson, D. 1991. Field report of harlequin duck streams surveyed. Unpubl. field notes on file Mont. Nat. Heritage Prog., Helena, Mont.

Kerr, R. 1989. Field survey data forms of the harlequin duck (Histrionicus histrionicus) of the Kootenai National Forest, Montana. 16 pp.

Kuchel, C. R. 1977. Some aspects of the behavior and ecology of harlequin ducks breeding in Glacier National Park, Montana. M. S. Thesis. Univ. of Montana, Missoula. 163pp.

Laurion, T. and B. Oakleaf. 1995. Harlequin duck survey, Shoshone National Forest. Wyoming Game and Fish Dept., Laramie, WY. 10pp.

Lee, D. B. N., and D. L. Genter. 1991. Results of harlequin duck (Histrionicus histrionicus) surveys in wilderness areas of the Flathead National Forest, Montana. Mont. Nat. Heritage Prog., Helena. 29 pp.

Lyon, L.J. and A. G. Christensen. 1992. A partial glossary of elk management terms. Gen.Tech, Rep. INT-288. U.S.D.A. Forest Service, Intermountain Research Station. 6pp.

Maj, M. E. And M. B. Whitfield. 1995. Harlequin duck surveys, final report 1995, Targhee National Forest. U.S. Forest Serv., Targhee Nat. For, Idaho Dep. Fish and Game, Northern Rockies Cons. Coop. 21 pp.

Markum, D. 1990. Distribution and status of the Harlequin Duck on the Gallatin National Forest, Montana. Mont. Nat. Heritage Prog., Helena.

Merz, N. 1991. 1991 Harlequin Duck Survey for the lower Clark Fork drainage. Nat. Heritage Prog., Helena.

Miller, V. E. 1988. Harlequin ducks (Histrionicus histrionicus) 1988 results of field surveys in west-central, Montana. Unpubl. rep. 13 pp.

Miller, V. E. 1989. 1989 field survey report: harlequin duck (Histrionicus histrionicus), Lower Clark Fork River drainage, west-central, Montana. Unpubl. rep. on file Mont. Nat. Heritage Prog., Helena. 48+ pp.

Mittelhauser, G. 1991. Harlequin ducks at Acadia National Park and coastal Maine, 1988-1991. Island Research Center, College of the Atlantic, Bar Harbor, Maine. 67 pp.

Patten, S. 1993. Acute and sublethal effects of the Exxon Valdez oil spill on harlequins and other seaducks. Alaska Dept. of Fish and Game, Anchorage, AK. 7 pp.

Pool, W. 1962. Feeding habits of the Harlequin Duck. Wildfowl 13:126-129.

Reichel, J. and D.L. Genter. 1993. Harlequin duck surveys in western Montana: 1992. Montana Nat. Heritage Prog. 67pp.

_____ and _____. 1994. Harlequin duck surveys in western Montana: 1993. Montana Nat. Heritage Prog. 87pp.

_____ and _____. 1995. Harlequin duck surveys in western Montana: 1994. Montana Nat. Heritage Prog. 58pp.

Skalski, J. R. 1990. A design for long-term status and trends monitoring. J. Env. Manage. 30:139-144.

_____. 1995. Use of "bellwether" stations and rotational sampling designs to monitor harlequin duck abundance. Unpubl. rept. U. of Wash., Seattle. 19pp.

Thomas, J.W., R. J. Miller, H. Black, J. E. Rodiek, and C. Maser. 1976. Guidelines for maintaining and enhancing wildlife habitat in forest management in the Blue Mountains of Oregon and Washington. Trans. N. Amer. Wild. And Natur. Resou. Conf. 41:452-476.

Thompson, J. R. Goggans, P. Greenlee, and S. Dowlan. 1993. Abundance, distribution, and habitat associations of the harlequin duck (*Histrionicus histrionicus*) in the Cascade Mountains, Oregon, 1993. Oregon Dept. of Fish and Wildlife, Portland OR. 37 pp.

U.S. Dept. of the Interior. 1991. Endangered and threatened wildlife and plants; candidate review for listing as endangered or threatened species, notice of review. Federal Reg. 56(225):58804-58836.

Wallen, R. L. 1987. Habitat utilization by harlequin ducks in Grand Teton National Park. M. S. Thesis, Montana State Univ., Bozeman. 67 pp.

_____. 1991. Annual variation in harlequin duck population size, productivity, and fidelity to Grand Teton National Park. Nat. Park Serv. 7 pp.

Appendix A, Table 1. Idaho harlequin duck breeding and probable breeding occurrences, 1995.

Occurrence	Status[1]	Rank[2]	Watershed	Primary ownership[3]
Upper Priest River	B	B	Priest River	IPNF
includes Gold Creek	B			
Hughes Fork	B			
Granite and N. Fork Granite Cr.	B			
Sullivan Creek (Washington)	B		Pend Oreille River	CNF
Lion Creek	B	U	Priest River	IDL
includes Two Mouth Creek	BU			
Middle Fork East River	B	C	Priest River	IDL
Long Canyon Creek	B	D	Kootenai River	IPNF
includes Smith Creek	B			
Moyie River	B	D	Kootenai River	IPNF
includes Deer Creek	PRB			
North Fork Coeur d'Alene River	B	D	Coeur d'Alene River	IPNF
includes Jordan Cr.	B			
East Fork Lightning Creek	B	D	Clark Fork River	IPNF
includes Lightning Creek	PRB			
Gold Creek, L. Pend Oreille	B	C	Lake Pend Oreille	IPNF
includes N. Gold Creek	B			
Granite Creek	B			
St. Joe River	B	CD	St. Joe River	IPNF
includes Simmons Creek	PRB			
Marble Creek	B	D	St. Joe River	IPNF
Little North Fork Clearwater River	B	U	Clearwater River	IPNF
North Fork Clearwater River	B	C	Clearwater River	CLNF
includes Kelly Creek	B			
Lochsa River	B	BA	Clearwater River	CLNF
includes White Sands Creek	PRB			
Papoose Creek	B			
Boulder Creek	BU			
Fish Creek	PRB			
Squaw Creek	BU			

[1] B = Breeding, PRB = Probable breeding, BU = Breeding status unknown.

[2] A = 20+ pairs within a single occurrence, B = 5 - 19 pairs within the occurrence and a minimum of 10 pairs within the occurrence and other occurrences within 20 km, C = 3+ pairs within the occurrence; if 5+ pairs then <10 pairs within the occurrence and other occurrences within 20 km. D = 1-2 pairs, U = Unknown. Not enough data to place in a range of 2 categories.

[3] IPNF= Idaho Panhandle National Forest, CNF = Colville National Forest, CLNF = Clearwater National Forest, IDL = Idaho Department of State Lands.

