Population Dynamics of Harlequin Ducks in British Columbia and Alberta

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ABSTRACT

Harlequin ducks (Histrionicus histrionicus) are Yellow-listed in both British Columbia and Alberta, and are listed as a sensitive species in most of the northwestern United States. Moulting and wintering aggregations in the Strait of Georgia include birds known to breed in British Columbia, Alberta, Montana, Idaho, Washington, and Oregon. The wintering population estimate for the Strait of Georgia is 11–15,000 birds, based on capture–mark–recapture studies. Research at White Rock, B.C. shows annual survival rates of 0.82 for adult males, and 0.74 for adult females. Breeding area studies in Banff National Park and Kananaskis Country, Alberta, show that the additional mortality of females takes place during nesting and brood rearing. Breeding ground studies and age ratio counts at the wintering area show that annual productivity and survival of juveniles are both low, resulting in low annual recruitment. These parameters, combined with strong site fidelity at both the breeding and wintering areas, make harlequin ducks susceptible to unnoticed population declines.

Key words: Alberta, Banff National Park, demographic parameters, harlequin duck, Histrionicus histrionicus, productivity, Strait of Georgia, survival rate.

The harlequin duck (Histrionicus histrionicus) is a sea duck with a Holarctic distribution, and is found on the Pacific and Atlantic coasts of North America. It migrates inland to turbulent mountain streams to breed, the only waterfowl species in the Northern Hemisphere to do so.

The Atlantic population of the harlequin duck was listed as endangered in Canada in 1990, when the numbers were estimated at <1,000 individuals (Goudie 1991). That population appears to be stable or increasing slowly. Best estimates of the Pacific population are 200–300,000, with reductions documented primarily in the eastern and southern parts of the range (Cassirer et al. 1993). In British Columbia, harlequin ducks are considered a species at risk (Lofroth et al. 1996), and they were added to Alberta's Yellow List in October 1996 (Alberta Environmental Protection 1996). The Yellow List is for species for which there has been concern expressed over long-term declines in numbers. The harlequin duck is classified as a sensitive species in Oregon, a priority habitat species in Washington, and a species of special concern in Idaho and Montana (Cassirer et al. 1993).

The Strait of Georgia, B.C. is an important wintering area for harlequin ducks breeding throughout the Pacific Northwest. Marked birds from studies on breeding streams in Alberta, British Columbia, Idaho, Montana, Oregon, and Washington have been re-sighted in the Strait (Fig. 1). Campbell et al. (1990) estimated the wintering population in the Strait of Georgia as >10,000, and recent marking studies put the estimate at 11–15,000 (R. I. Goudie, Harlequin Conservation Society, unpubl. data). With constantly increasing human pressures in the wintering and breeding areas, a better understanding of the demographic parameters of harlequin ducks will enable managers to monitor this important population. The harlequin duck is a good species

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with which to study natural survival rates, as there is little hunting mortality in our study areas.

We will show that harlequin ducks exhibit: 1) high annual adult survival, but higher female mortality in summer; 2) low productivity; and 3) low juvenile survival.

STUDY AREA

Our data come from concurrent work on moulting and wintering areas in the Strait of Georgia, B.C., and on breeding streams in Alberta. The wintering survival study was conducted from July 1994 to November 1998 on a 5.5-km stretch of coastal shoreline that is near the town of White Rock, in southwestern British Columbia. The study on the breeding streams was conducted between May and September (1995–98) on the Bow River in Banff National Park, near Lake Louise, Alberta, and on the Elbow River (1996–98) and Kananaskis River (1998), southeast of Banff. In 1997 and 1998, age ratio surveys were conducted in the Strait of Georgia, between Victoria and Campbell River, during October, November, and December.

