Partial clutch loss in Wood Ducks *Aix sponsa* nesting near Ottawa, Canada

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Partial clutch loss during egg-laying and incubation was examined in Wood Ducks *Aix sponsa* nesting near Ottawa, Ontario. Over four years, partial clutch loss occurred in 20% of nests, accounting for 2% of all eggs laid. Missing eggs did not appear to be the result of predation. Larger or early clutches were no more likely than smaller or later clutches to have eggs disappear. Wood Duck eggs did not disappear more often from Wood Duck nests that also contained Hooded Merganser *Mergus cucullatus* eggs, but Wood Duck eggs laid in Hooded Merganser nests disappeared more than host merganser eggs.

Key Words: Wood Duck, *Aix sponsa*, nest parasitism, Hooded Merganser, *Mergus cucullatus*, partial clutch loss

The use of nest boxes as management tools to supplement or replace natural cavities for breeding Wood Ducks *Aix sponsa* has been widely applied in North America (Bellrose & Holm 1994). During this time, however, it has become apparent that there is often a deleterious interaction between Wood Duck behaviour and box use associated with Wood Duck nest box programmes (Eadie *et al.* 1998). Specifically, nest boxes placed in high densities and that are highly visible lead to higher nesting interference among breeding females than would probably occur in natural nesting densities. Consequently, data from nest box programmes often indicate high levels of brood parasitism by conspecifics or other species (eg Hooded Merganser *Mergus cucullatus*), high nest abandonment and, over time, declines in overall duck production from a monitored location (Allen *et al.* 1990; Eadie *et al.* 1998).

In nest box programmes, partial clutch loss is another deleterious feature of Wood Duck reproductive ecology that may be influenced by high conspecific brood parasitism. Disappearance of Wood Duck eggs from clutches has generally been attributed to egg damage and removal. In some cases, egg damage is sufficient to lead to nest abandonment, but in cases with lower levels of damage, some researchers have reported that female Wood Ducks remove damaged eggs from their nest (Bellrose & Holm 1994). In other cases, eggs are simply reported as missing (Wilkins *et al.* 1990). The relationship between partial clutch loss and clutch size was examined in a nest box population of Wood Ducks breeding near Ottawa, Ontario, using observational data from a local nest box programme. Eggs in large clutches are more susceptible to damage from crushing by other layers of eggs (Semel & Sherman 1986), and similarly eggs in clutches generated by inter- or intraspecific nest parasitism are more likely to be damaged by competition among females in the nest box (Bellrose & Holm 1994). Thus, it was predicted that eggs would be missing more often in nests with larger clutches, and that eggs would disappear more often in Wood Duck nests where clutches also contained eggs from Hooded Mergansers. Because parasitism of clutches tends to occur more often in nests initiated earlier in the season (Eadie *et al.* 1998), it was also predicted that partial clutch loss would occur more commonly in early nests.

Method

This study was conducted at the Ottawa Duck Club (ODC; 45°22'N, 75°54'W) located in the Great Lakes - St Lawrence mixed forest of eastern Ontario, Canada. Nest boxes were first erected at this site in 1966, with 179 boxes available within the 1,620ha Shirley's Bay Crown Game Preserve, but a subset of 54 boxes established in 1995 around artificial ponds on the property was monitored (Mallory *et al.* 2002).

Members of the ODC monitored nest box use by waterfowl in 1995 and 1997-1999, using methods similar to those described by Allen *et al.* (1990). All nest boxes in this study were 30x30x60cm, were made of 1.5cm plywood painted white, green or brown, and had 5cm of wood shavings in the bottom of the box. Nest boxes were erected approximately 2m above the ground on metal poles without predator guards, were placed over land within 3m of the shoreline, were generally 25m or more from wooded areas (forest or shrub growth), and were highly visible. Ponds were 0.7-5ha in area, with nest boxes erected at approximately 50-100m intervals along shorelines. Boxes were checked weekly between mid-April and August, occasionally twice a week. All duck eggs were counted and inspected visually, returned to the nest bowl and covered with existing down feathers. When the total clutch size declined between visits, this was scored as partial clutch loss. Because not all eggs

were marked, the counts represent minimum estimates of clutch size or egg disappearance. For each nest, the clutch size for analyses was the maximum number of eggs in the nest during egg-laying and incubation. Nest initiation dates were determined either by direct observation of first eggs, or by backdating from the initiation of incubation and using egg-laying rates of one egg per day (Hepp & Bellrose 1995).

