LITERATURE CITED

BERTRAM, B.C.R. 1979. Ostriches recognise their own eggs and discard others. Nature 279:233–234.

BUCKLEY, P. A., AND F. G. BUCKLEY. 1972. Individual egg and chick recognition by adult Royal Terns (*Sterna maxima maxima*). Anim. Behav. 20:457–462.

BURTT, E. H., JR. 1977. Some factors in the timing of parent-chick recognition in swallows. Anim. Behav. 25:231–239.

FREDRICKSON, L. H. 1969. An experimental study of clutch size in the American Coot. Auk 86:541–550.

FREDRICKSON, L. H. 1970. Breeding biology of American Coots in Iowa. Wilson Bull. 82:445–457.

GRZYBOWSKI, J. A. 1979. Responses of Barn Swallows to eggs, young, nests, and nest sites. Condor 81:236–246.

HOOGLAND, J. L., AND P. W. SHERMAN. 1976. Advantages and disadvantages of Bank Swallow (*Riparia riparia*) coloniality. Ecol. Monogr. 55:33–58.

HORSFALL, J. A. 1984. Brood reduction and brood division in coots. Anim. Behav. 32:216–225.

LANIER, G. A., JR. 1982. A test for conspecific egg discrimination in three species of colonial passerine birds. Auk 99:519–525.

LESSELLS, C. M. 1986. Brood size in Canada Geese: a manipulation experiment. J. Anim. Ecol. 55: 669–689.

PEEK, F. W., E. FRANKS, AND D. CASE. 1972. Recognition of nest, eggs, nest site, and young in female Red-winged Blackbirds. Wilson Bull. 84:243–249.

ROTHSTEIN, S. I. 1975. An experimental and teleonomic investigation of avian brood parasitism. Condor 77:250–271.

SHUGART, G. W. In press. Individual clutch recognition by Caspian Terns. Anim. Behav.

TSCHANTZ, B. 1959. Zur Brutbiologie der Trottellumme (*Uria aalge* Pont.). Behaviour 14:1–100.

VICTORIA, J. K. 1972. Clutch characteristics and egg discriminative ability of the African Village Weaverbird *Ploceus cucullatus*. Ibis 114:367–376.

WELLER, M. W. 1971. Experimental parasitism of American Coot nests. Auk 88:108–115.

The Condor 89:676–678

GRASSHOPPER CONSUMPTION AND SUMMER FLOCKS OF NONBREEDING SWAINSON'S HAWKS[1]

C. G. JOHNSON, L. A. NICKERSON, AND M. J. BECHARD
Department of Biology, Boise State University, Boise, ID 83725

Key words: Swainson's Hawk; Buteo swainsoni; *grasshoppers; flocking.*

Over the past 100 years, several large flocks of Swainson's Hawks (*Buteo swainsoni*) have been reported in western North America. The accounts describe what appear to have been premigratory aggregations of up to 200 hawks gathered in late summer in locations experiencing grasshopper infestations (Fisher 1893, Bent 1937, Taylor 1946, Woffinden 1986). In June 1985, five flocks ($\bar{x} = 76$ birds) of immature and adult Swainson's Hawks were observed in southern Saskatchewan and Idaho in areas undergoing grasshopper outbreaks, but, in this case, flocking occurred a full 2 months earlier than previously reported.

We monitored the daily activities of one flock which was located 11 km southwest of Boise, Idaho, in a 36-km^2 area of agricultural habitat that consisted of alfalfa and corn fields heavily infested with grasshoppers (*Melanoplus* spp.). The area was crossed at 1.6-km intervals by county roads and included a canal system and reservoir that supported small stands of cottonwoods (*Populus trichocarpa*). It also contained three active Swainson's Hawk nests with young raised successfully in at least two. The third nest, when found in August, was being used as a roost so we were unable to ascertain its productivity.

Observations were made daily between 19:30 and 22:00. We drove within 100 m of the flock and used a window mounted spotting scope to make counts and record observations on feeding behavior. Pellets were collected at the bases of roost trees throughout the summer to determine the diet. Collections were made late in the day prior to beginning daily observations but, on two occasions, pellets were collected in the morning to obtain fresh samples. Mammal bones and insect body parts were used to identify prey.

[1] Received 1 December 1986. Final acceptance 16 March 1987.

When first observed on 20 June the flock consisted of 31 hawks. Thereafter, size fluctuated reaching a maximum of 238 birds on 4 August, followed by a rapid decline until late August. Birds of both light and melanistic color phases, as well as numerous intermediate forms similar to those described by Cameron (1908) and Bowles and Decker (1934), were observed. Most birds appeared to be immatures, but the large amount of variation in plumages made it impossible to determine the exact age structure of the group.

Buteos typically use a "perch and soar" style of hunting (Fitzner 1980). The birds we observed, however, foraged exclusively on the ground in recently mowed or plowed alfalfa fields. Mingling at times with Common Ravens (*Corvus corax*), they fed on grasshoppers using a "pounce and peck" type of hunting strategy similar to that reported by Fisher (1893) and Fitzner (1980). The group was frequently found at a previous day's feeding site, sometimes remaining at the same site up to 18 days before moving to a new location.