METHODS

In the coastal area, moulting harlequin ducks were corralled into a drive trap (Robertson et al. 1998). To capture birds on

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**Figure 1.** Selected locations of individual harlequin ducks banded on the breeding streams and re-sighted at moulting or wintering areas in western North America, and those banded on the moulting areas and re-sighted on the breeding streams.
the breeding stream, they were actively chased towards a mist-net set across the river (Smith 1996). Captured birds were marked on 1 tarsus with the standard United States Fish and Wildlife Service aluminum band, and on the other tarsus with a coloured plastic band with a unique 2-digit code. Band codes were subsequently read using a 20-45x or 20-60x telescope. Program MARK (White 1999) was used to obtain point estimates and confidence intervals for survival rates.

In addition, radiotelemetry techniques were used on the breeding streams. A subsample of ducks captured in the spring and autumn of 1997, and spring of 1998, were fitted with a 20.1-g intra-abdominal radio-transmitter with an external whip antenna (Korschgen et al. 1996). These transmitters were equipped with a mortality switch that changed pulse after 12 hours of inactivity. Females and young captured in autumn 1998 received a 4.0-g external radio attached mid-dorsally with a prong and sutures (Pietz et al. 1995). These transmitters had temperature thermistors that produced a slower pulse rate as the temperature dropped, indicating a dead bird. This work was performed under Simon Fraser University Animal Care Permit #478B.

During coastal age ratio surveys all harlequin ducks observed were sexed, and males were further classified as either hatch year (HY) or after hatch year (AHY) by plumage characteristics (Smith et al. 1998). Observations were made using 8x binoculars or 20-60x telescopes.

**RESULTS**

At White Rock, 150 birds were marked with leg bands: 77 males and 73 females, all ages combined. Included were 4 birds that were originally marked in Alberta and which moulted at White Rock. On the breeding streams, 287 birds (97 adult males, 72 adult females, and 118 ducklings) were marked with leg bands; these included 45 adults that were originally marked in other study areas in Alberta, British Columbia, and Washington. Radio-transmitters were attached to 76 birds in 1997 and 1998: 26 females, 7 males, and 43 juveniles.

**ADULT SURVIVAL**

Local survival rates for harlequin ducks moulting/wintering at White Rock were 0.822±0.030 (SE) for adult males and 0.739±0.037 for all female age classes (Table 1). These rates are significantly different \( Z = 1.75, P = 0.04 \). A constant recapture rate of 0.981±0.011 (0.944–0.994) was estimated for the model. Males disappeared from the study area at the same rate in the spring and summer period as in the fall and winter period \( \chi^2 = 0.662, P = 0.416 \), but females disappeared at twice the rate after the spring and summer period \( \chi^2 = 5.76, P = 0.016; \) Cooke et al. (2000).

The annual survival rate of the 1995–96 cohort of adult harlequin ducks \( n = 28 \) on the Bow River in Banff National Park was 0.750±0.073 for adult males and females to 1998 (Table 1). Of 7 males that received radio implants while on the breeding streams in 1997, none died during their residency on the stream. Of 26 females that received radio implants in 1997 and 1998, 7 died while still at the breeding stream (0.269) for a local summer survival rate of 0.731. Two of the 7 died during the pre-nesting phase (0.077), 1 died during incubation (0.038), and 4 died while accompanying broods (0.154).

**PRODUCTIVITY**

Twenty of the 26 radioed female harlequin ducks nested (0.769), laid 115 eggs (mean clutch size 6.2), and produced 56 young to class 3 (≥45 days). This was an observed productivity of 2.80 young per breeding female, or 2.15 per total (breeding and non/failed breeding) females. Twenty-three of these ducklings fledged and migrated from the breeding stream, for a real productivity of 1.15 young per breeding female, or 0.88 young per all females.

To make the comparison between productivity observed on the breeding stream to that observed via age ratio surveys we needed to make 2 calculations. We multiplied the 23 ducklings by 0.5 (assumed equal sex ratio of juveniles; Bellrose et al. 1961, Johnson et al. 1992) to arrive at 12 young per class 3 (≥45 days). This was an observed productivity of 2.80 young per breeding female, or 2.15 per total (breeding and non/failed breeding) females. Twenty-three of these ducklings fledged and migrated from the breeding stream, for a real productivity of 1.15 young per breeding female, or 0.88 young per all females.