Unless stated otherwise, all statistical comparisons were made using Fisher exact tests. Means are reported ±S.D.

Results

One hundred and twenty-three Wood Duck nests and 11 Hooded Merganser nests were monitored over four years, representing 768 nest box checks during egg-laying and incubation. The Wood Duck nests contained 1,827 Wood Duck eggs and 59 Hooded Merganser eggs (mean total eggs in nest 14.8±6.2). The Hooded Merganser nests contained 102 Hooded Merganser eggs and 22 Wood Duck eggs (mean total eggs in nest 9.3±2.3). In Wood Duck nests, 1,172 (64%) Wood Duck eggs and 41 (70%) Hooded Merganser eggs hatched. Partial clutch loss consisted of one to five eggs disappearing from nests between nest checks during egg-laying or incubation. This occurred in 24 (20%) Wood Duck nests monitored, with approximately equal occurrence in nests during egg-laying (n=11) or incubation (n=13; Binomial test, n.s.), and accounted for 42 Wood Duck eggs (2% of the total) (**Figure 1**). In Hooded Merganser nests, 79 (77%) Hooded Merganser eggs and six (27%) Wood Duck eggs hatched. One Hooded Merganser egg (1%) and nine Wood Duck eggs (41%) went missing from four (36%) Hooded Merganser nests.

For Wood Duck nests, median clutch size (Wood Duck eggs only) was 14 eggs. Eggs were missing from nests with 13 or fewer eggs (11 of 61 nests) in similar proportions to their disappearance from nests with 14 or more eggs (13 of 62 nests; P=0.82). When parasitic Hooded Merganser eggs were included as part of total clutch size, the median clutch size was 15 eggs. Again, partial clutch loss was not statistically more common in larger total clutches; it occurred in nine of 61 nests with 14 or fewer eggs and 15 of 62 nests with 15 or more eggs (P=0.25). One egg disappeared from 13 nests averaging 14.8±6.5 eggs, while two eggs disappeared from six nests averaging 16.3±3.6 eggs, and three or more eggs disappeared from five nests averaging 20±6.5 eggs. These clutch sizes do not differ significantly (Kruskal Wallis test, KW=2.3, P=0.32).

Wood Duck eggs disappeared from 18 of 98 nests where no Hooded Merganser eggs were present and from six of 25 nests containing some Hooded Merganser eggs (P=0.57). In Wood Duck nests containing Hooded Merganser eggs, 12 of 403 (3%) Wood Duck eggs disappeared whereas none of 59