Appendix A, Table 1, cont'd. Idaho harlequin duck breeding occurrences and probable breeding occurences, 1995.

Occurrence	Status[1]	Rank[2]	Watershed	Primary ownership[3]
Selway River includes Bear Creek	B BU	DC	Clearwater River	NPNF
North Fork Big Creek	B	D	Pahsimeroi River	CHNF
Big Elk Creek	PRB	D	S. Fork Snake River	TNF

1 B = Breeding, PRB = Probable breeding, BU = Breeding status unknown.

2 A = 20+ pairs within a single occurrence, B = 5 - 19 pairs within the occurrence and a minimum of 10 pairs within the occurrence and other occurrences within 20 km, C = 3+ pairs within the occurrence; if 5+ pairs then <10 pairs within the occurrence and other occurrences within 20 km.
D = 1-2 pairs, U = Unknown. Not enough data to place in a range of 2 categories.

3 NPNF= Nez Perce National Forest, CHNF = Challis National Forest, TNF = Targhee National Forest.

Appendix A, Table 2. Idaho streams where harlequin ducks have been observed or reported, but breeding status is unknown.

Stream	Watershed	Primary ownership[1]	No. surveys conducted
Soldier Creek	Priest Lake	IDL	1
Two Mouth Creek	Priest Lake	IDL	1
Boundary Creek	Kootenai River	IPNF	5
Pack River	Lake Pend Oreille	IPNF	3
includes Grouse Creek			2
Spring Creek	Lake Pend Oreille	IPNF	1
Priest River	Pend Oreille River	IPNF/IDL	0
Teepee Creek	North Fork Coeur d'Alene River	IPNF	3
Slate Creek	St. Joe River	IPNF	2
Mica Creek	St. Joe River	IPNF	1
North Fork St. Joe River	St. Joe River	IPNF	4
Orogrande Creek	North Fork Clearwater River	CNF	4
Crooked Fork	Lochsa River	CNF	5
Boulder Creek	Lochsa River	CNF	0
Squaw Creek	Lochsa River	CNF	1
Lolo Creek	Clearwater River	BLM/CNF	0
Bear Creek	Selway River	NPNF	2
Rapid River	Salmon River	NPNF	0
Bargamin Creek	Salmon River	NPNF	1
Camas Creek	Salmon River	SNF	0
North Fork Salmon River	Salmon River	SNF	1
Hayden Creek	Salmon River	SNF/PVT	0
includes Bear Valley Creek			
Big Wood River	Wood River	PVT	0

[1] IDL = Idaho Department of Lands, IPNF = Idaho Panhandle National Forests, BLM = Bureau of Land Management, CNF = Clearwater National Forest, NPNF = Nez Perce National Forest, TNF = Targhee National Forest, PVT = Private, SNF = Sawtooth National Forest.

Appendix A, Table 2, cont'd. Idaho streams where harlequin ducks have been observed or reported, but breeding status is unknown.

Stream	Watershed	Primary ownership[1]	No. surveys conducted
McCoy Creek	Snake River (Palisades Reservoir)	TNF	3
Sulphur Bar Creek	Snake River (Palisades Reservoir)	TNF	0

[1] TNF = Targhee National Forest.

Appendix A, Table 3. Partial list of potential harlequin duck breeding streams in Idaho.

Stream	Watershed	Primary ownership	No. surveys conducted
Trapper Creek	Priest Lake	IDL	0
North Fork East River	Priest River	IDL	0
Uleda Creek	Priest River	IDL	0
Trestle Creek	Lake Pend Oreille	IPNF	0
Pine Creek LaTour Creek	Coeur d'Alene River	BLM	0
Bussel Creek	St. Joe River	IPNF	0
Ruby Creek	St. Joe River	IPNF	0
Fly Creek	St. Joe River	IPNF	0
Vanderbilt Creek	North Fork Clearwater River	CNF	1
Weitas Creek	North Fork Clearwater River	CNF	1
Warm Springs Creek	Lochsa River	CNF	0
Meadow Creek	Selway River	NPNF	I
Moose Creek	Selway River	NPNF	1
Whitecap Creek	Selway River	NPNF	2
Targhee Creek	Henry's Fork Snake River	TNF	1
Palisades Creek	S. Fork Snake River	TNF	1

[1] CNF = Clearwater National Forest, IDL = Idaho Department of Lands, IPNF = Idaho Panhandle National Forests, NPNF = Nez Perce National Forest, TNF = Targhee National Forest.

Appendix B, Table 1. Montana harlequin duck breeding and probable breeding occurrences, 1995.

Occurrence	Status	Rank	Watershed	Primary ownership
Waterton River	B	CB	South Saskatchewan River	GNP
includes Kootenai Lakes	PRB			
Boundary Creek	PRB			
Olson Creek	B			
St. Mary River (above Lake)	B	CB	St. Mary River	GNP
includes St. Mary River	PRB			
Reynolds Creek	B			
Red Eagle Creek	B			
Rose Creek and Otokomi Lake	BU			
Belly River	PRB	U	St. Mary River	GNP
Badger Creek	B	CB	South Marias River	LCNF
includes North Badger Creek	B			
South Badger Creek	B			
Birch Creek	B	CB	South Marias River	LCNF
includes Birch Creek	PRB			
North Fork Birch Creek	PRB			
Middle Fork Birch Creek	PRB			
South Fork Birch Creek	B			
South Fork Two Medicine River	B	D	South Marias River	LCNF
includes Summit Creek	BU			
Two Medicine River	PRB	D	South Marias River	GNP,
includes Paradise Creek	PRB			BIR
North Fork Teton River	B	DC	Teton River	LCNF
Sun River	B	BA	Sun River	LCNF
includes Sun River	BU			
North Fork Sun River	B			
Biggs Creek	BU			
Moose Creek	B			
South Fork Sun River	B			
Straight Creek	B			
West Fork Sun River	B			
Ahorn Creek	PRB			
Woods Creek	BU			

[1] B = Breeding, PRB = Probable breeding, BU = Breeding status unknown.

[2] A = 20+ pairs within a single occurrence, B = 5 - 19 pairs within the occurrence and a minimum of 10 pairs within the occurrence and other occurrences within 20 km, C = 3+ pairs within the occurrence; if 5+ pairs then < 10 pairs within the occurrence and other occurrences within 20 km.
D = 1-2 pairs, U = Unknown. Not enough data to place in a range of 2 categories.

[3] BIR = Blackfoot Indian Reservation, GNP= Glacier National Park, LCNF = LewisClark National Forest.

Appendix B, Table 1, cont'd. Montana harlequin duck breeding and probable breeding occurrences, 1995.

