BREEDING ECOLOGY OF HARLEQUIN DUCKS (*Histrionicus histrionicus*) ON THE KANIKSU NATIONAL FOREST, IDAHO

by

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SUMMARY

During the summer of 1989, harlequin ducks were observed or reported on six tributaries to Priest Lake and Upper Priest Lake, three streams on the Sandpoint Ranger District (RD), and three streams on the Bonner's Ferry RD of the Kaniksu National Forest. A minimum of 20 adults were observed on the Priest Lake RD, and at least eight nearly fledged ducklings were produced on the Priest Lake RD and at least six were produced on the Sandpoint RD.

Harlequins appear to use streams on the Kaniksu National Forest primarily between April and September. During 1989, egglaying on the Upper Priest River was estimated to occur between May 14 and June 5, incubation between May 25 and July 2. Males were not observed on breeding areas after the end of May.

Pair density during the egglaying and nesting period was .25/km on Granite Creek and the North Fork of Granite Creek, and .15 pairs/km on the Hughes Fork. Average brood sizes just prior to and just after fledging were 4.67, survival to just before fledging on the Upper Priest River appeared to be 80%. Two of four class III broods observed on the Priest Lake Ranger District during 1988 and 1989 were unaccompanied by a hen. Ducklings appeared to take about 62 days to fledge during 1989.

Eleven adults and thirteen ducklings were trapped and marked during 1989. Males were larger than females, and females trapped in July weighed significantly less than females trapped in May. One of two pairs marked on the Priest Lake Ranger District in 1988 was observed again in 1989. This pair exhibited site and mate fidelity. Harlequin ducks marked on Gold Creek and the St. Joe River in 1988 were not reobserved in 1989.

In general, adult harlequin ducks were observed in fast flowing water with one or more loafing sites within 10 m, shrub or timber/shrub mosaic vegetation on the banks, and away from human activity. Adult harlequin ducks appeared to use much of the Upper Priest River, but, during 1989, nesting appeared to be confined to a stretch two to four kilometers below Upper Priest Falls. Broods were observed in reaches away from human activity in relatively slow water, with woody debris in the stream. Young broods used the upper sections of the river with dense shrub vegetation over six feet tall. Broods moved downstream and used more diverse habitats over the course of the summer. Low macroinvertebrate biomass could limit the number of harlequin ducks the Upper Priest River can support.

Recommendations include avoiding human disturbance of harlequin ducks during spring and summer, and maintaining woody debris, healthy macroinvertebrate populations, and riparian vegetation in and adjacent to streams. Baseline work on the Upper Priest River should continue, and habitat work should be expanded to other streams. Macroinvertebrate sampling is recommended for all streams used by harlequin ducks.

INTRODUCTION

The Idaho Panhandle National Forest contains some of the best harlequin duck habitat in northern Idaho (Wallen and Groves 1989). Harlequin ducks use streams on the Panhandle Forest for breeding, nesting and brood rearing during the summer. They are a relatively rare summer resident on these streams and have been designated a "sensitive species" by the U.S. Forest Service and a "species of special concern" by the Idaho Department of Fish and Game. Information on the breeding ecology of harlequin ducks in Idaho is available in Wallen and Groves (1988, 1989). Harlequin duck breeding ecology has also been studied in Alaska (Dzinbal 1982), Glacier National Park (Kuchel 1977), Grand Teton National Park (Wallen 1987), and Iceland (Bengston and Ulfstrand 1971, Bengston 1972).

The summer of 1989 was the third consecutive summer of work on harlequin ducks on the Idaho Panhandle National Forest. The first two summers consisted of extensive surveys conducted by Wallen and Groves (1988, 1989). They obtained information on distribution, chronology and habitat use, but recommended more intensive study to provide better information on these parameters in order to make specific management recommendations for this species. They identified the Kaniksu National Forest as having potentially the largest population of harlequin ducks in northern Idaho, and described the Upper Priest River drainage as providing the best harlequin duck habitat in northern Idaho. They recommended the Upper Priest River drainage for an intensive study of harlequin duck breeding ecology. The summer of 1989 was

the first year of concentrated study of harlequin ducks on the Kaniksu National Forest in general and the Priest Lake Ranger District (RD) in particular.

OBJECTIVES

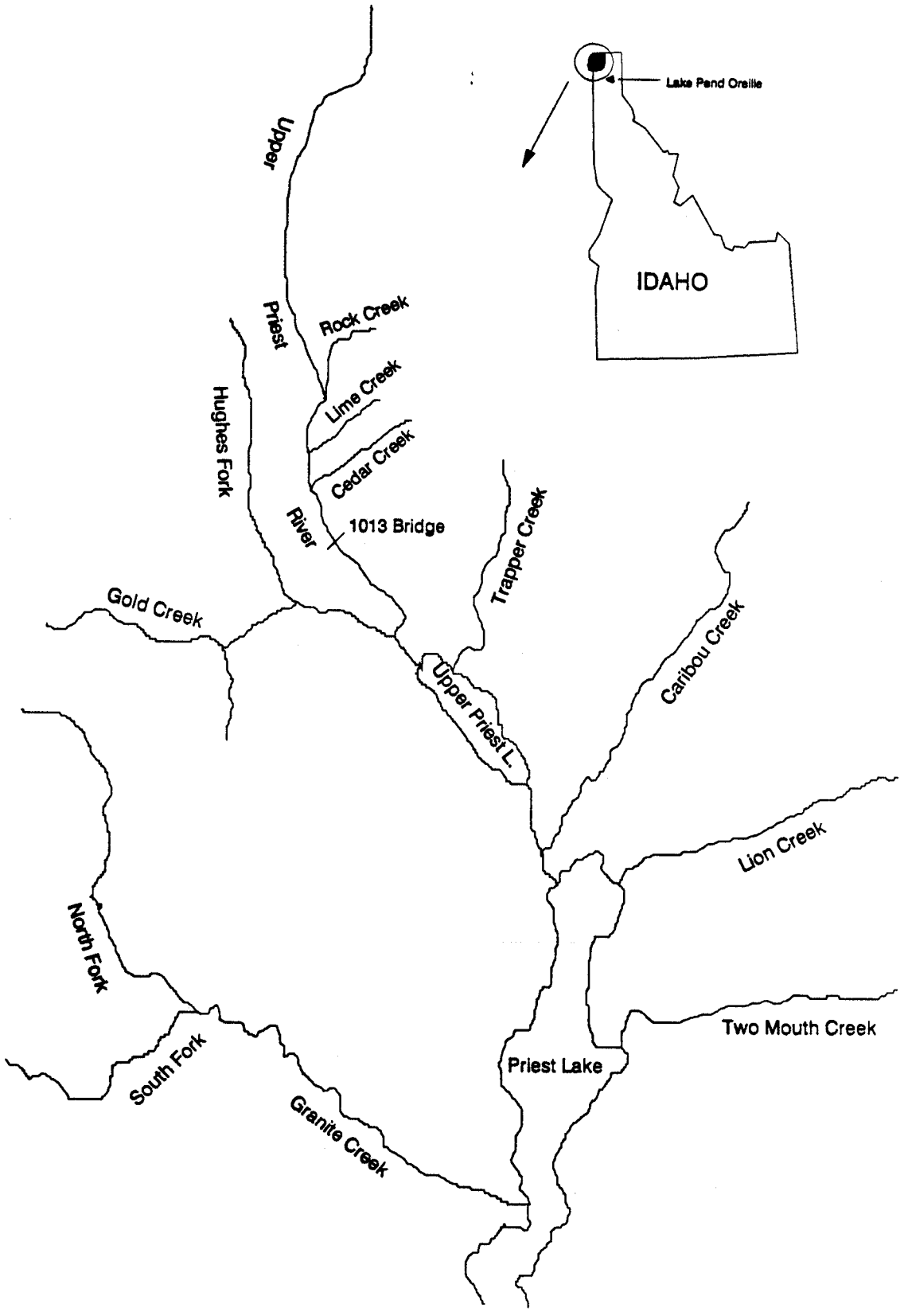
The general objectives of this project were to study the distribution and movements, assess habitat use, and estimate the productivity of harlequin ducks on the Kaniksu National Forest, particularly on the Priest Lake RD. The specific objective of the habitat use portion of this project was to characterize brood rearing habitat, and to examine the availability of these characteristics on the Upper Priest River.

