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EFFECT OF FOOD AVAILABILITY ON ARRIVAL AND DEPARTURE DECISIONS OF HARLEQUIN DUCKS AT DIURNAL FEEDING GROUNDS

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to determine the effect of date on mean arrival and departure times after the effects of cloud cover and wind had been considered. Interactions could not be included in the model because not all wind and cloud categories occurred within each date category. Tests were performed using GLMs in SPSS 8.0 (SPSS 1997). Residuals were inspected for deviations from normality and homoscedasticity. Tolerance for type I error was set at 5%. Average times that birds spent at nearshore feeding areas were calculated by adding mean arrival and departure times relative to sunrise and sunset to the median number of daylight hours during each date period. Means 6 SD are given.

RESULTS

Harlequin Ducks were never seen near shore during the night. Around sunset, birds in small flocks flew or

FIGURE 1. Timing of arrival and departure of Harlequin Ducks at nearshore, diurnal feeding areas on Hornby Island, British Columbia, during winter, herring spawning, and spring, 1998–2000.

times during spring than winter suggests a relaxation of time constraints as day length increased.

There was no evidence of nocturnal foraging, although some individuals in winter fed near shore until almost half an hour after sunset, when it was getting quite dark. Unlike nocturnally feeding species which may compensate for increased thermoregulatory costs and decreased foraging efficiency during stormy weather by moving earlier to feeding areas (Cox and Afton 1996, Green et al. 1999), diurnal foragers may be constrained by the length of daylight, beyond which they cannot see to feed. However, it is not clear why some diurnally foraging species with diets similar to some nocturnal feeders do not also feed nocturnally (Nilsson 1970).

Birds responded to the input of abundant food during herring spawning by arriving at feeding areas near shore a few minutes later and departing almost an hour earlier than before and after spawning. More similar arrival than departure times may have been due to energy constraints of fasting through the night. Ease of meeting daily energy requirements likely contributed to the highly variable arrival and especially departure times, and the greater response to cloudy and windy weather during spawning. However, it is interesting that Harlequin Ducks did not move offshore even earlier than they did during spawning, when only 16% of their time was spent feeding (MSR, unpubl. data). This may suggest that predation risk near shore was low during daylight hours, especially during spawning, when there were large groups of birds effecting vigilance. Alternatively, digestive constraints (Guillemette 1998) may mean that birds have to spend a majority of the day at the feeding grounds, even though feeding bouts are short. The fasting period also may prove limiting if birds move offshore too early.

Arriving and departing groups were small, and birds showed little tendency to synchronize movements. Contrary to our predictions, times were least synchronous during herring spawning, when birds should have had the temporal flexibility to coordinate their movements. Offshore groups also were small and showed no tendency to coalesce into rafts. There were significantly greater proportions of larger groups in departing and offshore than in arriving flocks, but all groups were composed of less than 30 birds, and the vast majority of groups were of less than five birds.

Overall, Harlequin Ducks adjusted their activity patterns to avoid crepuscular and nocturnal periods near shore, unless constrained by food availability and the length of daylight. Whether they chose not to feed at night because predation risk near shore was high or because they could not see to feed is unknown. Some nocturnal feeding observed in other seaducks, and suspected in Harlequin Ducks elsewhere (Bengtson 1966), suggests that Harlequin Ducks may be capable of feeding after dark. Predation risk at night may be high from mammalian predators such as mink (*Mustela vison*), which were common on shore.

The methodological implications of the study for time budget analysis indicate that using time between sunrise and sunset would provide a reasonably accurate surrogate for the time available for foraging during spring, but would be less accurate during winter and spawning. Average total time that birds were near shore was 13 min longer, 57 min shorter, and 4 min longer than the time between sunrise and sunset during

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