Occurrence	Status	Rank	Watershed	Primary ownership
Boulder River	B	CB	Yellowstone River	GNF
Lake Fork Rock Creek	PRB	DC	Clarks Fork Yellowstone	CNF
Big Creek	B	D	Kootenai River	KNF
Callahan Creek	B	D	Kootenai River	KNF
includes Callahan Creek	BU			
North Fork Callahan Creek	B			
Grave Creek	B	C	Kootenai River	KNF
Kootenai Falls	H	U	Kootenai River	KNF
Quartz Creek	B	D	Kootenai River	KNF
Wigwam River	PRB	U	Kootenai River	KNF
West Fork Yaak River	B	DC	Yaak River	KNF
Middle Fork Rock Creek	B	DC	Rock Creek	DNF
Big Creek	PRB	D	North Fork Flathead River	FNF
Upper North Fork Flathead River	B	BC	North Fork Flathead River	GNP, FNF
Includes Kishenehn Creek	B			
Trail Creek	B			
McDonald Creek	B	AB	Middle Fork Flathead River	GNP, FNF
includes Avalanche Creek	B			
Mineral Creek	B			
Snyder Creek	PRB			
Sprague Creek	BU			
Fish Creek	PRB			
Middle Fork Flathead R. (lower)	B			
Middle Fork Flathead River	B	CD	Middle Fork Flathead River	FNF, GNP
includes Bear Creek	BU			
Ole Creek	BU			

[1] B = Breeding, PRB = Probable breeding, BU = Breeding status unknown.

[2] A = 20+ pairs within a single occurrence, B = 5 - 19 pairs within the occurrence and a minimum of 10 pairs within the occurrence and other occurrences within 40 km, C = 3+ pairs within the occurrence; if 5+ pairs then < 10 pairs within the occurrence and other occurrences within 40 km.
D = 1-2 pairs, U = Unknown. Not enough data to place in a range of 2 categories.

[3] CNF = National Forest, DNF = Deerlodge National Forest, FNF = Flathead National Forest, GNP= Glacier National Park, KNF = Kootenai National Forest.

Appendix B, Table 1, cont'd. Montana harlequin duck breeding and probable breeding occurrences, 1995.

Occurrence	Status	Rank	Watershed	Primary ownership
Upper South Fork Flathead River	B	BC	South Fork Flathead River	FNF
includes White River	B			
Little Salmon Creek	B			
Spotted Bear River	B	CD	South Fork Flathead River	FNF
Sullivan Creek	B	D	South Fork Flathead River	FNF
Wounded Buck Creek	B	D	South Fork Flathead River	FNF
Swift Creek	PRB	DC	Stillwater River (north)	MDSL
North Fork Blackfoot River	B	C	Blackfoot River	LNF
includes Dry Fork of North Fork Blackfoot	BU			
East Fork North Fork Blackfoot	BU			
Rattlesnake Creek	PRB	DC	Middle Clark Fork	LNF
Trout Creek	B	D	Middle Clark Fork	LNF
Elk Creek	PRB	D	Lower Clark Fork	KNF
Noxon	B	BA	Lower Clark Fork	KNF
includes Marten Creek	B			
South Fork Marten Creek	B			
South Branch Marten Creek	BU			
McNeeley Creek	BU			
Rock Creek	B			
East Fork Rock	BU			
West Fork Rock	BU			
Swamp Creek	B			
Vermilion River	B			

[1] B = Breeding, PRB = Probable breeding, BU = Breeding status unknown.

[2] A = 20+ pairs within a single occurrence, B = 5 - 19 pairs within the occurrence and a minimum of 10 pairs within the occurrence and other occurrences within 40 km, C = 3+ pairs within the occurrence; if 5+ pairs then <10 pairs within the occurrence and other occurrences within 40 km. D = 1-2 pairs, U = Unknown. Not enough data to place in a range of 2 categories.

[3] FNF = Flathead National Forest, MTSL= Montana Dept. of StateLands, KNF = Kootenai National Forest, LNF = Lolo National Forest.

Appendix B, Table 2. Montana streams where harlequin ducks have been observed or reported, but breeding status is unknown.

Stream	Watershed	Primary ownership[1]	No. surveys conducted
Otatso Creek includes Slide Lake	St. Mary River	GNP	0
Cut Bank Creek	Cut Bank Creek	BIR	0
South Fork Teton River	Teton River	LCNF	3
Upper Madison River	Madison River	GNF	0
Elk Creek includes East Fork Elk Creek West Fork Elk Creek	Upper Yellowstone River	GNF	1
Mill Creek	Upper Yellowstone River	GNF	1
Sweet Grass Creek	Upper Yellowstone River	GNF	0
Rock Creek includes West Fork Rock Creek	Clarks Forks Yellowstone	CNF	0
West Fork Stillwater	Stillwater River (south)	CNF	1
Lake Creek	Kootenai River	KNF	1
Seventeenmile Creek	Yaak River	KNF	5
Clearwater River	Blackfoot River	LNF	0
Willow Creek	Blackfoot River	HNF	0
Cache Creek	Middle Clark Fork	LNF	0
Twelvemile Creek	Middle Clark Fork	LNF	2
North Fork Flathead River (south of Trail Creek)	North Fork Flathead River	GNP, FNF	5
Red Meadow Creek	North Fork Flathead River	FNF	3
Whale Creek	North Fork Flathead River	FNF	5

[1] BIR = Blackfeet Indian Reservation, BNF = Bitterroot National Forest, CNF = Custer National Forest, FNF = Flathead National Forest, GNF= Gallatin National Forest, GNP = Glacier National Park, KNF = Kootenai National Forest, LCNF = Lewis Clark National Forest, LNF = Lolo National Forest.

Appendix B, Table 2 cont'd. Montana streams where harlequin ducks have been observed or reported, but breeding status is unknown.

Stream	Watershed	Primary ownership[1]	No. surveys conducted
Starvation Creek	North Fork Flathead River	GNP	0
Middle Fork Flathead River sections between and above known sites	Middle Fork Flathead River	GNP, FNF	3
Granite Creek	Middle Fork Flathead River	FNF	0
Lincoln Creek	Middle Fork Flathead River	GNP	1
Nyack Creek	Middle Fork Flathead River	GNP	0
Bunker Creek	South Fork Flathead River	FNF	5
South Fork Flathead River includes sections above reservoir not included in Appendix B, Table 1.	South Fork Flathead River	FNF	5
Jocko River	Lower Flathead River	FIR	0
Stillwater River	Stillwater River (northern)	MDSL KNF	4
Bull River upper streaches of major forks	Lower Clark Fork	KNF	1-3
Deep Creek	Lower Clark Fork	LNF	0
Fishtrap Creek	Lower Clark Fork	LNF	5
Graves Creek	Lower Clark Fork	LNF	9
White Pine Creek	Lower Clark Fork	KNF	1

[1] BIR = Blackfeet Indian Reservation, BNF = Bitterroot National Forest, CNF = Custer National Forest, FNF = Flathead National Forest, GNF= Gallatin National Forest, GNP = Glacier National Park, KNF = Kootenai National Forest, LCNF = Lewis Clark National Forest, LNF = Lolo National Forest.

