# DISTRIBUTION AND RELATIVE ABUNDANCE

# OF

# HARLEQUIN DUCKS IN THE SOUTHWEST KUSKOKWIM MOUNTAINS

by

Brian J. McCaffery

and

Christopher M. Harwood

Key Words:

harlequin duck
helicopter survey
behavioral responses
recreational rafting
Kisaralik River
Kwethluk River
Eek River
Kuskokwim Mountains

U. S. Fish and Wildlife Service
Yukon Delta National Wildlife Refuge
P.O. Box 346
Bethel, Alaska 99559

December 1994

## Executive Summary

A harlequin duck (Histrionicus histrionicus) survey was conducted from a helicopter in the southwest Kuskokwim Mountains on 1-3 June 1994. A total of 546 km were surveyed along 19 different streams. Harlequin ducks were observed on the Kisaralik, Kwethluk, and Eek rivers, as well as on 13 of 16 tributaries. A total of 403 harlequin ducks were detected, including 164 pairs, 66 unpaired males, 7 unpaired females, and 2 of unknown sex. The density of harlequin ducks on the main stem of the Kisaralik was twice as high as the density on both its own tributaries and the Kwethluk River. Thus, the 1994 data indicate that the best harlequin habitat within the survey area exactly coincides with the area most likely to receive increases in recreational rafting. Since increases in recreational activity have been correlated with declines in the abundance and productivity of harlequin ducks elsewhere in North America, the U. S. Fish and Wildlife Service (USFWS) should initiate studies to determine how to minimize such negative impacts along the Kisaralik River.

## Introduction

The harlequin duck is widely distributed throughout the mountains of southwest Alaska (Gabrielson and Lincoln 1959, White and Boyce 1978, Petersen et al. 1991). The species has been reported from all major rivers flowing from the southwest Kuskokwim Mountains into the Kuskokwim River and Kuskokwim Bay (Petersen et al. 1991). Geographic variation in abundance, however, has not been documented in the region. More quantitative data have been gathered along the Kisaralik River than elsewhere, but even there, observations have been limited to the main stem of the river (Brown et al. 1985a; McCaffery, unpubl. data). The relative importance of both tributary streams and adjacent major rivers as harlequin habitat has not been determined previously.

USFWS is in the process of developing a management plan for the Kisaralik River on Yukon Delta National Wildlife Refuge (YDNWR). Several of the proposed management alternatives predict an increase in the level of recreational rafting along the river (USFWS 1993). Increases in recreational activity have apparently led to declines in harlequin duck abundance and/or productivity elsewhere in the species' range (Clarkson 1992, Genter 1992, Wallen 1992). Because the harlequin duck was declared a Category 2 candidate for the Endangered Species List by USFWS in 1991, YDNWR implemented a survey in the spring of 1994 to determine the status of the species in and around the Kisaralik River watershed prior to finalizing the management plan. Specific objectives included assessing the relative importance for harlequin ducks of 1) the main fork of the Kisaralik versus its tributaries, and 2) the Kisaralik watershed versus adjacent watersheds. An additional objective included evaluating the survey methodology.

## Study Area

The survey was conducted in the watersheds of the Kisaralik, Kwethluk, and Eek rivers (Fig. 1, Fig. 2). On YDNWR, these are the 3 largest rivers draining the southwest Kuskokwim Mountains (and associated ranges). The Kisaralik River originates in 3 alpine lakes just east of YDNWR: Kisaralik, North Fork, and Gold, at elevations of 481, 523, and 483 m, respectively. These lakes are surrounded by peaks reaching 1,500 m. The Kwethluk River is just south of the Kisaralik watershed, and begins in the Togiak Wilderness (Togiak National Wildlife Refuge). The river's source comprises several small glaciers on the northern face of peaks reaching nearly 1,400 m. Streams draining these glaciers coalesce on a glacial valley floor at an elevation of about 560 m. The Eek River is immediately south of the Kwethluk, and heads on the north slope of Mt. Oratia (1,420 m) in a series of alpine lakes at an average elevation of 640 m.

All 3 rivers flow generally westward and empty into the Kuskokwim River. The Kisaralik slices through and drains the Kilbuck Mountains, the Eek drains the Ouchklune and Eek Mountains, as well as the Great Ridge, and the Kwethluk drains the unnamed uplands between the other 2 watersheds.