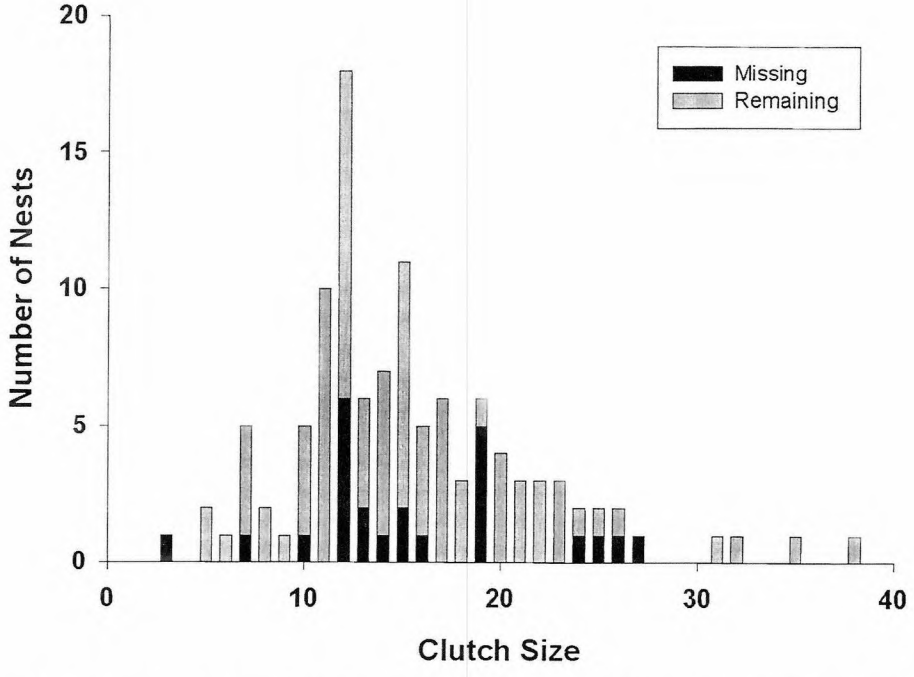

Figure 1. The distribution of nests where eggs went missing, grouped by clutch size, at the Ottawa Duck Club, Ontario, Canada. Eggs did not disappear more from larger clutches than from smaller clutches.

Hooded Merganser eggs disappeared, but this difference was not significant (P=0.38). In seven Hooded Merganser nests containing Wood Duck eggs, more Wood Duck eggs (9 of 22) than Hooded Merganser eggs (1 of 63; P<0.001) disappeared.

Tests were also undertaken to determine whether partial clutch loss was related to nest initiation date. After controlling for mean nest initiation date and annual clutch size, it was found that clutches initiated earlier in the season were larger (r=-0.36, n=123, P<0.001). Using the median nest initiation date for each year, eggs were found to have disappeared from a similar proportion of nests started before the median date (11 of 60) compared to those started after the median date (10 of 60; P=1.0).

Discussion

Few studies have kept detailed records on partial clutch loss in Wood Ducks during incubation, which may be due in part to the differing designs, goals and assessment procedures used in various nest box programmes (Bellrose & Holm 1994). In this study, a relatively small proportion of total Wood Duck eggs laid (2%) disappeared from nearly 20% of the nests monitored

at the ODC. This represents a minimum estimate, as some egg loss may have gone undetected (a few eggs could have been laid and removed between inspections). The small levels of partial clutch loss observed (up to five eggs) were not sufficient to lead to nest abandonment, consistent with results from other studies of responses to partial clutch loss in birds (Armstrong & Robertson 1988; Fernandez & Reboreda 2000). None the less, with approximately 14 eggs per average clutch, the 42 eggs that disappeared correspond to three full clutches over this time period.

What is notable at this site is that these losses do not appear to result from unrecorded predation. The potential predators at the ODC include Raccoons *Procyon lotor*, Starlings *Sturnus vulgaris*, Black Squirrels *Sciurus carolinensis* and perhaps Northern Flickers (Wilkins *et al.* 1990); the site is north of the range of the Black Rat Snake *Elaphe obsoleta*. However, Raccoon predation (ie broken eggs, hairs in the box) was observed at only one box in each of the years of this study, perhaps because they find the metal poles difficult to climb. Squirrel predation was never observed over 14 years of observations at this site, and was probably low because most of these boxes were located in open fields around the ponds (Mallory *et al.* 2002). Hence, any predation was likely to be avian. In the four years of this study, holes pecked in eggs were never observed, as would be expected with avian predation (Wilkins *et al.* 1990). The only birds observed regularly at boxes (other than ducks) were starlings, and starling predation on duck eggs has not been recorded by the author. In almost all cases, starlings built nests on top of existing Wood Duck clutches, but did not damage the duck eggs. Therefore, in the absence of physical evidence of predators in or near the nest boxes despite frequent visits to the ponds, it must be concluded that predation at this site was low.