Appendix B. Table 3. Partial list of potential harlequin duck breeding streams in Montana.

Stream	Watershed	Primary ownership[1]	No. surveys conducted
Sherburne River	St. Mary River	GNP	0
Middle Fork Teton River	Teton River	LCNF	0
Pattengail Creek	Wise River	BNF	0
West Fork Madison River	Madison River	GNF	1
Taylor Fork Gallatin River	Gallatin River	GNF	1
Upper Boulder River	Boulder River	DNF	0
Milk River (upper forks)	Milk River	BIR	0
West Fork Teton River	Teton River	LCNF	1
Dearborn River (& forks)	Dearborn/Missouri Rivers	LCNF	3
Forks of Boulder River	Upper Yellowstone River	GNF	2-4
Hellroaring Creek	Upper Yellowstone River	GNF	0
Slough Creek	Upper Yellowstone River	GNF	0
Big Creek	Upper Yellowstone River	GNF	1
Rock Creek	Upper Yellowstone River	GNF	0
Rosebud Creek	Stillwater River (south)	CNF	2
Stillwater River (& forks)	Stillwater River (south)	CNF	4
South Fork Callahan Creek	Kootenai River	KNF	4
Keeler Creek	Kootenai River	KNF	2
Fish Creek (& forks)	Middle Clark Fork River	LNF	0
Anaconda Creek	North Fork Flathead River	GNP	0
Bowman Creek	North Fork Flathead River	GNP	1
Camas Creek	North Fork Flathead River	GNP	0
Kintla Creek	North Fork Flathead River	GNP	2

[1] BIR = Blackfeet Indian Reservation, BNF = Bitterroot National Forest, CNF = Custer National Forest, FNF = Flathead National Forest, GNF= Gallatin National Forest, GNP = Glacier National Park, KNF = Kootenai National Forest, LCNF = Lewis Clark National Forest, LNF = Lolo National Forest.

Appendix B. Table 3, cont'd. Partial list of potential harlequin duck breeding streams in Montana.

Stream	Watershed	Primary ownership[1]	No. surveys conducted
Quartz Creek	North Fork Flathead River	GNP	0
Coal Creek	Middle Fork Flathead River	GNP	0
Dolly Varden Creek	Middle Fork Flathead River	FNF	2
Morrison Creek	Middle Fork Flathead River	FNF	1
Park Creek	Middle Fork Flathead River	GNP	0
Schafer Creek	Middle Fork Flathead River	FNF	2
Bunker Creek	South Fork Flathead River	FNF	5
Trout Creek	Lower Clark Fork River	KNF	3

[1] FNF = Flathead National Forest, GNP = Glacier National Park, KNF = Kootenai National Forest.

Appendix C, Table 1. Wyoming harlequin duck breeding and probable breeding occurrences, 1995.

Stream	Status[1]	Rank[2]	Watershed	Primary ownership[3]
Berry Creek	B	B	Snake River	GTNP
includes Moose Creek	B			
Owl Creek	B			
Cascade Creek	B	C	Snake River	GTNP
includes Leigh Creek	B			
Moran Creek	BU			
Granite Creek	B			
Teton Creek	B		Teton River	TNF
Darby Creek	B		Teton River	TNF
Crandall Creek	B	D	Clarks Fork of the	SNF
includes N. Fork Crandall Creek	B		Yellowstone River	
S. Fork Crandall Creek	B			
Lake Creek	PRB			
Torrey Creek	PRB	D	Wind River	SNF
includes West Torrey Creek	PRB			
Yellowstone River	B	AB	Yellowstone River	YNP
includes Hellroaring Creek	B			
Tower Creek	B			
Lamar River	PRB			
Soda Butte Creek	B			
Gardner River	PRB			
Mountain Ash Creek	B	D	Falls River	YNP
Pole Creek	B	D	Green River	BTNF
Fremont Creek	B	D	Green River	BTNF

[1] B = Breeding, PRB = Probable breeding, BU = Breeding status unknown.

[2] A = 20+ pairs within a single occurrence, B = 5 - 19 pairs within the occurrence and a minimum of 10 pairs within the occurrence and other occurrences within 40 km, C = 3+ pairs within the occurrence; if 5+ pairs then <10 pairs within the occurrence and other occurrences within 40 km.
D = 1-2 pairs, U = Unknown. Not enough data to place in a range of 2 categories.

[3] SNF = Shoshone National Forest, BTNF = Bridger-Teton National Forest, YNP = Yellowstone National Park, GTNP = Grand Teton National Park

Appendix C, Table 2. Wyoming streams where harlequin ducks have been observed or reported but breeding status is unknown.

Stream	Watershed	Primary ownership[1]	No. surveys conducted
Upper Wind River	Wind River	SNF	1
North Fork Shoshone River	Shoshone River	SNF	2
Muddy Creek	Clarks Fork of the Yellowstone River	SNF	1
Rock Creek	Clarks Fork of the Yellowstone River	BLM	1
South Fork Owl Creek	Big Horn River	SNF	1
Greybull River	Big Horn River	SNF	1
Pine Creek	Green River	BTNF	0
Greys River	Snake River	BTNF	0
Salt River	Snake River	BTNF	0
S. Fork Buffalo River	Snake River	BTNF	0
Upper Yellowstone River includes Thorofare Creek Pacific Creek Atlantic Creek	Yellowstone River	BTNF/YNP	1 Partial
String Lake outlet	Snake River	GTNP	28
Upper Snake River above Jackson Lake	Snake River	GTNP/YNP	1 Partial
Others[2]		YNP	

[1] BLM = Bureau of Land Management, BTNF = Bridger-Teton National Forest, GTNP = Grand Teton National Park, SNF = Shoshone National Forest, YNP = Yellowstone National Park

[2] Four additional streams are located within Yellowstone National Park but the locations are regarded as sensitive information.

Appendix C, Table 3. Partial list of potential harlequin duck breeding streams in Wyoming.

