Multistate modeling of brood amalgamation in White–winged Scoters *Melanitta fusca deglandi*

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Extended abstract

Multistate modeling of brood amalgamation in White–winged Scoters Melanitta fusca deglandi.— Female waterfowl may lose or abandon offspring shortly after hatch often resulting in the phenomena of post–hatch brood amalgamation (PHBA; Eadie et al., 1988). Potential fitness implications of this behavior has generated considerable debate (Eadie et al., 1988; Pöysä, 1995; Savard et al., 1998) about physiological or ecological costs and benefits to ducklings in amalgamated broods. Several researchers have proposed that PHBA is a result of, but is not limited to, accidental mixing (i.e., accidental mixing hypothesis), initial brood size at hatch (i.e., brood size and success hypotheses), or maternal female condition at hatch (i.e., energetic stress hypothesis) (Eadie et al., 1988; Bustnes & Erikstad, 1991; Pöysä, 1995).

We studied PHBA in July and August, 2000–2001, in a population of White–winged Scoters on Redberry Lake, Saskatchewan, (52° 00' N, 107° 10' W), a 4,500 ha federal bird sanctuary and World Biosphere Reserve. Ducklings ($n = 265$ in 2000 and $n = 399$ in 2001) were captured in nests at hatch, given a uniquely–colored nape marker for individual identification, and re–observed during daily observation sessions. We were interested primarily in movement probabilities during the first two weeks after hatch, when most travel by ducklings occurs, and after which duckling survival was constant (Traylor, 2003).

We used multistate modeling (Brownie et al., 1993) in Program MARK (White & Burnham, 1999) to test hypotheses concerning PHBA. We estimated probabilities of (1) staying with putative mothers and natal siblings, $\hat{\Psi}^{MM}$ or (2) movement to a foster brood followed by adoption by a foster mother and conspecific non–siblings, $\hat{\Psi}^{MF}$. We tested hypotheses about relationships between $\hat{\Psi}^{MF}$ and hatch date, brood size at hatch, female condition at hatch and size, duckling condition and size at hatch, and weather within one week of hatching.

An average of 37.7% and 9.6% of ducklings moved to foster broods in 2000 and 2001, respectively. PHBA was highest the first four days of duckling age in 2000 and the first ten days in 2001. Duckling movement to foster broods in 2000 was a function of hatch date ($\hat{\beta}_{HD} = -1.24$, 95% CL: –2.33, –0.15), female condition ($\hat{\beta}_{FC} = -0.83$, 95% CL: –1.52, –0.14), and female size ($\hat{\beta}_{FS} = -1.26$, 95% CL: –2.21, –0.32). In 2001, duckling movement probability was related to hatch date ($\hat{\beta}_{HD} = 0.33$, 95% CL: –0.07, 0.72), initial brood size ($\hat{\beta}_{BS} = -0.69$, 95% CL: –1.12, –0.25), female condition at hatch ($\hat{\beta}_{FC} = 0.35$, 95% CL: –0.08, 0.78), female size ($\hat{\beta}_{FS} = -0.32$, 95% CL: –0.74, 0.10), duckling condition ($\hat{\beta}_{DC} = -0.54$, 95% CL: –0.99, –0.10), and weather ($\hat{\beta}_{PI} = 1.14$, 95% CL: 0.63, 1.64); 95% CL ($\hat{\beta}_{HD}$, $\hat{\beta}_{FC}$, $\hat{\beta}_{FS}$) included zero suggesting weak effects on $\hat{\Psi}^{MF}$, but their inclusion resulted in considerably better models than if these effects were ignored.

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Our estimates of movement probabilities to foster broods are unbiased by any failure to account for detection probability and are the first published for ducklings. Unlike some studies that suggest PHBA occurs later in brood rearing (Pöysä, 1995), we found that most PHBA occurred soon after hatch (< 4 days) in scoters. We found that PHBA conformed to predictions from multiple hypotheses and was a function of weather, hatching synchrony, nesting densities, brood rearing areas and their likely effects on predation efficiency of gulls. Predation is likely the most important factor in evolution of PHBA (Bustnes & Erikstad, 1991; Pöysä et al., 1997). Redberry Lake's nesting gulls feed intensively on newly hatched ducklings. In addition, biotic and abiotic effects interact with disturbances (i.e., predation attempts, large wave action, conspecific interactions) that may have resulted in accidental mixing because ducklings have not fully imprinted on parents and are highly gregarious after hatch (Savard et al., 1998).

The energetic stress hypothesis reasons that PHBA may result from state–dependent decisions of maternal and foster hens contingent upon nutrient reserves of females at hatch. We found that likelihood of offspring movement was inversely related to female condition. Such females may make decisions about abandonment of ducklings before ducklings are completely hatched to spare energy associated with brood rearing (Eadie et al., 1988). The brood size hypothesis predicts that small broods are most likely to be abandoned (Pöysä, 1995). We found that adopted ducklings were from smaller broods. Parental investment theory predicts less parental care for offspring experiencing high mortality as it is indicative of future survival prospects and low reproductive value (Carlisle, 1985; Pöysä, 1995). Our combined findings of high duckling mortality soon after hatch from intense gull predation at hatch (Traylor, 2003), significant amount of adoption after hatch, and positive effects of brood size on duckling survival support the brood success hypothesis (Pöysä, 1995; Pöysä et al., 1997).

Use of multistate modeling enabled proper estimation of relationships between likelihood of duckling adoption and numerous ecological variables. PHBA in this population appears to be consistent with several hypotheses, although it is probably a complex function of numerous factors that vary year to year.

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