With the exception of Crooked Creek (see below), the main river and all major tributaries in both watersheds were surveyed from their headwaters downstream to an elevation of approximately 150 m. This elevation was chosen as the downstream border of the study area because general biological inventories of the rivers did not detect harlequin ducks below 150 m (Brown et al. 1985a,b,c). The Kisaralik was surveyed downstream to Clear Creek (110 m) and the Kwethluk was surveyed to within 4 km of Johnson Creek (150 m). Funding constraints precluded a survey of the entire Eek drainage; instead, only the upper 33 km were surveyed. In addition, 2 sections of Crooked Creek were not surveyed, including the lower 10 km and the upper 13 km.

## Methods

The survey was conducted from a Bell Jet Ranger 206 helicopter on 1-3 June 1994. The survey crew included the pilot, a front left seat observer (BJM), and a rear right seat observer (CMH). The left seat observer was responsible for making observations both to the front and left of the helicopter. Radio communication between the 2 observers minimized the chance of double-counting birds spotted by both observers.

The survey was flown at an altitude of 10-30 m above the water at an average speed of 30 knots. On several occasions when birds flushed ahead of the aircraft, we looped out of the river corridor at speeds of up to 100 knots to pass the birds before resuming the survey, in order to reduce the risk of repeatedly pushing the same birds ahead of us for several km. At other times, forward air speed dropped to <30 knots when it was

necessary to fly slowly over areas where streams meandered extensively.

Along most streams, the pilot attempted to position the helicopter midstream to allow both observers an opportunity to scan their respective sides. In practice, however, the long axis of the helicopter was rarely parallel to the streambank. Throughout most of the survey, the nose of the helicopter was pointed slightly toward the right bank, resulting in an even larger field of view forward of the left front seat observer. Along several particularly narrow streams (i.e., Quartz and Solomon creeks along the Kisaralik; Swift, Akoswift, and Little Swift along the Kwethluk), the pilot flew along the right bank and only the left front seat observer made observations and recorded data. With 2 exceptions (totalling <5 km), only the main channels of the larger streams were surveyed; birds in secondary channels would not have been detected. However, areas flooded by beaver activity immediately adjacent to the main channels were surveyed.

Data were recorded independently by the 2 observers on hand-held cassette recorders. Cassettes were transcribed at the end of each day at base camp, and tallies were kept individually by the left and right observers. Species, number of individuals, and sex (when possible) were recorded for all bird observations, although only harlequin data are presented and discussed in this report. Locations were recorded by township, range, and section, as well as by stream or, in the case of larger streams, stream segments. Stream segments were usually defined on the basis of conspicuous hydrological, geological, biological, and/or administrative landmarks.

For each harlequin duck observation, we noted whether the bird was paired (i.e., with a member of the opposite sex) or unpaired. In addition, we recorded the behavior of nearly half of the harlequins observed in order to evaluate the short-term impact of the survey. Behavioral categories included: dive, fly, swim, off-bank (i.e., climbed into the water from the bank and began swimming), and surface-paddle (i.e., "rowing" with the wings and\or running along [but not leaving] the surface). The latter 3 behaviors have been lumped as "surface" responses (i.e., did not fly or dive) for the purposes of discussion. We have not attempted statistical analyses of the behavioral data because they do not represent a random sample.

## Results

A total of 546 km were surveyed along 19 different streams (Table 1). Harlequin ducks were observed on all 3 major rivers, as well as on 13 of 16 tributaries. A total of 403 harlequin ducks were detected, including 164 pairs, 66 unpaired males, 7 unpaired females, and 2 of unknown sex. Overall, the left front seat observer detected 346 harlequin ducks (86%) and the right rear observer detected 57 (14%).