Stream	Watershed	Primary ownership[1]	No. surveys conducted
Middle Fork Popo Agie River	Popo Agie River	SNF	1
North Fork Popo Agie River	Popo Agie River	SNF	1
Smith Lake Creek	Popo Agie River	SNF	0
Warm Spring Creek	Wind River	SNF	1
Jackey's Fork	Wind River	SNF	1
Dinwoody Creek	Wind River	SNF	1
West Dunoir Creek	Wind River	SNF	1
Brooks Lake Creek	Wind River	SNF	1
South Fork Shoshone River	Shoshone River	SNF	1
Grinnell Creek	Shoshone River	SNF	1
Bear Creek	Shoshone River	SNF	1
Eagle Creek	Shoshone River	SNF	1
Elk Fork	Shoshone River	SNF	1
Anderson Creek	Big Horn River	SNF	1
Clarks Fork of theYellowstone River	Clarks Fork of the Yellowstone River	SNF	0
Closed Creek	Clark Fork	SNF	0
Timber Creek	Clark Fork	SNF	0
Buffalo Fork Snake River	Snake River	BTNF	
includes North Fork			0
Soda Fork			0
Spread Creek	Snake River	BTNF	0
Flat Creek	Snake River	BTNF	0
Crystal Creek	Snake River	BTNF	0

1 - SNF= Shoshone National Forest, BTNF = Bridger-Teton National Forest, TNF = Targhee National Forest
2 - Seven streams located within Yellowstone National Park are considered potential habitat for harlequin ducks but have not been surveyed yet.

Appendix C, Table 3, cont'd. Partial list of potential harlequin duck breeding streams in Wyoming.

Stream	Watershed	Primary ownership[1]	No. surveys conducted
Slate Creek	Snake River	BTNF	0
Clear Creek	Snake River	BTNF	0
Cottonwood Creek	Snake River	BTNF	0
Fish Creek	Snake River	BTNF	
includes N. Fork Fish Creek			0
S. Fork Fish Creek			0
Upper Gros Ventre River	Snake River	BTNF	0
Mosquito Creek	Snake River	BTNF	0
Cliff Creek	Hoback River	BTNF	0
Willow Creek	Hoback River	BTNF	0
Upper Hoback River	Hoback River	BTNF	0
Bailey Creek	Snake River	BTNF	0
Little Grey's River	Greys River	BTNF	0
Smith Fork	Smith Fork	BTNF	0
Hamms Fork	Hamms Fork	BTNF	0
Upper Green River	Green River	BTNF	0
New Fork River	Green River	BTNF	0
Boulder River	Green River	BTNF	0
Moose Creek	Teton River	TNF	1
South Leigh Creek	Teton River	TNF	4
Bitch Creek	Teton River	TNF	
includes N. Fork Bitch Creek			4
S. Fork Bitch Creek			4
Badger Creek	Teton River	TNF	2
Others[2]			

1 - SNF= Shoshone National Forest, BTNF = Bridger-Teton National Forest, TNF = Targhee National Forest
2 - Seven streams located within Yellowstone National Park are considered potential habitat for harlequin ducks but have not been surveyed yet.

Appendix D, Table 1. Minimum number harlequin duck pairs on streams monitored in Idaho, 1989-1994 (Atkinson and Atkinson 1990, Atkinson 1991,Cassirer and Groves 1990, Cassirer and Groves 1994, Cassirer 1995a, Cassirer 1995b, Maj and Whitfield 1995).

Stream	1989	1990	1991	1992	1993	1994	1995
Granite Creek (Priest Lake)	3	2	2	3	-	-	3
Gold Creek (Priest Lake)	-	2	2	4	-	-	1
Upper Priest River	-	4	2	3	-	-	-
Hughes Fork	-	5	4	2	-	-	1
Granite Creek (L. Pend Oreille)	-	-	2	1	0	-	1
Gold Creek (L. Pend Oreille)	-	2	4	4	2	-	2
Moyie River	-	2	-	-	1	2	2
Smith Creek	-	0	-	-	-	0	-
Boundary Creek	-	0	-	-	1	0	-
Marble Creek	-	1	1	-	-	-	-
Big Elk Creek	1	2	0	-	-	-	1

Appendix D, Table 2. Minimum number harlequin duck pairs on streams monitored in Grand Teton National Park, Wyoming 1985 - 1994 (Wallen 1987, 1991, unpubl. data).

Stream	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Upper Berry Creek	1	2	2	1	2	3	2	3	1	3	3
Upper Moose Creek	4	6	1	2	3	2	3	4	4	2	3
Berry/Moose Cr. Delta	5	3	3	2	2	1	2	4	2	2	4
Cascade Creek	3	2	1	2	2	2	1	2	2	2	1
Granite Creek	2	1	-	-	-	-	-	-	-	-	-
Total (Berry, Moose, Cascade, and Delta)	13	13	7	7	9	8	8	13	9	9	11

Appendix D, Table 3. Minimum number harlequin duck pairs on streams monitored in Wyoming outside Grand Teton National Park, 1989 - 1995 (Atkinson and Atkinson 1990, Atkinson 1991, Maj and Whitfield 1995).

Stream	1989	1990	1991	1992	1993	1994	1995
Teton Creek	-	1	1	-	-	-	0
Darby Creek	-	1	0	-	-	-	0

Appendix D, Table 4. Minimum number harlequin duck pairs on streams monitored in Montana outside Glacier National Park, 1988 - 1995). (Carlson 1990; Diamond and Finnegan 1993, 1994; Fairman, Jones and Genter 1989; Fairman and Miller 1990; Gangemi 1991; Johnson 1991; Kerr 1989; Lee and Genter 1991; Markum 1990; Merz 1991; Miller 1988, 1989; Reichel and Genter 1993, 1994, 1995).

Stream	1988	1989	1990	1991	1992	1993	1994	1995
Marten Creek	2[1]	2[1]	2[1]	5	5	5	5	5
Rock Creek	0[1]	1[1]	0[1]	1[1]	0[1]	2	3	1[1]
Swamp Creek	0	2	2	2	2	2	1	3
Vermilion River	4	2	3	2	1	3	2	2
Trail Creek	-	0[1]	5	5	4	6	4	6
Spotted Bear Creek	-	-	0[1]	3	2	1	3	2
Sullivan Creek	-	-	1[1]	2	2	0	2	2
Big Creek (Koocanusa)	-	0	1	-	-	0	0	0
Callahan Creek	-	1	1	-	-	0	-	1
Graves Creek (Fortine)	-	2	2	-	-	0[1]	4	4
Little Salmon	-	-	-	1	2	-	1	-
Trout Creek (Superior)	-	1	1	-	0	0	-	0
White River	-	-	-	-	3	-	4	-
S. Fork Sun River	-	-	-	3	6	-	2	-
W. Fork Sun River	-	-	-	2	4	-	10	-
Badger Creek	-	-	-	1	4	4	-	3
Birch Creek	-	-	-	2	2	2[1]	-	7

[1] Incomplete or poorly timed surveys.

Appendix D, Table 5. Minimum number of harlequin duck pairs on McDonald Creek, Glacier National Park, Montana, 1974 - 1995 (Kuchel 1974, Ashley 1992, 1994a, 1994b).

Stream	1974	1975	1990	1991	1992	1993	1994	1995
McDonald Creek	11	14	4[1]	14	4[1]	17	12	21[2]

[1] Incomplete or poorly timed surveys.
[2] Estimate from observations of marked birds, maximum of 12 pairs seen on a single survey.