Why, then, did these eggs disappear? It is possible that some eggs were damaged and removed by the nesting female, even though no one at the club has ever observed this behaviour. Damaged eggs should occur more frequently in large clutches, because these clutches usually result from conspecific nest parasitism. Hence, skirmishes among females during competition for the nest site (Bellrose & Holm 1994), or stacking of eggs on top of other eggs, could make egg damage more probable (Semel & Sherman 1986). Removal of damaged eggs has been reported for Wood Ducks (Bellrose & Holm 1994), as it has for many other birds (Kemal & Rothstein 1988, Mallory *et al.* 2000). Indeed, 18 of 20 eggs that went missing at Wood Duck nests in an Illinois study were damaged prior to removal by the female (Semel & Sherman 1986), and this might also explain egg disappearance in a Louisiana study (Strader *et al.* 1978). In one study that reports on 'missing eggs', up to 11% of all eggs

laid at the Yazoo National Wildlife Refuge were reported as missing, although this is probably biased high by unrecorded predation at a site with high identified predation (Wilkins *et al.* 1990). In the ODC nest boxes, however, the large floor in the nest boxes accommodated nests of 24 eggs without having eggs rest on top of each other, and, despite many nests holding large clutches (>15 eggs), damaged eggs were rarely observed. Moreover, even if large, parasitised clutches and corresponding egg damage at the ODC did contribute to some egg losses, it was unlikely to explain all egg disappearance; partial clutch loss occurred in clutches of all sizes.

Eggs might also disappear because the nest host or the parasite actively removes an egg. The ODC data suggest that Hooded Mergansers might be removing Wood Duck eggs, as was observed by Dugger *et al.* (1999) in Hooded Merganser nests in Missouri. Certainly, Wood Duck eggs disappeared from over half of the mixed clutches where the Hooded Merganser was the host, and in some of these cases it is believed that a Wood Duck initiated the nest and was usurped by a merganser. Presumably, then, the merganser removed some of the initial Wood Duck eggs once her nest and clutch were established. There was no statistical difference in the occurrence of partial clutch loss in Wood Duck nests containing or lacking Hooded Merganser eggs, but this does not preclude the possibility that mergansers were responsible for some of these egg removals. Hooded Mergansers might remove Wood Duck eggs for two reasons. First, because the number of eggs hatched may be reduced in large clutches (Eadie *et al.* 1998; Mallory *et al.* 2002), parasitic female mergansers might benefit by removing a Wood Duck egg and thereby increasing the chance that their own eggs receive adequate heating. Recent evidence suggests Hooded Mergansers have good egg recognition capabilities (Mallory & Weatherhead 1993; Dugger *et al.* 1999). It is unclear what egg recognition capabilities Wood Ducks possess. Second, the shells of the Hooded Merganser eggs are much thicker than those of the Wood Duck. (Mallory & Weatherhead 1990), so in mixed clutches Wood Duck eggs may break more easily and be removed as part of nest maintenance.

It is unclear how common partial clutch loss is among cavity-nesting ducks. Erskine (1971) reported that partial clutch loss was observed rarely among Buffleheads *Bucephala albeola* in two years of study, and Mallory (1991) never observed it among Common Goldeneyes or Hooded Mergansers, despite frequent inter- and intraspecific brood parasitism. Clearly, it does occur in Wood Ducks using nest boxes (eg Wilkins *et al.* 1990); the extent of occurrence in Wood Ducks using natural cavities is unknown. These observational data suggest that frequent nest box checks during incubation are required to measure the true clutch

size of females, as some eggs disappear during laying and incubation. Moreover, the roles that egg breakage and interspecific nest parasitism play in partial clutch loss require experimental study to elucidate the causes of egg disappearance.

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