STUDY AREA

The Kaniksu National Forest is composed of several disjunct areas located in northern Idaho and northeastern Washington, and bordering Montana and Canada. The Priest Lake Ranger District is located in the northeastern part of the Forest adjacent to Canada and includes a portion of northeastern Washington (Figure 1). The climate is northern continental with a pacific maritime influence. Annual precipitation averages 817 mm (32 in), about 60% of which occurs primarily as snow from November through March. Summer is relatively warm and sunny but short, occurring essentially in July (mean temp 65^{o}) and August (mean temp 63^{o}) (Finklin 1983).

The Upper Priest River is located on the northern portion of

Figure 1. Location of areas on the Kaniksu National Forest surveyed for harlequin ducks, summer 1989.



the Priest Lake RD. Most of the approximately 32 km of the river on the district have been proposed for federal "wild and scenic" designation. A trail follows along the river bottom above the outlet to the Upper Priest Lake to the 103 bridge, and above Lime Creek to Upper Priest Falls, but rarely comes within 50 m of the river. Road 1013 travels above the river and is only within view of the river when it crosses over a bridge about three km above the confluence with the Hughes Fork. The river flows primarily through old growth western red cedar (*Thuja plicata*) and western hemlock (*Tsuga heterophylla*). Near the northern boundary of the Kaniksu Forest the river cascades over sheer rock walls (Upper Priest Falls), below the falls it is a relatively narrow, rocky mountain stream. About three km downstream, the canopy opens up and the river meanders for the next kilometer; there are several debris jams and one old beaver dam in this section. It then enters a relatively straight channel in an old growth cedar forest for about the next four km.

The next reach, starting just above the mouth of Lime Creek contains some very large (about 50 m) debris jams, and some braiding of the channel occurs in this area to below Cedar Creek. The river meanders through the next several kilometers below Cedar Creek to about 3/4 of a kilometer above the 1013 bridge where it goes through a bedrock canyon. Below the 1013 bridge the river meanders and braids through dense shrubs and old growth cedar stands. There are many debris jams in this stretch. Below the confluence with the Hughes Fork the river becomes a wide,

flat, meandering stream through willow and alder wetlands until it empties into Upper Priest Lake.

The river is a spawning stream for bull trout (*Salvelinus confluentus*) and cutthroat trout (*Oncorhyncus clarkii lewisii*), but both species occur at low densities (Irving 1987). All rivers in the study area including the Upper Priest River are closed to fishing. A few other more common summer residents on the Upper Priest River include dippers (*Cinclus mexicanus*), common mergansers (*Merganser merganser*), belted kingfishers (*Ceryle alcyon*), and mink (*Mustela vison*).

Data collected at a permanent U.S. Forest Service gauging station located just upstream from the 1013 bridge indicate that during the years 1985-1987, runoff on the Upper Priest River peaked at maximum flows of 1313 to 1780 cubic feet per second (cfs) between May 1 and May 29. Low summer flows were 10 to 13 cfs in August and September. Peak runoff during 1988 occured betweeen April 13 and May 29, with maximum flows on May 13. Peak runoff in 1989 occurred between April 22 and June 9, with maximum flows on May 12.

The Hughes Fork is a major tributary to the Upper Priest River. The North Fork of Granite Creek and Granite Creek are located to the southwest and flow into Priest Lake near the northern end of the lake at Reeder Bay. Several streams on the east side of Upper Priest Lake, and Priest Lake were also surveyed. Trapper Creek flows into the northern end of Upper Priest Lake, Caribou Creek flows into the "Thorofare" between Priest Lake and Upper Priest Lake and Lion Creek flows into the

northern end of Priest Lake at Squaw Bay. Some work was also done on Gold Creek and the East Fork of Lightning Creek, both tributaries to Lake Pend Oreille on the Sandpoint RD.

METHODS

Observations

Searches were conducted on streams known to have been used by harlequin ducks in the past, and on several adjacent streams where harlequins have never been observed. Searches in May and June consisted of walking or driving along the streambank. During July and August most searches were conducted by wading in the stream. Posters requesting reports of harlequin duck observations (Appendix A) were posted at trailheads, ranger stations and tourist facilities. Posters requesting reports of marked harlequin ducks (Appendix A) were also distributed to natural resource agencies responsible for management of harlequin duck wintering areas in western Washington, Oregon and British Columbia, and to local Audubon chapters and Christmas Bird Count compilers.

Trapping and marking

Harlequins were trapped using methods similar to those described by Kuchel (1977) and Wallen (1987). Two people stretched a 10-cm mesh mist net across the stream downstream from the ducks and clipped each end into carabiners attached to eight-foot lengths of PVC pipe secured on each bank. One person hid on the bank 5-10 m upstream from the net and the other pushed the

ducks downstream towards the net by walking behind them, either in the stream or along the bank. When the ducks were below the person hiding on the bank but still a few meters in front of the net, the person hiding on the bank jumped out behind the ducks and flushed them into the net.

All ducks were banded with U.S. Fish and Wildlife Service leg bands, and most were marked with colored nylon nasal discs attached to stainless steel rods inserted through the nares (Bartonek and Doty 1964, Lokemoen and Sharp 1985). These markers allow individual identification and enabled us to gather data on movements, mate fidelity, and fidelity to breeding areas. We also hope the markers will allow us to identify coastal wintering areas and migration routes of harlequin ducks that breed in northern Idaho. This type of marker is the only type that has been successfully used on harlequin ducks that can be seen while the duck is swimming. Patagial markers (Dzinbal 1982), and radio transmitters (Wallen 1987) have been lost or have malfunctioned. Nasal markers do not appear to affect behavior or survival in dabbling ducks (Bartonek and Dane 1964, Byers and Montgomery 1981).

Before being released, the ducks were weighed, and culmen length, wing chord and total body length were measured. Body measurements were analyzed with an analysis of variance and pairwise comparisons using Fisher's protected least-significant-difference test (Fisher 1949).

Habitat use

General habitat characteristics including cover type, stream habitat type, substrate, and proximity to human access were noted whenever harlequins were observed.

In order to compare habitat used by broods with randomly available habitat on brood rearing streams, detailed vegetative and structural characteristics were measured on eighteen sites systematically placed 1,640 m apart on Upper Priest River between the Upper Priest Falls and the confluence of Upper Priest River and the Hughes Fork starting at a randomly selected point 635 m below Upper Priest Falls. The same characteristics were measured at two locations used by broods less than three weeks of age and three locations used by broods over three weeks old. The two age groups were considered separately in order to test the hypothesis that habitat used by broods during the first three to four weeks differs from that used by older broods (Kuchel 1977). The Upper Priest River appeared to be the only river used for brood rearing on the Priest Lake Ranger District during 1989.

