

plant biomass, thereby reducing either the vegetative or macroinvertebrate (Krull 1970) food resources used by native waterfowl. In this study, we were unable to document any effect of swan herbivory on aquatic vegetation. However, swan populations in the area are increasing (Allin et al. 1987) and breeding territories are becoming smaller. For instance, in 1983 there were two breeding pairs on Lake Whitney, but by 1990 there were six. Hence, while current swan densities are not having an impact on aquatic plant biomass in New England ponds, this may change if swan densities increase substantially.

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Siblicide and Cannibalism at Northern Goshawk Nests

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In many asynchronously hatching birds, brood size decreases during the nestling period in a characteristic pattern, starting with the last-hatched chick. This has been widely interpreted as a system by which family size is adjusted to match available levels of essential parentally provided resources (Lack 1954). One cause of this mortality in some raptors and other predatory birds is fatal sibling aggression (e.g. O'Connor 1978, Stinson 1979, Mock et al. 1990), after which the victim's tissues are sometimes ingested by family members (Ingram 1959, Mock 1984, Bortolotti et al. 1991). There is some controversy over how often consumption of the victim occurs and, as a separate issue, how important an evolutionary component the cannibalism per se may be (reviews in Elgar and Crespi 1992, Stanback and Koenig 1992).

Siblicide and cannibalism is uncommon among avian species (Mock 1984, Mock et al. 1990, Stanback and Koenig 1992). Most reports are based on indirect evidence, such as remains of nestlings found in nests (Heintzelman 1966, Pilz 1976, Moss 1979, Bechard 1983), and may fail to unequivocally identify the cause of death. Observational accounts of siblicidal and cannibalistic events are few (Newton 1978, Pilz and Seibert 1978, Jones and Maney 1990, Bortolotti et al. 1991, Negro et al. 1992). The key events tend to be brief (Mock 1984) and may go unwitnessed unless a nest is under constant observation.

We report the observation of a nestling Northern Goshawk (*Accipiter gentilis*) killing and cannibalizing a sibling after the adult female disappeared from the nest area. In addition, we describe a separate incident

in which a nestling goshawk was likely cannibalized, but the ultimate cause of death is unknown.

On 9 July 1992, an adult female goshawk unexplainably disappeared from a nest containing three nestlings on the North Kaibab Ranger District, Kaibab National Forest, Arizona. Although radio telemetry indicated the adult male goshawk remained in the area during the following days, he was not observed delivering prey or attempting to care for the nestlings during two 3-h blocks and one 6-h block of nest monitoring.

During nest observations on 11 July, the eldest nestling, a male (21 days old), became aggressive toward his two siblings. At 1655 MST the eldest nestling (N1) approached the two younger siblings (N2 and N3) and made pecking attacks at their heads. Nestlings N2 and N3 retreated to the nest rim and assumed submissive postures described by Schnell (1958), after which N1 discontinued his attacks and remained in the nest. When N3 attempted to move back onto the nest, N1 attacked it with aggressive pecks to the head and eyes. N3 was not aggressive in defending itself, but rather struggled to escape from the attack of N1. Bleeding around the left eye of N3 became apparent at 1710. At 1718 the N3 nestling ceased all movement, and nestling N1 began feeding on it by pecking small pieces of flesh from its head and neck.

Nestling N2 attempted to re-enter the nest at 1728, 1734, and 1741, but with each attempt N1 stopped feeding and attacked N2 until it retreated to the nest rim. N1 approached N2 at 1745 and attacked it with pecks to the head. N2 retreated out of the nest and onto a branch, where it assumed a submissive posture until falling to its death at 1807. Meanwhile N1 had returned to feed upon N3, completely stripping the head and neck of tissue. At 1831, N1 discontinued feeding, apparently physically unable to tear apart the victim's head and neck, or to peck tissue from the main body. Observations ceased at 1858 when the relief crew arrived and climbing equipment became available. We removed N1 from the nest and placed it in the care of a wildlife rehabilitation facility.