Kisaralik Watershed - A total of 238 harlequin ducks were detected on 288 km of stream in the Kisaralik watershed (0.83 birds/km), including 91 pairs, 51 unpaired males, 3 unpaired females, and 2 ducks of unknown sex. Along the main river, 106 harlequins were seen on 91 km of river (1.16/km); harlequins were detected on all river segments except the 18 km between Clear Creek and Quartz Creek (i.e., the lower end of the study area) and the 6 km between Quicksilver Creek and Upper Falls. A total of 132 harlequins were seen along 197 km of Kisaralik tributaries (0.67/km); harlequins were detected on all tributaries except Solomon and Anvil creeks. Harlequins were observed from an elevation of 183 m on the main river near the Little Crow Hills to 518 m on the stream connecting the North Fork Lakes. All harlequins were observed along streams with the exception of a single pair on a beaver pond adjacent to upper Swift Creek.

Harlequin ducks were not distributed uniformly throughout the Kisaralik watershed. For example, the 13 km of river between the mouths of Gold Creek and the North Fork supported 45% of all pairs and 50% of all unpaired birds along the main river. In fact, the density of birds along this stretch of the Kisaralik (3.77/km) was more than 5x higher than the density of birds along the rest of the river (0.73/km). Similarly, there was substantial variation in density among the tributaries. The highest densities occurred along lower Quicksilver Creek (1.70/km), Gold Creek (1.29/km), and North Fork (1.15/km). These 3 streams comprised only 34% of all tributary kilometers surveyed, but accounted for 69% of harlequin detections.

Kwethluk Watershed - A total of 141 harlequin ducks were detected on 225 km of stream in the Kwethluk watershed (0.63/km), including 63 pairs, 11 unpaired males, and 4 unpaired females. Along the main river, 58 harlequins were seen on 98 km of river (0.59/km); harlequins were detected along all 3 river segments. A total of 83 harlequins were seen along 127 km of Kwethluk tributaries (0.65/km); harlequins were detected on all tributaries except Akoswift Creek. Harlequins were observed from an elevation of 198 m on the lower Kwethluk to 652 m in both the Swift and Little Swift drainages. Several pairs were detected away from typical riparian habitat. Along upper Fork Creek, 1 pair was detected in a flooded marsh, and a second was detected on a lake. On Little Swift Creek, 1 pair occupied a lake at 652 m, and 2 other pairs were found just downstream on a lake at 625 m. Finally, a pair was seen on a beaver pond along the upper Kwethluk about 6 km downstream of the glacial headwaters.

As on the Kisaralik, harlequin duck distribution was patchy in the Kwethluk watershed. Tremendous variation occurred along the Kwethluk River, which is naturally divided into 3 segments. The upper 27 km flow west through the steep headwater mountains, the middle 44 km flow northwest through a long, relatively level valley, and the lower 27 km downstream of the major tributaries flow across the upland plateau between Greenstone Ridge and the foothills of the Kilbuck Mountains. Harlequin duck densities

along the upper, middle, and lower segments of the Kwethluk were 1.44/km, 0.27/km, and 0.26/km, respectively. Among tributaries with harlequins, Little Swift and Fork creeks supported densities of 1.25/km and 1.00/km, respectively, whereas Swift and Crooked creek densities were only 0.50/km and 0.48/km, respectively.

Eek River - A total of 24 harlequin ducks were detected on 33 km of stream just below the Eek River headwaters (0.73/km), including 10 pairs and 4 unpaired males. Unlike the Kisaralik and Kwethluk watersheds, however, no harlequins were seen on either streams or lakes in the immediate vicinity of the Eek headwaters. The first harlequin was detected 11 km downstream of the headwater lake at an elevation of 503 m. The last harlequin detected was at 328 m near the downstream border of the surveyed area.

Behavioral Responses - The response to the survey helicopter was recorded for 195 of the 403 harlequin ducks observed (48%). Of these individuals, 32 dove (16%), 50 flew (26%), and 113 (58%) remained on the surface of the water. The actual proportion of birds remaining on the surface was much higher than this figure suggests. When we started the survey, only birds which flew or dove were noted; if the bird remained on the water, no behavioral data were recorded on the cassette. By the end of the first day, however, this system became confusing, so we started recording behavioral responses on all harlequins when possible, including those which remained on the surface. The data presented above include only those for which the behavior was explicitly stated, and thus underestimates the proportion which did not flush from the surface.

Among paired birds, 18% dove, 22% flew, and 60% remained on the surface. Among the 86 pairs for which behavioral data were recorded, members of 85 pairs (99%) exhibited the same behavior as their mate. Unpaired males responded differently than paired birds: 5% dove, 57% flew, and only 38% remained on the surface. No behavioral data were gathered for the 7 unpaired females.