Habitat components were compiled from previous North American studies of harlequin duck breeding habitat (Kuchel 1977, Dzinbal 1982, Wallen 1987, Wallen and Groves 1989) and were expanded and modified to coordinate with U.S. Forest Service fisheries habitat evaluation methods used on the Priest Lake Ranger District. Some characteristics described by Platt et al. (1987) were also incorporated.

Habitat measurements were made on 20 m sections of stream centered at brood sightings or at random points (Figure 2).

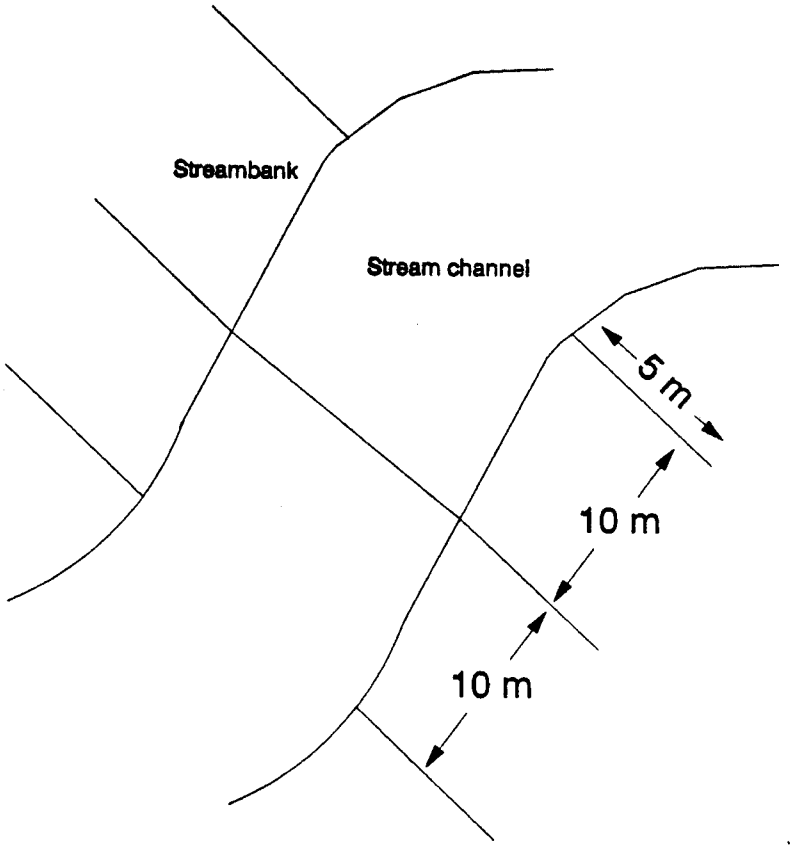


Figure 2. Diagram of habitat plot layout at random sites and sites used by harlequin duck broods.

Three streambank transects were measured at 10-m intervals along the section and averaged. Streambank components measured along each transect were bank composition, riparian vegetative structure, vegetative overhang, streambank undercut, sight distance, shrub density and shrub height. One transect was extended across the stream in the center of the 20-m section and stream width, depth, surface velocity, substrate, habitat type, and canopy cover in the center of the stream were measured along this transect. Number of midstream loafing sites, type and diameter of large woody debris and number of islands were measured within each 20-m section. Intensity of human disturbance was classified by accessibility to trails and roads. Classification and description of habitat measurements are described in Appendix B.

Habitat measurements were made between July 15 and August 31. Young brood sites were sampled four to six weeks after the broods were observed due to logistical constraints. Because of small sample sizes, no statistical tests were used to compare used versus random sites on the Upper Priest River or sites used by broods less than and greater than three weeks old.

RESULTS

Distribution

Searches were conducted on six streams where harlequins have been observed in the past, and on five streams where harlequins have never been observed (Appendix C). Harlequin ducks were observed on a total of 40 occasions on Granite Creek, the North

Fork of Granite Creek, the Upper Priest River and the Hughes Fork on the Priest Lake Ranger District, and on the East Fork of Lightning Creek and Gold Creek, tributaries to Lake Pend Oreille on the Sandpoint RD (Table 1). Harlequins were reported by other observers on Granite Creek, the Upper Priest River and Gold Creek on the Priest Lake Ranger District; on Two-Mouth Creek, a tributary to Priest Lake on the east side of the lake; on the Pack River on the Sandpoint RD and on Twenty-mile Creek and the Moyie River on the Bonner's Ferry RD (Table 2). A minimum of 22 adults were observed on the Priest Lake RD. Two broods were observed on the Upper Priest River and one was seen on the East Fork of Lightning Creek. No broods were found on Gold Creek on Lake Pend Oreille and the North Fork of Granite Creek, both of which are known to have produced broods in previous years (Wallen and Groves 1989).

Chronology of harlequin duck activities

Harlequins had already arrived on the Priest Lake Ranger District on May 3, 1989, the first day of the field season. Pairs were observed on 15 occasions and bachelor males on four occasions through May 28. On June 7 and 8, no males or females were observed in locations on the North Fork of Granite Creek or the Hughes Fork where they had previously been seen, and no males were observed for the remainder of the summer. We returned to Priest Lake on July 1 and observed 9 lone females on 5 occasions from July 2 through 5. Both paired females trapped and marked in

Table 1. Observations of harlequin ducks on the Kaniksu National Forest in 1989.

DATE	CREEK	OBSERVATION (band number)	UTME	UTMN	TRS
26-May	Granite Creek	pair, swimming (90213, 90214)	500,700	5,392,650	T62N,R5W,S28,SE
26-May	Granite Creek	pair, swimming	500,840	5,392,740	T62N,R5W,S28,SE
27-May	Granite Creek	pair, swimming	501,420	5,392,020	T62N,R5W,S33,NE
27-May	Granite Creek	1 male, loafing (90212)	502,120	5,391,300	T62N,R5W,S34,SW
04-May	Hughes Fork	pair, feeding	501,380	5,408,280	T63N,R5W,S9,NE
04-May	Hughes Fork	pair, swimming	501,460	5,408,040	T63N,R5W,S10,NW
04-May	Hughes Fork	1 male, flying	502,000	5,407,360	T63N,R5W,S10,SW
05-May	Hughes Fork	pair, feeding	501,380	5,408,300	T63N,R5W,S9,NE
05-May	Hughes Fork	pair, feeding	501,460	5,408,040	T63N,R5W,S10,NW
06-May	Hughes Fork	pair, swimming (90203, 90204)	501,380	5,408,220	T63N,R5W,S9,NE
23-May	Hughes Fork	pair, on bank (90203, 90204)	500,410	5,409,980	T63N,R5W,S4,NW
25-May	Hughes Fork	pair, swimming, (90203, 90204)	500,320	5,409,480	T63N,R5W,S4,NW
28-May	Hughes Fork	pair, swimming (90215, 90216)	504,800	5,406,500	T63N,R5W,S13,NW
03-May	N. Fork Granite	pair, swimming	494,980	5,396,600	T37N,R45E,S11,NE
04-May	N. Fork Granite	pair, feeding	494,880	5,396,640	T37N,R45E,S11,NE
23-May	N. Fork Granite	pair, loafing	495,320	5,396,260	T37N,R45E,S11,NE
24-May	N. Fork Granite	pair, swimming	495,100	5,396,560	T37N,R45E,S11,NE

Table 1 cont'd. Observations of harlequin ducks on the Kaniksu National Forest in 1989.