The male goshawk may have provided food to the nestlings when the nest was not being observed. We believe this unlikely, however, due to the starved condition of all three nestlings and the lack of any new prey remains in the nest or nest stand. We suspect these nestlings had been deprived of food for 2.5 days or more. Food stress has been associated with cannibalism in the American Kestrel (*Falco sparverius*; Bortolotti et al. 1991), and we believe it may have led to the siblicide and cannibalism of the goshawk nestling.

An important question is whether N1 viewed its siblings as competitors for limited resources or as potential meals. The initial attack by N1 was apparently directed at forcing the siblings from the nest. When the N2 and N3 nestlings retreated to the nest rim and assumed submissive postures, N1 stopped attacking.

The N1 nestling resumed its attacks, eventually killing N3, only after N3 had attempted to re-enter the nest. Once N3 was dead, however, the cannibalistic event may have simply been opportunistic scavenging. On the other hand, the final attack by N1 upon N2 was apparently unprovoked.

We are also aware of one case of probable cannibalism. In 1991 we found feathers and the right talons and tarsus of a goshawk nestling in a nest with a surviving sibling. The surviving nestling (33 days old) was in excellent physical condition when we made this discovery. Although siblicide is a possibility, we never observed any act of sibling aggression at this nest. There were no obvious indications the victim nestling was ill, injured, or suffering from a lack of food during a nest observation just two days earlier. Infanticide is a possible cause of death, and likely to occur under some circumstances (Newton 1978, Moss 1979), but we never observed any evidence of this occurring during 1,539 h of observations at 20 Northern Goshawk nests.

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Gastroduodenal Motility and Glandular Stomach Function in Young Ostriches

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Gastroduodenal motility has been described in several avian species. In domestic turkeys (*Melagris gallopavo*; Duke et al. 1972, Dziuk and Duke 1972), chickens (*Gallus gallus*; Roche et al. 1971), Cedar Waxwings (*Bombycilla cedorum*; Levey and Duke 1993), and Leach's Storm-Petrels (*Oceanodroma leucorhoa*; Duke et al. 1989), the sequence begins with contraction of the pair of thin muscles of the muscular stomach. Next, a wave of contraction starts through the duodenum and while this wave progresses, the pair of thick muscles contracts. Last, a wave of contraction moves orad to aborad through the glandular stomach (Duke et al. 1972, Dziuk and Duke 1972). Ingesta moves from the muscular stomach into the duodenum during contraction of the thin muscles, from the muscular stomach to the glandular stomach during contraction of the thick muscles, and from the glandular stomach back to the muscular stomach during glandular stomach contraction. Members of the Strigiformes (Duke et al. 1976), Falconiformes (Duke 1989), and Ciconiiformes (Rhoades and Duke 1975) lack the thin and thick muscles in their muscular stomach, however, and their contractile pattern consists of a wave of contraction that starts

at the orad end of the glandular stomach and proceeds through the muscular stomach and duodenum. Most avian species possess thin and thick muscles and the muscular stomach is two to three times larger than the glandular stomach (McLelland 1979). However, in some species (e.g. Struthioniformes, Procellariiformes, and Sphenisciformes), the glandular stomach is larger than the muscular stomach. A major function of the large glandular stomach in storm-petrels and other procellariiforms is to retain their very high fat diet and slowly pass it to the duodenum where fat digestion occurs. This avoids loading too much fat into the duodenum at once which would reduce digestibility (Duke et al. 1989).

The large glandular stomach of Ostriches (*Struthio camelus*) may temporarily store newly ingested food, but postmortem examinations of several birds showed no evidence that it serves as a fermentation chamber (Duke pers. obs.). The paired ceca and colon, however, clearly serve this function (Skadhauge et al. 1984). The gastroduodenal contraction sequence has not been described in Ostriches, and the purpose of the large glandular stomach is unknown. Therefore, our ob-