Among flying birds, the direction and duration of flight varied. Most birds flushed ahead of the helicopter, but some flew back toward and then under the helicopter. When birds flushed forward, we swung out of the main river corridor and accelerated in order to pass them. This tactic may have resulted in missing a few birds on the bypassed sections of stream, but was usually successful at reducing both the duration of our impact on birds known to have flushed and the probability of accidentally double-counting them. On 3 occasions, however, after returning to the river corridor and dropping to survey speed, we were passed from behind by the birds we had earlier flushed. In all 3 cases, a second acceleration allowed us to move successfully beyond the ducks.

## Discussion

Relative Importance of the Kisaralik River - The 1994 survey suggests that the Kisaralik River supports a disproportionately high number of harlequin ducks, relative to adjacent drainages in the survey area. Within the Kisaralik watershed, the density of harlequin ducks on the main river was 1.16/km, versus a density of 0.67/km on the Kisaralik's tributaries. No harlequin ducks were seen on the lower 18 km of the main river; if this segment is excluded, the density on the river increases to 1.45/km, over 2x the density on the tributaries.

The Kisaralik watershed also supported a higher density of harlequins than did the Kwethluk. Most of this difference was due to the different densities on the 2 main rivers (1.16/km vs. 0.59/km, for the Kisaralik and Kwethluk Rivers, respectively). Densities on the tributaries in the 2 watersheds were virtually identical (0.67/km vs. 0.65/km, for the Kisaralik and Kwethluk tributaries, respectively).

Only the upper 33 km of the Eek River were surveyed, so a comparison of this segment and the entire Kisaralik and Kwethluk rivers is inappropriate. A comparison of comparable segments of the 3 rivers, however, is possible. The densities of harlequin ducks over the upper 33 km of the Kisaralik, Kwethluk, and Eek rivers were 2.1/km, 1.30/km, and 0.73/km, respectively.

Overall, 26% of the harlequins detected on the survey were located on the Kisaralik River between Kisaralik Lake and Quartz Creek, although this comprised only 14% of the surveyed habitat. To the extent that the abundance of breeding pairs reflects habitat quality, the 1994 data indicate that the best harlequin habitat within the survey area exactly coincides with the area which would be impacted by increased recreational activity.

Survey Evaluation - The aerial survey was specifically designed as a breeding pair survey. We tried to schedule the field work during an interval that maximized the number of pairs detected, i.e., after the arrival of the breeding population, but before males abandoned their mates. Based on limited data on breeding phenology in this region (Petersen et al. 1991), the first week of June was selected for surveying. Without a detailed study specifically assessing the breeding status of all birds seen, it is difficult to quantitatively evaluate the timing of the survey. However, a consideration of the ratios between paired and unpaired birds is helpful. Breeding pairs comprised 81% of all birds detected on the survey. In addition, the ratio of paired to unpaired males was 2.5:1. Two studies in Iceland reported ratios of paired to unpaired males of 1.25 and 1.75, respectively (Bengston 1972, Inglis et al. 1989) Although the southwest Kuskokwim Mountains may simply have a higher proportion of breeding males than the site in Iceland, the high ratio of paired to unpaired males in our study area suggests that most of the males that had paired were still with their mates. This latter

hypothesis is supported by the fact that only 4% of females were not with males. Thus, the limited data which can be brought to bear on the issue suggest that the timing of the survey was appropriate.

The harlequin duck densities reported here represent densities of detected birds, not absolute densities. We assume that we failed to detect some birds along the survey route. From our data alone, it is impossible to estimate the fraction of birds detected from the helicopter. We suspect, however, that the helicopter survey was very effective at locating breeding pairs, and was probably more effective than either walking or floating surveys would have been. To begin with, the vast majority of an observer's time in a helicopter can be spent observing. In contrast, both ground and water-based surveyors must, by necessity, spend more of their time watching where they are going as opposed to watching for birds.