APPENDIX E. INVENTORY AND MONITORING PROTOCOL FOR HARLEQUIN DUCKS

These inventory and monitoring guidelines are based on data collected in Idaho, Montana, and Wyoming breeding areas. Breeding chronology of harlequin ducks varies by area, for instance harlequin duck arrival and breeding activities in Grand Teton National Park, Wyoming occur 2 - 4 weeks later than in northern Idaho (Wallen 1987, Cassirer and Groves 1994). Therefore, this protocol is only specifically applicable to the area it was developed, and other areas where similar breeding chronology has been documented.

Monitoring

A rotational survey design (Skalski 1990, 1995) has been selected for monitoring harlequin duck pair numbers and productivity in the U.S. Rocky Mountains. All harlequin duck breeding streams and probable breeding streams that can reasonably be surveyed are incorporated in this survey design. Streams currently of unknown status should be added to this list in the future if inventory efforts reveal they are harlequin duck breeding streams. Selected "bellwether" streams are monitored on an annual basis (Table 1). These streams were selected based on relative accessibility, consistence of harlequin duck use, and distribution throughout the Rocky Mountain breeding range. A minimum of 25% of the remaining breeding or probable breeding streams in the subprovince (Table 2) are randomly selected and surveyed on a rotational basis. Monitoring should be conducted whether or not any management activites are scheduled in the area.

A population estimate is derived by combining the actual number observed during pair surveys on the "bellwether" streams" and nonbellwether "rotational" streams. The number of pairs observed on the "bellwether" streams is summed and the average number observed on the rotational streams is applied to all remaining breeding or probable breeding streams (Skalski 1995).

$$\hat{N}_T = r\bar{N}_r + (M - r)\bar{N}_p$$

where M = the total number of breeding streams.
N = the number of pairs observed.
r = the number of bellwether streams surveyed every year.
p = the number of nonbellwether (rotational) streams surveyed every year.

It should be noted, however, that this population estimate is an index, but likely underestimates the true population size because of the observability of harlequin ducks (see pair surveys under survey methodology).

Variance is estimated assuming a total count on the bellwether streams, and a variance estimate for observations on the rotational streams.

$$Var\ (\hat{N}_T) = (M - r)^2(1/p\text{-}1/M - r)S^2$$

where

$$s^2 = \frac{\sum_{j=1}^{p} (Np_j - \bar{Np})^2}{(p\text{-}1)}$$

Inventory

Inventory should be conducted on streams where harlequin ducks have been observed but breeding status is unknown and on streams which are potentially suitable harlequin duck habitat (see conservation assessment), including those listed in Appendices B and D, Table 3. On streams where breeding status is unknown, a minimum of 4 surveys, 3 of which are pair surveys, should be conducted over a period of 3 or more years prior to determining stream status. On streams which are potential habitat, but where no ducks have been observed, at least 4 surveys should be conducted over 2 years, including at least 2 pair surveys, prior to determing stream status. However, if a brood or nest is observed at any time during surveys, the stream will be classified as a breeding stream.

Survey Methodology

Timing is critical for both inventory and monitoring surveys. Timing is probably the most important factor in survey success. For this reason, most surveys must be conducted specifically for harlequin ducks, rather than in combination with fish or other wildlife surveys. Survey are conducted during two periods: spring pair surveys and summer brood surveys.

Pair surveys

In the northern Columbia Basin and Rocky Mountain Front subprovinces, spring pair surveys should be conducted between 25 April and 25 May. In the Intermountain subprovince spring pair surveys should be conducted between 5 May and 15 June. Although these are the periods when pairs are most likely to be observed, even when conducted during this period, surveys underestimate the actual number of pairs present by an average of 31 percent (Cassirer and Groves 1994). Because count accuracy can be variable, at 2 surveys should be conducted during this period for monitoring purposes. The survey with the highest number of ducks should be used for monitoring estimates.

Brood surveys

Brood surveys conducted for monitoring purposes should occur between 15 July and 5 August in the northern Columbia Basin subprovince and between 1 August and 21 August in the Intermountain subprovince. Although ducklings hatch several weeks prior to these dates in both subprovinces, because of mortality rates typically occurring in young ducklings, surveys conducted during this period give a more accurate estimate of ducklings fledged. Ducklings should be aged by plumage development (Fig. 1) during brood surveys. Inventory surveys for presence only can be conducted as early as 1 July in the northern Columbia Basin and as early as 15 July in the Intermountain subprovince.

Inventory surveys should cover the entire stream from 2nd- or 3rd-order headwaters to the mouth. Inventory of this area should be conducted during the spring, and again during the summer, (or until ducks are observed, whichever is first) for at least 2 years before determining stream status. Therefore, inventory should be an ongoing program, not simply associated with proposed management activities.

Little specialized equipment is required for harlequin duck surveys. Some equipment that may be useful is:

8 to 10 power waterproof binoculars
Felt-soled wading boots
Neoprene stocking foot chest waders

Surveys can be conducted during any weather and at any time of day. Surveyors should use binoculars as much as practical, particularly in long, straight stream reaches. Harlequin ducks are commonly observed sitting on instream rocks or on the streambank, swimming or feeding in the middle of the stream, or paddling along the bank eddy. In the spring, the male is usually spotted first. Look carefully for the female nearby, the white spot on the side of her head is usually her most conspicuous feature. Both the male and female appear dark in flight, with no white markings on the underside of the wings.

Surveys can be conducted on foot, by boat, or by driving next to the stream. Walking is the best way to survey most streams. Walking surveys can be conducted in an up- or downstream direction. It is easier to survey downstream, however the ducks will not swim as quickly upstream as they float downstream, they are more observable when surveys are conducted going upstream. Also keep in mind the direction of the sun; observability can be greatly reduced on surveys conducted in the direction of the sun. If a road is available, use a crew of at least 2 people. Drop 1 person off at the beginning of the survey reach, a second person drives to a midpoint, preferably where the truck is visible from the stream or at a bridge or trail crossing, and walks to the end of the survey reach. After ducks are observed move off the stream to walk around them. When surveys are conducted in a downstream direction, you can often get closer to the ducks by making a wide circle around to get below them and approach from downstream. Count on covering about 1 mile per hour in spring surveys and 1.5 miles per hour in summer surveys. Because the ducks are mobile, enough people should be surveying to cover the entire stream in 1 day.

Boating is a very good way to survey, especially in the spring. Rafts or drift boats are best, because 1 person can row while 1 or 2 passengers look for ducks. Fifteen to 20 miles of stream is a reasonable distance to cover by boat in a day, but distance covered will vary with water conditions and access. Kayaking is also a good survey method and may be the only way to cover some streams at certain times of year. Depending on the stream and season, kayakers should be comfortable running class IV or V water and should also be familiar with harlequin ducks. Inner tubes may be used in summer surveys when the water is too low for boating but too deep or swift for walking. A wet suit or neoprene chest waders are usually necessary when inner tubing, even in warm weather.