DATE	CREEK	OBSERVATION (band number)	UTME	UTMN	TRS
25-May	N. Fork Granite	2 males, (90211, 90212)	495,360	5,396,120	T37N,R45E,S11,SE
26-May	N. Fork Granite	pair, swimming	497,180	5,394,720	T37N,R45E,S13,NE
26-May	N. Fork Granite	1 male, swimming	495,360	5,396,120	T37N,R45E,S11,SE
02-July	N. Fork Granite	1 female loafing on rock	496,750	5,394,750	T37N,R45E,S13,NE
03-July	Upper Priest R	2 female loafing (90216, 90218)	503,300	5,409,200	T36N,R5W,S2,SW
04-July	Upper Priest R	2 females loafing (90219)	504,600	5,408,800	T63N,R5W,S2,SW
04-July	Upper Priest R	1 female loafing on rock	504,600	5,408,800	T63N,R5W,S2,NW
05-July	Upper Priest R	female loafing on log	502,150	5,423,700	T64N,R5W,S22,SE
05-July	Upper Priest R	hen with 6 ducklings on bank (90231-90234)	501,750	5,422,350	T64N,R5W,S27,NW
05-July	Upper Priest R	hen with 4 ducklings on gravel bar (90226-90230)	501,550	5,421,800	T64N,R5W,S27,SW
05-July	Upper Priest R	1 female, swimming, feeding	501,500	5,419,550	T64N,R5W,S34,SW
12-July	Upper Priest R	1 female, swimming, feeding	502,500	5,410,500	T64N,R5W,S34,SE
13-July	Upper Priest R	2 females, loafing on log	502,350	5,423,860	T65N,R5W,S22,NE
14-July	Upper Priest R	hen with 4 ducklings, on rock (90226-90230)	502,100	5,416,880	T64N,R5W,S10,SW
15-July	Upper Priest R	hen with 4 ducklings, swimming (90226-90230)	502,100	5,416,880	T64N,R5W,S10,SW

Table 1 cont'd. Observations of harlequin ducks on the Kaniksu National Forest in 1989.

DATE	CREEK	OBSERVATION (band number)	UTME	UTMN	TRS
26-Aug	Upper Priest R.	hen with 4 ducklings, swimming (90226-90230)	502,850	5,410,050	T63N,R5W,S3 NE
27-Aug	Upper Priest R.	hen with 4 ducklings, swimming (90226-90230)	504,600	5,408,800	T63N,R5W,S2 SW
28-Aug	Upper Priest R.	hen with 4 ducklings, swimming (90226-90230)	502,940	5,409,940	T63N,R5W,S3 NE
29-Aug	Upper Priest R.	4 ducklings, swimming (90231-90234)	502,040	5,417,040	T39N,R5W,S10 SW
26-June	Gold Cr., L. Pend Oreille	1 female, loafing on rock	541,200	5,312,500	T53N,R1W,S3 SE
22-July	East Fork Lightning Cr.	hen with 6 ducklings (90220-90225)	567,100	5,344,100	T57N,R3E,S27 NW
23-July	East Fork. Lightning Cr.	hen with 6 ducklings (90220-90225)	566,900	5,344,000	T57N,R3E,S27 SW
31-July	East Fork Lightning Cr.	hen with 6 ducklings, swimming (90220-90225)	566,050	5,343,250	T57N,R3E,S32 SW

Table 2. Reported observations of harlequin ducks on the Kaniksu National Forest in 1989.

DATE	CREEK	OBSERVER	OBSERVATION	TRS
early May	Moyie River	Ken English	pair	T36N,R2E,S35
early May	Twenty-Mile Creek	Ken English	2 males and 1 female	T61N,R1E,S30
late May	Two Mouth Creek	Ron Krummes	pair	T62N,R4W,S27 SE
25-May	Granite Creek	Larry Meyer	male on rock	T62N,R5W,S33 NE
28-May	Upper Priest River	Art & Kathleen Carothers	pair on log	T63N,R5W,S11 NW
May or June	Pack River	Steve Murphy	pair	T60N,R2W,S21 SE
22-June	Gold Cr.	Lisa Hawdon	3 females swimming	T63N,R5W,S17 NE

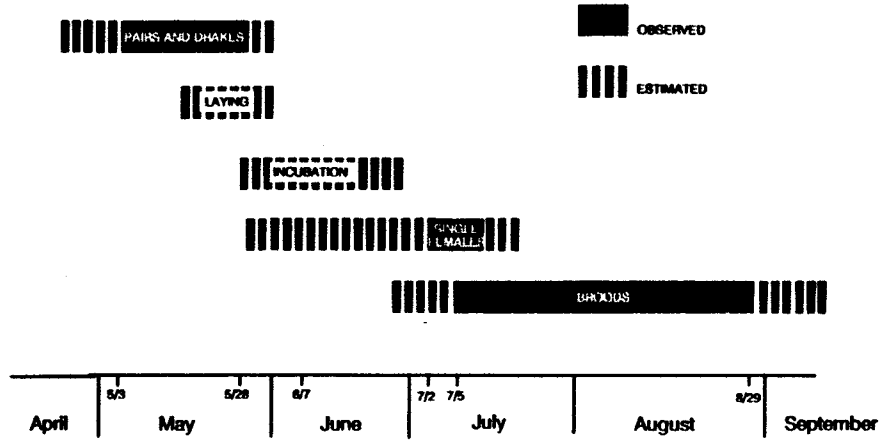
May were observed alone or with unmarked females in July. Broods were first observed on July 5. Two broods were observed that day, one was classified as Ia, about three days old, and the other as Ic, about 12 days old (Larson and Taber 1980). Both broods were still present on August 28 and 29, near the end of the field season. One brood had fledged by August 28, at about 67 days of age, the other had not fledged by August 29, at about 58 days of age.

Based on this information, pairs arrived on the Priest Lake RD before May 3rd, incubation started some time between May 25 and June 2 and males had left the area by June 7 (Figure 3). Assuming an average clutch size of six and a laying rate of one egg every other day (Bengston 1972), egglaying probably occurred between May 14 and June 5. Females without young remained at least through the first week in July. Broods remained at least until the end of August. Ducklings fledged between 58 and 67 days, or around the age of 9 weeks.

Breeding density

During the third week in May we estimated that three pairs occupied the 12-km stretch of Granite Creek and the North Fork of Granite Creek between the Blacktail bridge and the Tilicum Creek Bridge for a breeding density of one pair per .25 km. Two pairs were estimated to have occupied the 13-km stretch of the Hughes Fork from the confluence with the Upper Priest River to Hughes Meadow, a density of one pair per .15 km. The Upper Priest River was not surveyed in May.

Figure 3. Chronology of harlequin duck use on the Priest Lake Ranger District Kaniksu National Forest, summer 1989.



Trapping, marking and body measurements

Eleven adults and 13 ducklings were trapped during the summer (Appendix D). One adult female and five ducklings trapped on the East Fork of Lightning Creek were only leg banded. All other ducks were banded and nasal marked. Trapping was successful in 9 of 13 attempts. Another seven adults and three ducklings had been trapped in 1988 (Wallen and Groves 1989). Only adults were nasal marked in 1988.

Both times pairs were trapped in 1989, the male was caught and the female managed to go over or under the net. However, on both occasions, about 10 minutes later the female flew back upstream, and was caught when she flew into the net. This also occurred once with a pair of females and once with a hen with a brood.