Habitat in the survey area also contributed to the relative effectiveness of the helicopter. Only 11% of the survey area was below the coniferous treeline. Across the rest of the area, either tundra or riparian willows lined the streams. As a result, the helicopter was usually highly mobile and visibility of the river was excellent. Along a few streams, riparian willows were dense, relatively tall (5-10 m), and interfered with visibility. In most such sites, however, spring run-off was flooding the willows and probably would have rendered shoreline sites inaccessible to a surveyor on foot. Similarly, most of the streams in the southwest Kuskokwim Mountains are too treacherous to float during the peak of spring run-off, precluding water-based surveys.

An additional advantage of helicopter surveys is that the disturbance to the birds is usually brief and transient. Nearly 75% of the harlequin ducks encountered dove or remained on the surface. As a result, these individuals remained near the site where they were first spotted, and visible reactions to the helicopter were usually limited to a few dozen seconds. Even for the 26% of the birds that flew, flights rarely exceeded 2 minutes, and usually resulted in displacements of only a few hundred meters at most. In contrast, the slow pace of ground surveys can result in disturbances of several minutes at a time; raft and kayak surveys can result in birds being pushed downstream many kilometers from the point of initial contact (J. Reichel, Montana Natural Heritage Program, pers. comm.). Finally, among the species characteristic of alpine streams regularly encountered along the survey route (harlequin duck, common merganser [Mergus merganser], red-breasted merganser [M. serrator], wandering tattler [Heteroscelus incanus], spotted sandpiper [Actitis macularia], mew gull [Larus canus], arctic tern [Sterna paradisaea], American dipper [Cinclus mexicanus]), the harlequin duck was the least likely to flush ahead of the helicopter.

## Conclusions

The 1994 survey indicated that the Kisaralik River supports a disproportionately high number of harlequin ducks relative to adjacent tributaries and watersheds. Given the possible advent of commercial rafting along the river, and the impact that similar activity has had on harlequin ducks elsewhere, additional management action is clearly warranted. Based on the frequency of pairs in early June, it seems probable that the recreational rafting season (approximately 1 July-31 August) overlaps both late incubation and most of the brood-rearing period along the Kisaralik. Unfortunately, there are virtually no data on the timing, habitat, or success of nests and broods in this region. In fact, there are very few data on breeding harlequins anywhere in Alaska outside of Prince William Sound. Future field work on the Kisaralik River should focus on filling these data gaps. Without such information, it will be impossible to effectively manage recreational activity so as to minimize the impact to breeding harlequin ducks.

## Acknowledgments

The 1994 harlequin duck survey in the southwest Kuskokwim Mountains would not have been possible without the expertise and enthusiasm of our pilot, Tom Ratledge of Yukon Aviation. The authors and their wives are extremely grateful for his contribution. John Morgart and Gene Miller (USFWS-YDNWR) facilitated the field effort by arranging for fuel delivery to, and camping facilities at, the Canyon Creek field camp. Finally, suggestions and encouragement from Vern Byrd, Frances Cassirer, Pete Clarkson, Ian Goudie, Jim Reichel, and Rick Wallen were greatly appreciated.

## Literature Cited

Bengston, S.-A. 1972. Breeding ecology of the harlequin duck Histrionicus histrionicus (L.) in Iceland. Ornis Scand 3:1-19.

Brown, M., N. Brown, M. Ada, K. Bolovan, M. Lapin, K. Sullivan, and C. Ziobron. 1985a. Yukon Delta National Wildlife Refuge general biological inventory, Kisaralik River-1985. Unpubl. rep. U.S. Fish Wildl. Serv., Bethel, Alaska. 40pp.

_____, P. Paniyak, and M. Lapin. 1985b. Yukon Delta National Wildlife Refuge general biological inventory, Eek River-1985. Unpubl. rep. U.S. Fish Wildl. Serv., Bethel, Alaska. 52pp.

_____, _____, and M. Lapin. 1985c. Yukon Delta National Wildlife Refuge general biological inventory, Kwethluk River-1985. Unpubl. rep. U.S. Fish Wildl. Serv., Bethel, Alaska. 44pp.

Clarkson, P. 1992. A preliminary investigation into the status and distribution of harlequin ducks in Jasper National Park. Proceedings of the Harlequin Duck Symposium, Northwest Section of the Wildlife Society Meeting, April 23-24, 1992. Moscow, Idaho.