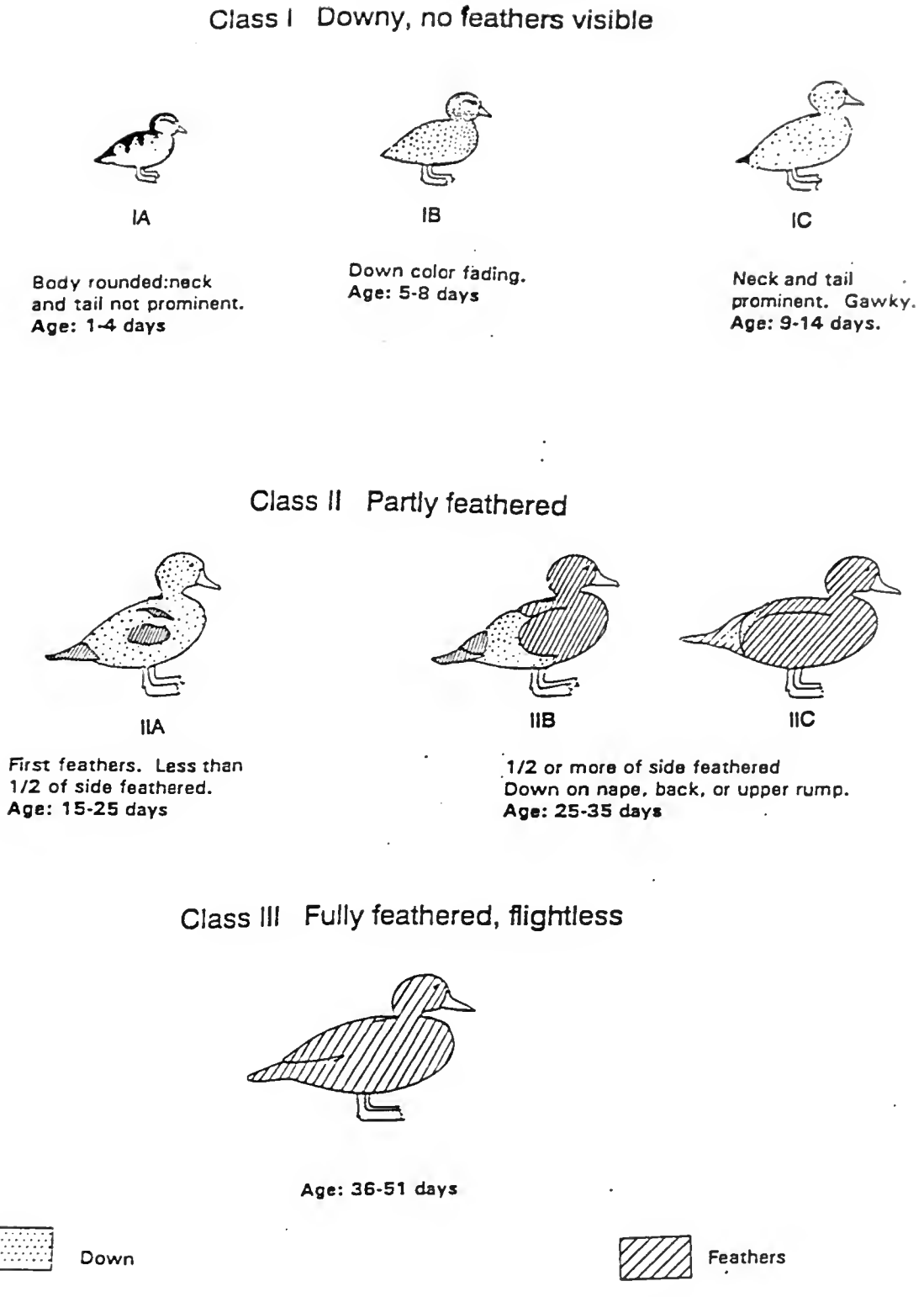
Driving surveys can be conducted by 2 people along roads that closely follow the stream. Drive slowly with the observer in the passenger side of the vehicle next to the stream or in the back of a pickup. Check areas where the stream is not in full view of the road on foot.

The spring pair survey period coincides with peak spring runoff in the Rocky Mountains. Therefore walking surveys of all but the smallest streams will usually be conducted by hiking along the streambank. Surveyors should be prepared for inclement weather and snow. If roads are not plowed, snowmachines may be necessary to get to survey areas. Camping out may be required to cover the upper reaches of some streams.

Streams will be relatively low during brood surveys and walking surveys can be conducted by a combination of wading in the stream and walking along the bank. Felt-soled boots with neoprene socks and wool socks are recommended for walking in the stream. Stocking foot chest waders with felt-soled boots may be useful in cooler weather or higher water.

Data Collection

Record data on a standardized form (Table 3), and enter the information into a computer data base. Please send copies of all inventory and monitoring data, even when no ducks are observed, as well as observation reports to the appropriate Conservation Data Center or Natural Heritage Program.



Appendix E, Fig. 1. Guide to aging harlequin ducklings in the field (Cassirer and Groves 1994, from diagram in Dimmick and Pelton 1994:173, after Gollop and Marshall 1954).

Appendix E, Table 1. Rocky Mountain streams to monitor annually for harlequin ducks.

Stream	State[1]	Watershed	Primary ownership[2]	Monitoring group[3]
Gold Creek	ID	Lake Pend Oreille	IPNF	CB
Granite Creek	ID	Lake Pend Oreille	IPNF	CB
Granite Creek	ID	Priest River	IPNF	CB
Middle Fork East River	ID	Priest River	IPNF	CB
Moyie River	ID	Kootenai River	IPNF	CB
St. Joe River	ID	St. Joe River	IPNF	CB
Lochsa River	ID	Clearwater River River	CNF	CB
Trail Creek	MT	N. Fork Flathead River	FNF	CB
McDonald Creek	MT	Middle Fork Flathead R.	GNP	CB
Spotted Bear River	MT	S. Fork Flathead River	FNF	CB
Marten Creek	MT	Lower Clark Fork River	KNF	CB
Rock Creek	MT	Lower Clark Fork River	KNF	CB
S. Fork/ W. Fork Sun River, Straight Creek, Ahorn Creek	MT	Sun River	LCNF	CB
Big Elk Creek	ID	Snake River (Palisades Reservoir)	TNF	INT
Darby Creek	WY	Snake River (Palisades Reservoir)	TNF	INT
Teton Creek	WY	Teton River	TNF	INT
Berry Creek	WY	Snake River (Jackson L.)	GTNP	INT
Moose Creek	WY	Snake River (Jackson L.)	GTNP	INT
Cascade Creek	WY	Snake River (Jackson L.)	GTNP	INT
Yellowstone River	WY	Yellowstone River	YNP	INT
Boulder River	MT	Upper Yellowstone River	GNF	INT

1 ID = Idaho, WY = Wyoming, MT = Montana.

2 IPNF = Idaho Panhandle National Forests, CNF = Clearwater National Forest, TNF = Targhee National Forest, LCNF = Lewis-Clark National Forest, KNF = Kootenai National Forest, LNF = Lolo National Forest, FNF = Flathead National Forest, GNF = Gallatin National Forest, GNP = Glacier National Park, GTNP = Grand Teton National Park, HNF = Helena National Forest YNP = Yellowstone National Park.