Overall, birds captured in 1988 tended to weigh more than birds captured in 1989 ($p=.043$),and wing lengths averaged 7mm longer ($p=.0009$), however sample sizes for both years were small. The heaviest female recorded in any breeding ecology study (750 g), was trapped on the Hughes Fork in 1988. Body length and culmen length were similar between years ($p > .2$). During both years males were significantly larger than females in body length, had longer wings and weighed an average of 34 g more although the latter was not statistically significant. Culmen lengths were similar between sexes (Table 3). Females captured in July and August (n=7) weighed an average of 85 g less than females captured in May (n=4). This difference was statistically significant in both 1988 ($p=.0015$) and 1989 ($p=.0024$). One

Table 3. Summary of measurements of adult harlequin ducks trapped in northern Idaho in 1988 and 1989 and the probability of differences between sexes.

	Males				Females				
	n	average	s.e.[1]	range	n	average	s.e.	range	p
Weight (g)	6	615	14.78	570-660	12	581	19.43	520-750	.3160
Total Length (mm)	6	420.50	4.45	400-431	11	400.82	3.80	380-422	.0049
Culmen (mm)	4	25.55	.53	24.6-27.0	11	25.43	.27	24.2-26.7	.8176
Wing chord (mm)	6	203.5	2.05	198-212	11	199.09	1.24	192-205	.0157

[1] sample standard error

female trapped in May 1989, weighed 40 g less when retrapped in July.

Three broods were captured in 1989 and one brood was captured in 1988. Average brood size at age class III (fully feathered), at the end of July and August of 1989, was 4.67. Ducklings had reached adult body length and culmen length by 58 days but, at fledging, still weighed less and had shorter wing chord lengths than adults (Table 4). Ducklings also had yellowish legs and feet, whereas those of adults are dark grey. Six individuals were observed again after being marked. Perhaps the most significant re-observation was a pair marked on May 3, 1988, on the Hughes Fork observed together again at the same location on May 6, 1989. They remained on the Hughes Fork until at least May 25 1989 but did not appear to breed successfully. Two males marked together on the North Fork of Granite Creek on May 25 were observed separately several days later, one on the main stem of Granite Creek and one on the North Fork of Granite Creek. Two paired females marked in May were observed again in July. One had been marked on Granite Creek and was re-observed on the North Fork of Granite Creek, the other was marked on the Hughes Fork and was later observed on the Upper Priest River.

Habitat use

When adult observations on all streams on the Priest Lake RD were pooled, adult harlequins were found to be most commonly observed in riffles or runs with a cobble or boulder substrate and one or more loafing sites within 10 m. Vegetative structure

Table 4. Summary of measurements of ducklings captured in 1988 and 1989.

Estimated age	Brood size	With hen ?	Body length (mm) Average	Body length (mm) s.d.[1]	Culmen (mm) Average	Culmen (mm) s.d.	Weight (g) Average	Weight (g) s.d.	Wing chord (mm) Average	Wing chord (mm) s.d.
25 days	4	y	333.33	6.51	21.62	.35	363.33	27.54	105.67	11.02
46 days	6	y	396.60	15.5	24.86	.93	472.00	47.65	173.6	2.88
58 days	4	n	403.50	19.33	24.00	1.10	497.50	53.77	187.00	10.98
67 days	4	y	417.25	4.99	26.15	.31	502.50	17.08	191.75	1.71

[1] sample standard deviation

was most commonly shrub or timber/shrub mosaic. About 2/3 of the time they were observed in areas away from human activity (Table 5).

The remainder of the results pertain to the Upper Priest River. Most of the Upper Priest River is not accessible by road or trail (Table 6). Adult harlequins were most often observed in areas that were inaccessible, but appeared to use the river without regard to human accessibility. Broods were never observed in areas near roads.

Adults were most often observed in the fast flowing riffle or pocketwater habitat types, broods younger than 3 weeks old were observed in slower flowing glides and pools, and broods over 3 weeks old were observed in pocketwaters and glides (Table 7). Adults were most often seen in straight or curved channels, broods less than three weeks of age used curved and braided channels, and broods greater than three weeks of age used straight and meandering channels (Table 9).

There appeared to be several differences in habitats used by broods during the first three weeks, and randomly available habitat. The early stages of brood rearing occurred in the upper section of the river, where the stream was narrower and higher in elevation. Young broods were observed in slow water pools and glides in braided or curved stream channels. Shrubby streambank vegetation appeared to be important to young broods. They appeared to use stream reaches in areas classified as tall shrub riparian vegetative structure. Shrubs were taller, shrub density

Table 5. Percent of observations of adult harlequin ducks in various habitat categories on the Priest Lake Ranger District. See Appendix B for habitat definitions.

		HUMAN ACCESSIBILITY			
n		adjacent	near	accessible	inaccessible
31		6.5	25.8	0	67.7
		LOAFING SITES / 10m			
n	0	1-3	>3		
26	32.1	42.9	25.0		
		SUBSTRATE			
n	cobbles	boulder	cobble/bedrock		
27	74.1	18.5	7.4		
		STREAM HABITAT TYPE			
n	riffle	run	pocketwater	glide	pool
25	60.0	20.0	8.0	8.0	4.0
		VEGETATIVE STRUCTURE			
n	graminoid	shrub	timber/shrub	pole	oldgrowth
23	8.7	30.4	39.2	8.7	13.0

Table 6. Comparison of human accessibility of randomly selected sites and sites used by harlequin ducks on Upper Priest River, summer 1989.

	n	Percent Accessible		
		Near		Inaccessible
Random	18	11.1	5.6	83.3
Broods <3 weeks	2	0	50.0	50.0
Broods >3 weeks	5	0	0	100.0
Adults	9	22.2	11.1	66.7

Table 7. Comparison of stream habitat types of randomly selected sites, and sites used by harlequin ducks on Upper Priest River, summer 1989.

	n	Percent				
		pool	riffle	run	pocketwater	glide
Available	18	5.6	16.7	16.7	38.9	22.2
Broods <3 weeks	2	50.0	0	0	0	50.0
Broods >3 weeks	5	0	0	0	40.0	60.0
Adults	7	14.3	42.9	14.3	28.6	0

was greater and visibility from the bank was poorer than at random sites (Tables 8 and 9).

Broods over three weeks old were observed primarily in old growth, which also comprised over 50% of the streambank vegetative structure at random sites, but were still occasionally observed in areas of tall shrub and tall/shrub timber mosaic. All broods were observed in areas of low gradient, slow average and maximum surface velocities and rubble substrates between 15 and 30 cm in diameter. Woody debris, primarily ramps, was present at most sites where broods were observed. There appeared to be no difference in water depth, diameter of woody debris, streambank composition and canopy cover between areas used by broods and random areas on the Upper Priest River (Appendix E).

Behavior

Several behavioral observations were made incidental to other work. Two adult females were observed with a merganser with 3 ducklings on July 5, and an adult female harlequin was observed associating with an adult female merganser on July 12.

Table 9. Comparison of percentage of measurements in various habitat categories at randomly selected sites and sites used by harlequin duck broods on Upper Priest River, summer 1989.

		Streambank Vegetative Structure						
	n	sapling	old growth	graminoid	forb	low shrub	high shrub	low shrub/ timber	high shrub/ timber
Available	18	1	57.6	2.8	3.8	9.4	11.3	7.5	6.6
Broods <3 weeks	2	0	25.0	0	0	0	75.0	0	0
Broods >3 weeks	5	0	55.6	5.6	5.6	0	16.7	0	16.7

		Substrate			
	n	clay/silt	small rubble	large rubble	boulder
Available	18	5.6	16.7	55.6	22.2
Broods <3 weeks	2	0	100.0	0	0
Broods >3 weeks	3	0	33.3	66.7	0

		Sight Distance			
	n	0-5m	5.1-10m	10.1-20m	20.1-30m	over 30m
Available	18	2.8	28.7	38.0	23.1	7.4
Broods <3 weeks	2	16.7	58.3	16.7	8.3	0
Broods >3 weeks	3	0	16.7	61.1	16.7	5.6

Table 9 cont'd. Comparison of percentage of measurements in various habitat categories at randomly selected sites and sites used by harlequin duck broods on the Upper Priest River, summer 1989.