Gabrielson, I. N., and F. C. Lincoln. 1959. The birds of Alaska. Stackpole Co., Harrisburg, Pennsylvania, and Wildlife Management Institute, Washington, D.C. 922pp.

Genter, D. L. 1992. Status of the harlequin duck (Histrionicus histrionicus) in Montana. Proceedings of the Harlequin Duck Symposium, Northwest Section of the Wildlife Society Meeting, April 23-24, 1992. Moscow, Idaho.

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

Petersen, M. R., D. N. Weir, and M. H. Dick. 1991. Birds of the Kilbuck and Ahklun Mountain Region, Alaska. North American Fauna 76. U.S. Fish Wildl. Serv., Washington, D.C. 158pp.

United States Fish and Wildlife Service. 1993. Draft Management Plan and Environmental Assessment for the Kisaralik River. Yukon Delta National Wildlife Refuge, Bethel, Alaska. 74pp.

Wallen, R. 1992. Annual variation in harlequin duck population size, productivity, and fidelity in Grand Teton National Park, Wyoming. Proceedings of the Harlequin Duck Symposium, Northwest Section of the Wildlife Society Meeting, April 23-24, 1992. Moscow, Idaho.

White, C. M., and D. A. Boyce, Jr. 1978. A profile of various rivers and their raptor populations in western Alaska, 1977. U.S. Bur. Land Manage., Tech. Rep. BLM/AK/TR/78/01. 77pp.

Table 1. Observations of harlequin ducks in the southwest Kuskokwim Mountains, 1-3 June 1994.

| Stream | km | pairs | unpaired males | unpaired females | sex? | Total |
|---|---|---|---|---|---|---|
| Kisaralik R.[1] | 91 | 38 | 26 | 3 | 1 | 106 |
| Quartz Ck.[1] | 40 | 5 | 1 | 0 | 0 | 11 |
| Swift Ck.[1] | 18 | 3 | 0 | 0 | 0 | 6 |
| Solomon Ck.[1] | 5 | 0 | 0 | 0 | 0 | 0 |
| Quicksilver[1] | 38 | 16 | 13 | 0 | 0 | 45 |
| North Fork[1] | 26 | 14 | 2 | 0 | 0 | 30 |
| Gold Creek[1] | 17 | 9 | 4 | 0 | 0 | 22 |
| QuickTrib NW[1,2] | 15 | 2 | 0 | 0 | 0 | 4 |
| QuickTrib NE[1,2] | 16 | 2 | 2 | 0 | 1 | 7 |
| QuickTrib SE[1,2] | 8 | 2 | 2 | 0 | 0 | 6 |
| Rocky Cr.[1] | 6 | 0 | 1 | 0 | 0 | 1 |
| Anvil Cr.[1] | 8 | 0 | 0 | 0 | 0 | 0 |
| Kwethluk R.[3] | 98 | 27 | 3 | 1 | 0 | 58 |
| Crooked Cr.[3] | 42 | 8 | 2 | 2 | 0 | 20 |
| Fork Cr.[3] | 31 | 14 | 3 | 0 | 0 | 31 |
| Swift Cr.[3] | 24 | 6 | 0 | 0 | 0 | 12 |
| Akoswift Cr.[3] | 14 | 0 | 0 | 0 | 0 | 0 |
| Little Swift[3] | 16 | 8 | 3 | 1 | 0 | 20 |
| Eek River[4] | 33 | 10 | 4 | 0 | 0 | 24 |
| Totals: | 546 | 164 | 66 | 7 | 2 | 403 |

1. Kisaralik watershed
2. Three unnamed tributaries of Quicksilver Creek have been designated NW (northwest), NE (northeast), and SW (southwest).
3. Kwethluk watershed
4. Eek watershed