3 CB = Columbia Basin, INT = Intermountain.

Appendix E, Table 2. Rocky Mountain streams to monitor on a rotational basis for harlequin ducks.

Stream	State[1]	Watershed	Primary ownership[2]	Monitoring group[3]
Gold Creek, Priest L.	ID	Upper Priest River	IPNF	CB
Upper Priest River	ID	Upper Priest River	IPNF	CB
Hughes Fork	ID	Upper Priest River	IPNF	CB
East Fork Lightning Creek	ID	Lake Pend Oreille	IPNF	CB
N. Fork Coeur d'Alene River	ID	N. Fork Coeur d'Alene R.	IPNF	CB
Marble Creek	ID	St. Joe River	IPNF	CB
Little N. Fork Clearwater R.	ID	N. Fork Clearwater River	IPNF	CB
North Fork Clearwater River	ID	N. Fork Clearwater River	CNF	CB
Selway River	ID	Clearwater River	NPNF	CB
White Sands Creek	ID	Lochsa River	CNF	CB
Long Canyon Creek	ID	Kootenai River	IPNF	CB
Smith Creek	ID	Kootenai River	IPNF	CB
N. Fork Big Creek	ID	Pahsimeroi River	CHNF	INT
Granite Creek	WY	Snake River	GTNP	INT
Boundary Creek	MT	Waterton River	FNF	CB
Olson Creek	MT	Waterton River	FNF	CB
Waterton River	MT	Waterton River	FNF	CB
Kootenai Lakes includes Olson Creek Waterton River S. end Waterton Lake	MT	South Saskatchewan River	GNP	CB
Belly River	MT	St. Mary River	GNP	CB
Red Eagle Creek	MT	St. Mary River	GNP	CB
North Fork Sun River	MT	Sun River	LCNF	CB
Moose Creek	MT	Sun River	LCNF	CB

1 ID = Idaho, WY = Wyoming, MT = Montana.

2 IPNF = Idaho Panhandle National Forests, CNF = Clearwater National Forest, TNF = Targhee National Forest, LCNF = Lewis-Clark National Forest, KNF = Kootenai National Forest, LNF = Lolo National Forest, FNF = Flathead National Forest, GNF = Gallatin National Forest, GNP = Glacier National Park, GTNP = Grand Teton National Park, HNF = Helena National Forest YNP = Yellowstone National Park.

3 CB = Columbia Basin, INT = Intermountain.

Appendix E, Table 2, cont'd. Rocky Mountain streams to monitor on a rotational basis for harlequin ducks.

Stream	State[1]	Watershed	Primary ownership[2]	Monitoring group[3]
Badger Creek	MT	South Marias River	LCNF	CB
Birch Creek	MT	South Marias River	LCNF	CB
South Fork Two Medicine River	MT	South Marias River	LCNF	CB
N. Fork Teton River	MT	Teton River	LCNF	CB
Lake Fork Rock Creek	MT	Clarks Fork Yellowstone R.	CNF	INT
Grave Creek	MT	Kootenai River	KNF	CB
Big Creek	MT	Kootenai River	KNF	CB
Callahan Creek	MT	Kootenai River	KNF	CB
Kootenai Falls	MT	Kootenai River	KNF	CB
Quartz Creek	MT	Kootenai River	KNF	CB
N. Fork Blackfoot River	MT	Blackfoot River	KNF	CB
Rattlesnake Creek	MT	Middle Clark Fork River	LNF	CB
Trout Creek	MT	Middle Clark Fork River	LNF	CB
Big Creek	MT	N. Fork Flathead River	FNF	CB
Kishenehn Creek	MT	N. Fork Flathead River	FNF	CB
Middle Fork Flathead R.	MT	Middle Fk. Flathead R.	FNF/GNP	CB
Little Salmon Creek	MT	S. Fork Flathead River	FNF	CB
S. Fork Flathead River	MT	S. Fork Flathead River	FNF	CB
White River	MT	S. Fork Flathead River	FNF	CB
Wounded Buck Creek	MT	S. Fork Flathead River	FNF	CB
Vermilion River	MT	Lower Clark Fork River	KNF	CB
Elk Creek	MT	Lower Clark Fork River	LNF	CB
Swamp Creek	MT	Lower Clark Fork River	LNF	CB

1 ID = Idaho, WY = Wyoming, MT = Montana.

2 IPNF = Idaho Panhandle National Forests, CNF = Clearwater National Forest, TNF = Targhee National Forest, LCNF = Lewis-Clark National Forest, KNF = Kootenai National Forest, LNF = Lolo National Forest, FNF = Flathead National Forest, GNF = Gallatin National Forest, GNP = Glacier National Park, GTNP = Grand Teton National Park, HNF = Helena National Forest YNP = Yellowstone National Park.

3 CB = Columbia Basin, INT = Intermountain.

Appendix E, Table 3. Data form for harlequin duck surveys.

HARLEQUIN DUCK SURVEY FORM

Surveyors' names:_____

Address:_____

Date:_____ Time start:_____ Time end:_____

Stream name:_____

Start location:_____

End location:_____

Distance (km):_____

Type of survey (walk, boat, drive):_____

Observations/comments:_____

Harlequin duck observations

Note: Idaho, Montana, Wyoming and several coastal states and provinces have marked harlequin ducks. Colored nasal markers on the bill, and colored, numbered, and metal legbands on both legs are being used. Please check for marks on all harlequins and include a detailed description of any observed.

Time:_____ Number:_____ Sex:_____ Age class:_____

Location: UTMN_____ UTME_____

T_____ R_____ S_____ 1/4_____

Activity/comments:_____

Time:_____ Number:_____ Sex:_____ Age class:_____

Location: UTMN_____ UTME_____

T_____ R_____ S_____ 1/4_____

Activity/comments:_____

Time:_____ Number:_____ Sex:_____ Age class:_____

Location: UTMN_____ UTME_____

T_____ R_____ S_____ 1/4_____

Activity/comments:_____