		Channel Type			
	n	straight	curved	meander	braided
Random	18	38.9	16.7	38.9	5.5
Broods <3 weeks	2	0	50.0	0	50.0
Broods >3 weeks	6	66.7	33.3	0	0
Adults	29	41.4	37.9	20.7	0

Table 10. Habitat characteristics at randomly selected sites and at sites used by broods on the Upper Priest River, summer 1989.

	n	elevation(f)		gradient(°)		width(m)		$\bar{x}$ velocity (m/sec)		shrub density		shrub height(cm)	
		$\bar{x}$	s.e.[1]	$\bar{x}$	s.e.	$\bar{x}$	s.e.	$\bar{x}$	s.e.	$\bar{x}$	s.e.	$\bar{x}$	s.e.
Random	18	2731	47.35	2.28	.5	14.02	.85	.480	.041	6.64	1.30	115.09	48.18
Broods <3 weeks	2	3025	125.00	.75	.25	9.20	1.30	.409	.090	9.42	.92	170.71	11.36
Broods> 3 weeks	3	2650	50.00	.67	.17	13.07	1.14	.377	.093	2.11	.43	79.33	19.04

[1] sample standard error

One case of brood hiding was observed when a female with four ducklings became aware of people on the bank. She drifted downstream, but the ducklings didn't follow her and apparently hid along the streambank. After we followed her downstream around several bends, she stopped and looked at us, then slowly swam upstream along the opposite bank, preening and feeding. When she reached a bend in the stream she flew back upstream toward her brood. Ducklings appeared to be very adept at hiding under woody debris for a half-hour or more.

DISCUSSION

Chronology

For the most part, the chronology described for the Upper Priest River in 1989 corresponds to that described by Wallen and Groves (1989) for Granite Creek and the Lochsa River in 1988. As they suggested, harlequin ducks seem to arrive in Idaho in April. During 1988, incubation was initiated around May 15. During 1989 incubation appeared to start about May 25 for the older of the two broods using the Upper Priest River. Broods appeared to remain on Upper Priest River at least until early September, as one brood had not fledged at the end of August. This was somewhat longer than suggested by Wallen and Groves (1989)

Ducklings seemed to take longer to fledge on Upper Priest River in 1989 (62 days) than they did in Iceland (42 days), Grand Teton (42 days) or Glacier (55 days), however our sample size was small (n=2).

Breeding Density and Reproduction

Average breeding densities of .25 pairs/km on Granite Creek and .15 pairs/km on the Hughes Fork were considerably lower than average breeding densities found in Iceland (1.3 breeding pairs/km, Bengston 1972), Glacier National Park (.67 - .91 /km) (Kuchel 1977), and Grand Teton National Park (.89 /km) (Wallen 1987). Low pair densities were also observed by Wallen and Groves (1989) for streams throughout northern Idaho.

Average class III brood size in 1989 was 4.67, somewhat higher than the 3.5 observed in 1988 (Wallen and Groves 1989). Average class III brood sizes in Grand Teton and Glacier National Parks were 5.4 and 3.88, respectively (Wallen 1987, Kuchel 1977). Eight of ten ducklings observed as Class I on the Upper Priest River survived to Class III. Kuchel (1977) observed survival rates to Class III from 18% to 83% and felt that the timing, intensity and duration of spring runoff directly affected duckling survival.

Two of the four class II and above broods observed on the Priest Lake Ranger District in 1988 and 1989 were unaccompanied by hens. Wallen (1987) observed that 40% of the class III broods observed in Grand Teton were not accompanied by a hen.

Body measurements

Adult harlequins trapped during 1988 and 1989 had smaller wing chord and culmen lengths than harlequins in Sawmill Bay, Alaska, as reported by Dzinbal (1982), but were comparable in

weight. Harlequins in northern Idaho appeared to be slightly larger and averaged about 27 g heavier than those in Grand Teton National Park (Wallen 1987).

Habitat use

Habitat data collected this year can only be regarded as preliminary because of small sample sizes. However, to date, there is no indication of a lack of any structural habitat components for adult harlequins on the Upper Priest River. Adults did not appear to be limited to certain areas or habitat types on the stream. Young broods on the other hand, were only found in the meandering, curved and braided reach of the stream two to four km below Upper Priest Falls. This may have been the only area used for nesting during the summer of 1989. Ducklings appeared to hatch in the upper reaches of the river and progressively move downstream during the course of the summer, similar to the findings of Kuchel (1977) and Wallen (1987). Preliminary results seem to indicate that habitat use by ducklings is most selective during the first three weeks or less as suggested by Kuchel (1977). Miller (1989) also observed that older broods in northwestern Montana were seen in more open habitats than younger broods. However, the habitat on the Upper Priest River differs from that in other areas where harlequin duck breeding habitat has been intensively studied. Most of the Upper Priest River contains neither the backwaters and oxbow-shaped pond habitat types found on Macdonald Creek (Kuchel 1977), nor the stairstep waterfalls found on many streams in Grand Teton

National Park (Wallen 1987). Instead it tends to alternate between meandering reaches with debris jams and straight or curved pocketwater channels with average gradients less than 3 degrees. Therefore, as more data are collected, habitat use patterns may be expected to differ somewhat from those found in other studies.

Macroinvertebrates

Macroinvertebrate biomass is one other factor suspected to affect harlequin duck populations on summer breeding areas (Bengston and Ulfstrand 1971). During 1988, Priest Lake RD personnel used a modified Surber sampler to sample macroinvertebrates at three stations on the Upper Priest River between the 1013 bridge and Rock Creek. The upper station, below Rock Creek had a total macroinvertebrate dry weight biomass of .7 g/m^2 and the lower stations had macroinvertebrate biomasses of .3 g/m^2. These low levels would limit the number and size of fish that could be supported (Mangum 1988), and may also limit numbers of harlequin ducks, because they feed primarily on benthic invertebrates (Bengston 1972). Macroinvertebrate biomass in Granite Creek averaged 2.8 g/m^2 and is less likely to be limiting to duck populations. Species composition may also be important. In Iceland, harlequin ducks subsist largely on Dipteran Simuliidae larvae and pupae during the breeding season, although this may be more related to species abundance than preference by harlequins. Ducklings consume relatively more macroinvertebrate drift than adults.

CONCLUSIONS AND RECOMMENDATIONS

Harlequin ducks have been documented to use at least five streams on the Priest Lake RD, two streams on the Sandpoint RD and two streams on the Bonner's Ferry RD. Data from 1988 and 1989 indicate that broods have been produced on four of these streams: Upper Priest River, North Fork of Granite Creek, Gold Creek, and E. Fork of Lightning Creek. Broods were successfully produced on only two of these in 1989.