**AGE RATIOS**

The median ratio of hatch-year harlequin duck males \( n = 245 \) to adult males \( n = 3305 \) was 0.08 (range 0.03 to 0.23) during combined October, November, and December surveys in the Strait of Georgia.

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**Table 1. Survival rates of harlequin ducks in British Columbia (1994–98) and Alberta (1995–98).**

<table>
<thead>
<tr>
<th>Study area</th>
<th>Age and sex</th>
<th>Mean survival rate</th>
<th>Standard error</th>
<th>95% confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Rock, BC&lt;sup&gt;a&lt;/sup&gt;</td>
<td>adult M</td>
<td>0.822</td>
<td>0.030</td>
<td>0.756–0.873</td>
</tr>
<tr>
<td>White Rock, BC&lt;sup&gt;a&lt;/sup&gt;</td>
<td>all F</td>
<td>0.739</td>
<td>0.037</td>
<td>0.661–0.805</td>
</tr>
<tr>
<td>Banff, AB</td>
<td>adult M and adult F</td>
<td>0.750</td>
<td>0.073</td>
<td>0.582–0.866</td>
</tr>
</tbody>
</table>

<sup>a</sup> Cooke et al. (2000).
DISCUSSION

For many years wildlife monitoring has involved counting individuals of a species to determine its population size and density. It is increasingly being recognized that these methods are insufficient for conservation purposes (Goss-Custard 1993). Densities alone may be misleading indicators, as they are not necessarily related to habitat quality in a linear manner (Crick et al. 1997). Additionally, for a long-lived species such as the harlequin duck, declines in population size may only be observed after long periods of low survival or reproduction (Crick et al. 1997). Thus, we need to have an understanding of the processes that lead to population changes (Greenwood et al. 1993). These processes are the standard demographic parameters: reproduction, survival, emigration, and immigration. In this paper we attempt to estimate the first 2 processes.

Adult male harlequin ducks had higher local survival rates than adult females. This is consistent with the male-biased sex ratio in many duck species (Bengtson 1972, Sargeant and Raveling 1992). The apparently lower male survival on the breeding stream may not reflect true mortality, as generally only paired males return to the breeding stream. Some males that have only been sighted once may still be alive, but are now breeding in a different area. If a male’s original mate dies, he will re-pair and follow his new mate to her natal stream.

During the summer months, adult female survival was lower than adult male survival. As both sexes would be expected to face the same mortality risk during migration, this suggests that higher female mortality is associated with nesting. Incubation and brood rearing are the sole responsibility of the female. Additionally, males are on the breeding streams only 6–8 weeks, while successful females may be there for 16–20 weeks (C. M. Smith unpubl. data), which could increase their predation risk if the breeding stream is riskier than the coastal environment. Winter survival was similar in the 2 sexes, further suggesting that differential mortality of the sexes occurs in the summer.

Barring additional migration mortality, the ratio of juveniles to adults observed at the wintering area should be similar to the ratio of those departing the breeding stream. In our study the median juvenile/adult ratio at the wintering area was 0.08, compared to 0.35 on the breeding stream. This discrepancy could be due to: 1) a higher rate of non-breeding, or lower productivity, by females in other breeding populations; 2) the majority of juveniles winter in areas apart from adults, and were not covered by the surveys; or 3) there is an even higher mortality of postfledging juveniles on other breeding grounds, or during migration.

The demographic parameters that we have described here—high adult survival rates, low productivity, and low juvenile survival—are typical of sea ducks (Goudie et al. 1994, Krementz et al. 1997). These parameters, combined with strong site fidelity at both the breeding and wintering areas (Smith 1996, Robertson and Cooke 1999), make harlequin ducks susceptible to unnoticed population declines.

ACKNOWLEDGEMENTS

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LITERATURE CITED