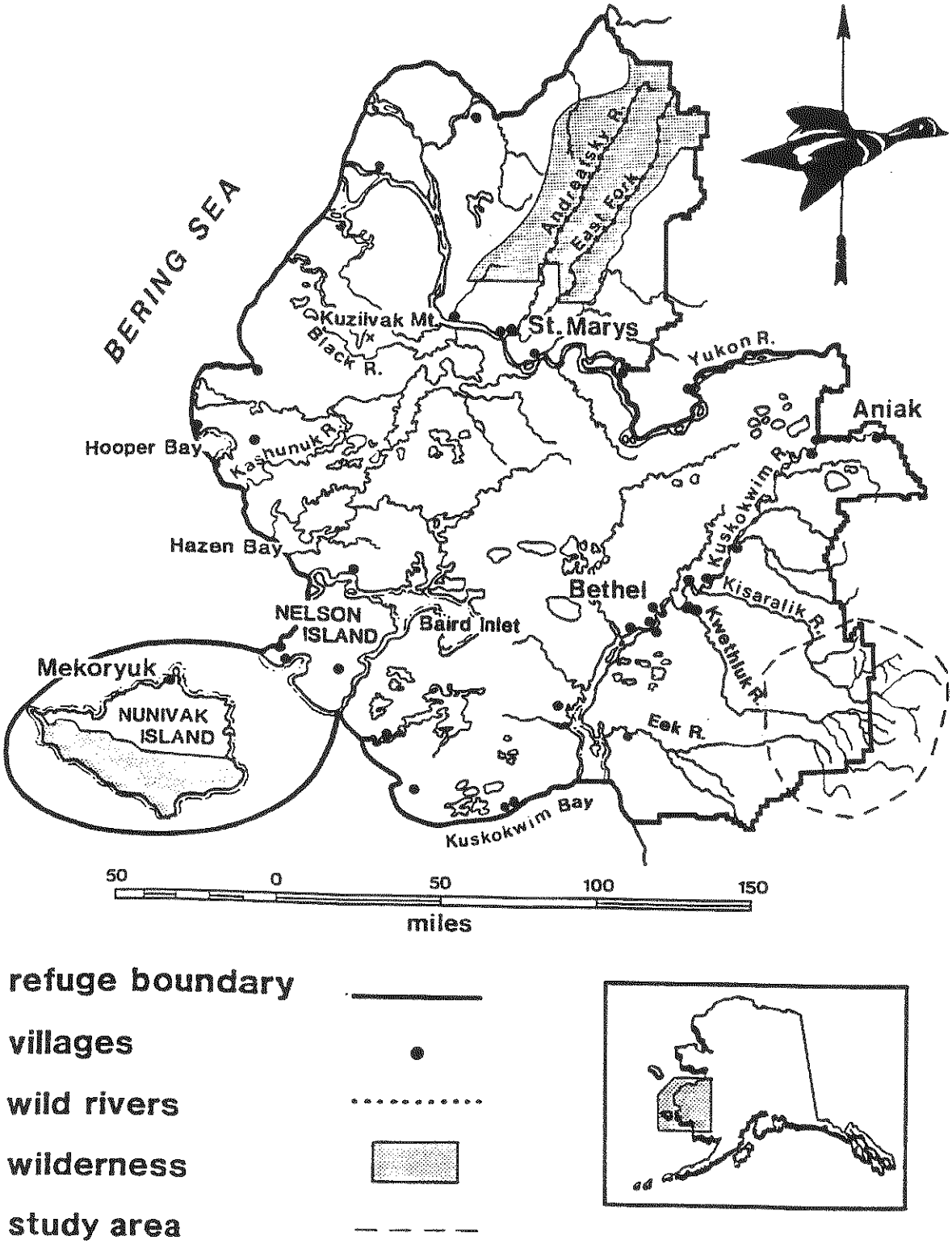
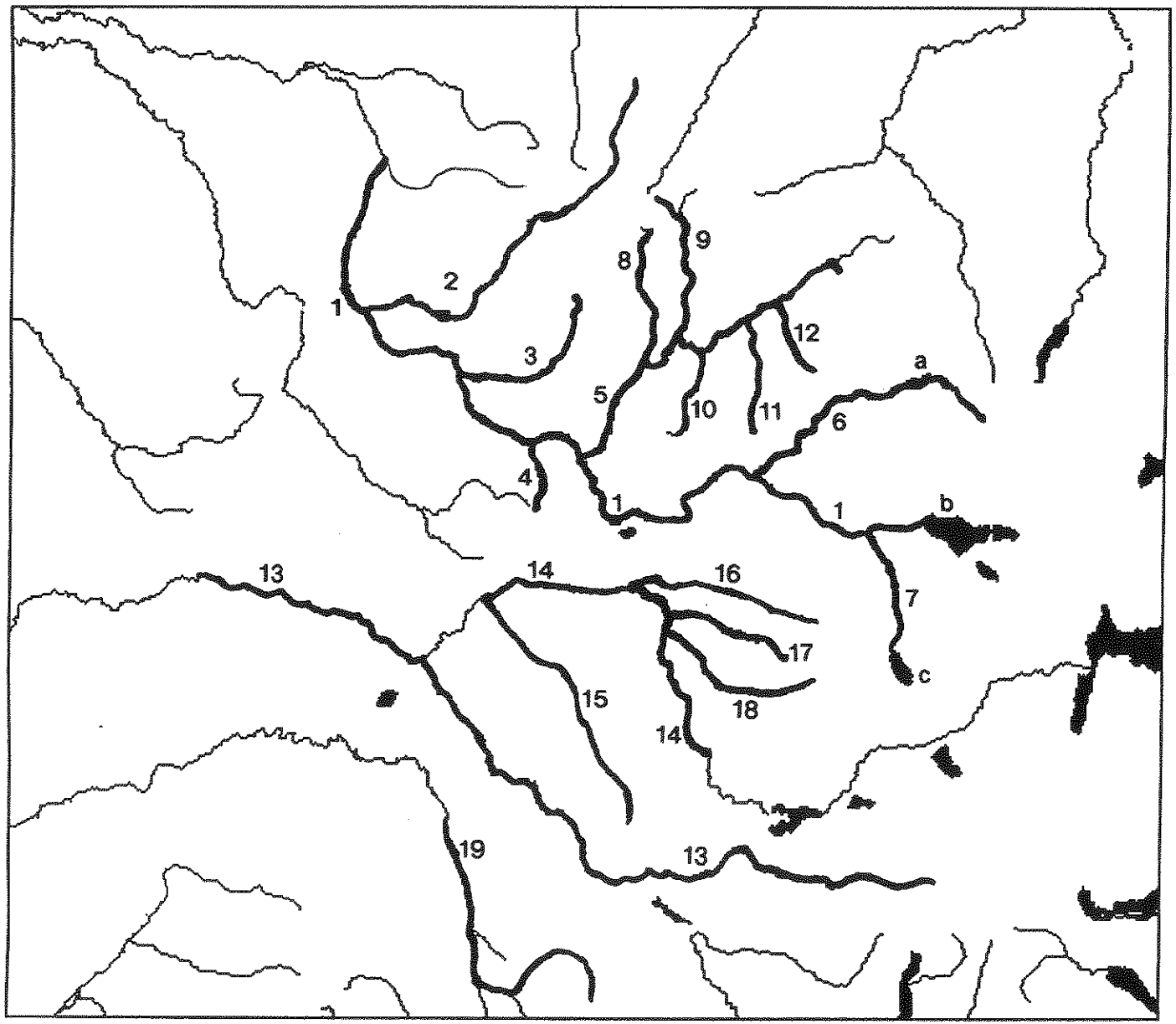



Figure 1. Yukon Delta National Wildlife Refuge and 1994 Harlequin Duck Survey Area (see southeast corner).




| No. | Stream |
|---|---|
| 1 | Kisaralik R. |
| 2 | Quartz Cr. |
| 3 | Swift Cr. |
| 4 | Solomon Cr. |
| 5 | Quicksilver Cr. |
| 6 | North Fork |
| 7 | Gold Cr. |
| 8 | QuickTrib NW |
| 9 | QuickTrib NE |
| 10 | QuickTrib SE |
| 11 | Rocky Cr. |
| 12 | Anvil Cr. |
| 13 | Kwethluk R. |
| 14 | Crooked Cr. |
| 15 | Fork Cr. |
| 16 | Swift Cr. |
| 17 | Akoswift Cr. |
| 18 | Little Swift Cr. |
| 19 | Eek R. |

| | |
|---|---|
| a | North Fork Lakes |
| b | Kisaralik Lake |
| c | Gold Lake |

Figure 2. 1994 Harlequin Duck Study Area. Surveyed streams boldly highlighted.