Harlequin ducks apparently use streams on the Kaniksu National Forest primarily from April through September. During 1989, breeding chronology on the Upper Priest River appeared to be about one week later than that suggested by Wallen and Groves (1989) for northern Idaho in 1988. The peak runoff period on the Upper Priest River also occurred about one week later in 1989 than 1988. Pair density appeared to be low during both years. During 1989, brood survival to just before fledging appeared to be fairly high, and ducklings appeared to develop slowly relative to ducklings in other areas. Habitat use measurements confirmed the results of other studies in defining shrubby riparian vegetation, lack of human disturbance and loafing sites as important factors for harlequin ducks. Relatively slow water velocity, woody debris, and dense, shrub riparian vegetation, were characteristic of early brood rearing sites.

The results of this year's work give preliminary answers to some of the questions Wallen and Groves (1989, p. 28) considered necessary to answer for management purposes. However, most of these results are based on small sample sizes. Most questions

can be adequately answered only over a period of several years, particularly those regarding wintering areas, return rates and fidelity to streams and mates. Habitat use work needs to continue in order to collect more data at brood-rearing sites and to describe habitat availability on other streams on the Kaniksu. The Upper Priest River should be continually monitored as a "control," and trends there in population density and productivity should be compared to other streams which may be affected by logging, road construction or other human activities.

Because preliminary results indicate that harlequins use limited areas away from human activity with a dense shrub component, woody debris and meandering channels for brood rearing, these areas should be preserved. Trails or roads should be greater than 50 m away from streams used by harlequin ducks, and should not be visible from the stream. Logging acitivity in the riparian corridor should be avoided.

The fishing closures on the Priest Lake RD are probably beneficial for harlequins. Despite the closure however, EFC did observe people fishing on the Upper Priest River on 5 out of 15 days on the river between July 3 and August 31, and once on the North Fork of Granite Creek. Wallen (1987) felt that anglers caused the greatest disturbance to harlequins in Grand Teton National Park, and that management of human disturbance should be a priority for conservation of harlequin ducks.

Although little is known about harlequin duck food habits on streams, other studies suggest macroinvertebrate levels may play a role in determining harlequin duck population densities. It

would be useful to expand macroinvertebrate sampling to the Hughes Fork, East Fork of Lightning Creek and Gold Creek on Lake Pend Oreille, the St. Joe River, the Lochsa River and Kelly Creek.

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Appendix A
Posters distributed requesting reports of harlequin duck observations

Appendix B
Description of habitat characteristics measured on the Upper Priest River, summer 1989

Appendix Table B1. Measurements taken systematically along streams and at brood sightings.

Stream components

Elevation: from 1:24,000 topographic maps

Gradient: measured in degrees using a clinometer

Channel type: adapted from Bloom (1978, p.207-208)

meander- stream channel is located in alluvium generally in a flat bottomed valley, and follows sinuous curves with deep pools separated by shallow riffles. The channel appears to shift slightly during peak flows.

braided- stream channel is located in a flat bottomed valley, midstream bars occur and divide the stream into separate but intersecting and shifting channels.

straight- stream channel is linear and structurally controlled by a "V" shaped valley. Rapids and runs characterize the stream flow. No movement of the channel during peak flow periods.

curved- stream channel is structurally controlled by a "V" shaped valley, unlike the meander, and the channel curves or zigzags more abruptly than a meander. No movement of the channel occurs during peak flow periods.

Stream width: wetted width at a 90^{o} angle to stream flow.

Stream depth: measured at 1/5, 2/5, 3/5 and 4/5 of stream width.

Stream velocity: measured at the surface with a Pierce AA current meter at 1/5, 2/5, 3/5 and 4/5 of stream width.

Bottom material (substrate type):
classified as clay/silt, sand, fine gravel .2-.6 cm, coarse gravel, .7-7 cm, small rubble, 8-15 cm, large rubble, 16-30 cm, boulder, >30 cm, or bedrock.

Habitat type:

pool- deep slow water areas, created by obstructions such as boulders or logs.
riffle- shallow water areas where the water surface is influenced by the stream bottom (white water).
run- deeper than a riffle, velocity greater than .3 m per second.
pocketwater- a run or a riffle with boulders (> 30 cm in diameter), which create numerous small pools.
glide- run areas with velocities < .3 m/sec.
backwater- areas located off the main channel and out of the current.

Number of midstream loafing sites- rocks or logs in the stream which would be suitable for resting sites.

Number of islands in stream.

Characterization of large woody debris (Platts et al 1987)-
bridge- log across stream.
collapsed bridge- log that extends across stream, but is submerged in the middle of the stream.
ramp- one end of log in stream, the other on bank.
drift- log floating in stream.

Diameter of woody debris: measured with a dbh tape near the middle of the log.

Streambank characteristics

Bank composition: percent vegetation, riprap, bedrock, silt, sand and cobbles.

Riparian vegetative structure: classified as seedlings, saplings, pole, immature, mature, old-growth, graminoid, forbs, low shrub (< 1.8 m), high shrub (> 1.8 m), low shrub / timber mosaic, or high shrub / timber mosaic.

Vegetative overhang: centimeters of live vegetation within 30 vertical centimeters of the water surface and overhanging the water column.

Streambank undercut: amount of bank overhang at the edge of the stream.

Sight distance: distance at which a perpendicular section of stream is 100% obscured to a standing human observer.

Shrub density: the number of shrubs stems over 20 cm high in a 5 x .5 m rectangular plot perpendicular to the stream.

Shrub height: the height of shrubs located at 1 m intervals on 5 m transects from edge of streambank.

Human accessibility:
adjacent- established area of human activity maintained within 10 m.

near- established area of human activity maintained > 10 m and < 50 m from the creek.

away accessible- area which, though > 50 m from an area of human activity, is made accessible by a maintained trail.

away inaccessible- area which is > 50 m from an area of human use and not accessible by maintained trail.

Appendix C
Areas and dates surveyed during 1989

Appendix Table C. Areas and dates of harlequin duck surveys on the Kaniksu National Forest, summer 1989.

Stream	Date	Surveyed from	Surveyed to
Granite Creek	May 26	T62N,R5W,S33NE	T62N,R5W,S30NE
	May 27	T62N,R5W,S33NE	T62N,R5,S3SE
	July 2	T62N,R5W,S30NE	T62N,R5W,S2SE
	August 30	T62N,R5W,S30NE	T62N,R5W,S11NE
N. Fork Granite Creek	May 3	T62N,R5W,S30NE	T37N,R45E,S2NE
	May 4	"	"
	May 5	"	"
	May 23	"	"
	May 24	"	"
	May 25	"	"
	May 26	"	"
	June 8	"	"
	July 2	"	"
	August 20	"	"
S. Fork Granite Creek	July 11	T37N,R45E,S26NE	T37N,R45E,S24NE
Hughes Fork	May 4	T63N,R5W,S45SE	T63N,R5W,S10SW
	May 5	T63N,R5W,S45SE	T63N,R5W,S10NW
	May 6	T63N,R5W,S4NW	T63,R5W,S10NW
	May 23	T63N,R5W,S9NE	T63N,R5W,S10SW
	May 24	T64N,R5W,S33NW	T63N,R5W,S16SW
	May 25	T64N,R5W,S33NW	T63N,R5W,S4NW
	May 28	T63N,R5W,S15NE	T63N,R5W,S13SW
	June 7	T63N,R5W,S15NE	T63N,R5W,S13SE
	July 3	T63N,R5W,S33NW	T63N,R5W,S10SW
	August 30	T63N,R5W,S10SW	T63N,R5W,S13SE
Trapper Creek	June 6	T63N,R4W,S19NE	T63N,R4W,S8NW
Upper Priest River	June 6	T63N,R5W,S19NW	T63N,R5W,S2SW
	June 8	T64N,R5W,S15SE	T63N,R5W,S3SW
	July 3	T64N,R5W,S15SE	T63N,R5W,S2SW
	July 5	T65N,R5W,S14SE	T64N,R5W,S15SE
	July 12	T64N,R5W,S27SE	T63N,R5W,S13SE
	July 13	T65N,R5W,S14NE	T65N,R5W,S22SW
	July 14	T64N,R5W,S3SW	T64N,R5W,S22NE
	August 1-2	T64N,R5W,S3SW	T63N,R5W,S2SW
	Aug. 22-25	T65N,R5W,S14SE	T64N,R5W,S3SW
	August 26	T64N,R5W,S34SE	T64N,R5W,S2NW
	August 27	T64N,R5W,S2SW	T64N,R5W,S13SE
	August 28	T64N,R5W,S34SE	T64N,R5W,S2NW
	August 29	T64N,R5W,S10SW	T64N,R5W,S23SW
	August 31	T64N,R5W,S15SE	T64N,R5W,S23SE
Gold Creek, Priest L.	July 4	T63N,R5W,S17SE	T38N,R45E,S12NE
Caribou Creek	August 31	T63N,R4W,S34NE	T63N,R4W,S4SE

Appendix Table C cont'd. Areas and dates of harlequin duck surveys on the Kaniksu National Forest, summer 1989.

Stream	Date	Surveyed from	Surveyed to
Lion Creek	August 31	T62N,R4W,S12NW	T62N,R4W,S11NW
Gold Cr,, L. Pend Oreille			
	June 26	T53N,R1W,S2NW	T53N,R1W,S3NE
	August 3	T53N,R1W,S2NW	T53N,R1W,S3NE
E. Fork Lightning Cr.	July 22-23	T29N,R3E,S27NW	T29N,R3E,S32SW
	July 31	T29N,R3E,S27SW	T29N,R3E,S32SW

Appendix D
Harlequin duck trapping record, summer 1989

Appendix Table D. Harlequin duck trapping record, 1989.

DATE	CREEK	AGE SEX	BAND NUMBER	MARKER LEFT	MARKER RIGHT	BODY LNGTH (cm)	CULMEN LENGTH (mm)	WEIGHT (gm)	WING LENGTH (cm)
25-May-89	N. Fork Granite	AHYM	805-90211	Black plus	Yellow plus	400	-	570	201
25-May-89	N. Fork Granite	AHYM	805-90212	Blue plus	Yellow plus	425	-	640	205
26-May-89	Granite Creek	AHYM	805-90213	Red plus	Blue plus	420	25.6	590	205
26-May-89	Granite Creek	AHYF	805-90214	Red plus	Red plus	393	24.6	560	198
28-May-89	Hughes Fork	AHYM	805-90215	Gray plus	Orange plus	420	24.6	590	212
28-May-89	Hughes Fork	AHYF	805-90216	Gray plus	Blue plus	395	25.3	590	202
26-Jun-89	Gold Cr., PDO	AHYF	805-90217	Blue plus	Green plus	395	26.5	530	205
03-Jul-89	Upper Priest R.	AHYF	805-90218	White plus	White plus	405	26.1	555	200
05-Jul-89	Upper Priest R.	AHYF	805-90216	Gray plus	Blue plus	retrap		550	-
04-Jul-89	Upper Priest R	AHYF	805-90219	Gray plus	Green plus	380	24.5	525	204
31-Jul-89	E. Fork Lightng	YOY	805-90220	-	-	415	25.7	500	176
31-Jul-89	E. Fork Lightng	YOY	805-90221	-	-	400	24.5	510	173
31-Jul-89	E. Fork Lightng	YOY	805-90222	-	-	388	23.4	420	170
31-Jul-89	E. Fork Lightng	YOY	805-90223	-	-	375	25.3	420	172
31-Jul-89	E. Fork Lightng	YOY	805-90224	-	-	405	25.4	510	177

Appendix Table D cont'd. Harlequin duck trapping record, 1989.

DATE	CREEK	AGE SEX	BAND NUMBER	MARKER LEFT	NASAL MARKER RIGHT	BODY LNGTH (cm)	CULMEN LENGTH (mm)	WEIGHT (gm)	WING LENGTH (cm)
31-Jul-89	E. Fork Lightng	AHYF	805-90225	-	-	-	-	-	-
28-Aug-89	Upper Priest R.	YOY	805-90226	Orange oval	Black oval	418	26.4	500	1922
8-Aug-89	Upper Priest R.	YOY	805-90227	Green oval	White oval	421	26.3	520	191
28-Aug-89	Upper Priest R.	YOY	805-90228	White oval	Orange oval	410	25.7	510	194
28-Aug-89	Upper Priest R.	YOY	805-90229	Gray oval	Orange oval	420	26.2	480	190
28-Aug-89	Upper Priest R.	AHYF	805-90230	Green oval	Blue oval	415	26.2	520	202
29-Aug-89	Upper Priest R.	YOY	805-90231	Gray oval	Blue oval	383	23.8	480	184
29-Aug-89	Upper Priest R.	YOY	805-90232	Black oval	Blue oval	420	23.4	530	183
29-Aug-89	Upper Priest R.	YOY	805-90233	Blue oval	Blue oval	420	25.6	550	203
29-Aug-89	Upper Priest R.	YOY	805-90234	Red oval	Blue oval	391	23.2	430	178

Appendix E
Selected harlequin duck habitat use data collected on the Upper Priest River, summer 1989

Appendix Table E. Selected habitat characteristics at random sites and sites used by broods on the Upper Priest River, summer 1989.

	n	Streambank composition (%) vegetation		riprap		bedrock		sand		silt		cobbles	
		$\bar{x}$	s.e.	$\bar{x}$	s.e.	$\bar{x}$	s.e.	$\bar{x}$	s.e.	$\bar{x}$	s.e.	x	s.e.
Random	18	64.70	4.67	10.41	2.9	1.39	1.06	2.92	.95	2.59	1.20	16.04	3.14
Broods <3 weeks	2	68.33	13.33	4.17	2.5	0	0	0	0	7.5	4.2	18.33	18.33
Broods >3 weeks	3	64.44	2.78	6.67	3.37	0	0	2.22	1.21	1.7	1.7	25.0	

	n	depth(f)		vegetative overhang(cm)		streambank undercut(cm)		canopy cover(%)		surface velocity(m/sec) minimum		maximum	
		$\bar{x}$	s.e.	$\bar{x}$	s.e.	$\bar{x}$	s.e.	$\bar{x}$	s.e.	$\bar{x}$	s.e.	$\bar{x}$	s.e.
Random	18	.41	.04	5.90	3.14	5.45	1.67	49.86	3.65	.207	.025	.864	.094
Broods <3 weeks	2	.36	.03	78.92	5.78	0	0	58.00	5.00	.267	.048	.640	.244
Broods >3 weeks	3	.52	.36	1.72	1.72	2.39	2.39	56.00	5.57	.161	.052	.524	.120

Appendix Table E. Comparison of percent of observations of broods and random sites on Upper Priest River in categories classified according to number of loafing sites /10 m.

	n	0	1-3	>3
Random	18	66.7	27.8	5.5
Broods <3 weeks	2	50.0	50.0	0
Broods >3 weeks	6	50.0	50.0	0

Appendix Table E. Comparison of percent of brood observations with random sites in categories classified according to amount of woody debris on the Upper Priest River, summer 1989.

	n	0	1-3	>3
Random	18	66.7	27.8	5.5
Broods <3 weeks	2	50.0	50.0	0
Broods >3 weeks	3	33.3	66.7	0

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