Each night, just before sunset, the flock moved to one of three roosts that consisted of small clumps of cottonwoods ranging from 18 to 32 m in height, adjacent to either foraging or bathing sites. The roost used during late June and early July also supported an active American Kestrel (*Falco sparverius*) nest. As many as 50 hawks regularly used this roost despite its proximity to humans, dogs, and territorial kestrels. During the warm, August afternoons, the flock bathed at a reservoir located in the study area. After bathing, birds perched in adjacent dead cottonwoods, preened until sunset, then flew to a roost which had earlier been an active Swainson's Hawk nest territory.

Grasshopper remains were found in 98.8% of the pellets analyzed ($n = 300$) and they were the only remains found in 76.7%. Beetle (Curculionidae) and vole (*Microtus montanus*) remains occurred in 21.4% and 1.3% of the pellets, respectively. We attempted to estimate a hawk's daily grasshopper consumption by pairing all the grasshopper mandibles found in a pellet and equating a pair of mandibles to one grasshopper. A total of 7,736 mandible pairs were obtained from 65 pellets for an average of 98.3 (± 4.0, SE) grasshoppers per pellet (Table 1). Comparison of collection means indicated the number of grasshoppers in a pellet remained relatively constant throughout the study period ($P > 0.05$, ANOVA). Likewise, there was only slight variation between estimates for freshly cast and dry pellets ($P > 0.05$, Student's t-test). Assuming that a hawk cast once a day, its daily grasshopper consumption would have equalled 100 insects. This estimate compares very closely to the estimate of 97 grasshoppers calculated by Fisher (1893) during his 1888 study. Using our estimate for daily consumption with the average monthly flock size, we estimated that the group consumed at least 310,000 grasshoppers while on the study area.

We concluded that flocks of Swainson's Hawks can be rather widespread in years when grasshopper infestations are great. Seldom observed in the past, it is unlikely that such aggregations are ever very common, but form only in those locations where the environmental requisites of the species become optimal. By attracting birds from surrounding habitats, these flocking loci harbor mixed groups of immature and adult hawks sharing such resources as food, roosts, perches, and bathing sites. Flocking does not usually occur until late summer when grasshopper hatching is completed and infestations are most severe (Fisher 1893, Bent 1937). Nevertheless, our study indicates that, in years when there are large hatches of grasshoppers earlier in the summer, flocks can form as soon as 15 June and last for the duration of the nesting season.

TABLE 1. Grasshopper consumption by flock of Swainson's Hawks studied during the summer of 1985.

Date	Number of pellets analyzed	Total number of grasshoppers	Mean number of grasshoppers per pellet (±1 SE)
7 July	7	520	74.3 ± 13.2
12 July	6	464	77.3 ± 9.0
22 July	10	891	89.1 ± 11.9
22 July	10[a]	1,202	120.2 ± 10.5
23 July	6	626	104.3 ± 13.9
27 July	10	932	93.2 ± 6.1
30 July	10[a]	1,066	106.6 ± 8.4
13 August	6	691	115.2 ± 13.0
Total	65	6,392	98.3 ± 4.0

[a] Freshly cast pellets.

These results bring to light an interesting feature of the feeding ecology of this species and point to an area where further study is needed. Like several Old World migratory raptors, such as the Western Red-footed Falcon (*F. vespertinus*) and Eleonora's Falcon (*F. eleonorae*), the Swainson's Hawk is principally an insect feeder on its wintering grounds (Smith 1980; Houston, pers. comm.; White, pers. comm.). However, when moving north to breed, it undergoes a dietary shift, switching to larger prey such as ground squirrels, *Spermophilus* spp., deer mice, *Peromyscus maniculatus,* pocket gophers, *Thomomys* spp., and voles, *Microtus* spp. (Bechard 1980, Fitzner 1980, Schmutz et al. 1980). Presumably, such a shift to larger, mammalian food items is necessitated by the demands on breeding hawks to meet the dietary needs of brooding females and developing young. If so, it would follow that, when a Swainson's Hawk is unconstrained by the requisites of breeding, its North American diet would continue to be insectivorous. Given the abundance and ease of capture of insects such as grasshoppers and the level of opportunism shown by the Swainson's Hawk, such a diet would provide a rich prey base upon which young, inexperienced hawks could depend without competing with breeding members of the population for food. Few data are available on the dietary habits of nonbreeding birds, but observations on flocks of immature and unmated Swainson's Hawks feeding largely on grasshoppers indicate that the diet of this segment of the population could in fact remain insectivorous for most of the species' summer residence in North America (Fisher 1893, Taylor 1946, Woffinden 1986, this study). Such a dichotomy in diets between differing age and breeding classes of Swainson's Hawks has received little attention from past studies that have been based on

observations of food items at nests. Because of this possible bias, we feel that future studies should emphasize the dietary habits of nonbreeding Swainson's Hawks to determine the importance of insects such as grasshoppers in the feeding ecology of this species.

We would like to express our thanks to C. Baker, D. Francis, C. S. Houston, C. Ketchum, M. Kochert, J. Marks, B. McCarty, and M. Nelson for their assistance during this study.

LITERATURE CITED

BECHARD, M. J. 1980. Factors affecting nest productivity of Swainson' Hawks (*Buteo swainsoni*) in southeastern Washington. Ph.D. diss., Washington State Univ., Pullman.

BENT, A. C. 1937. North American birds of prey. Part 1. U.S. Natl. Mus. Bull. 167.

BOWLES, J. H., AND F. R. DECKER. 1934. Swainson's Hawk in Washington state. Auk 51:446–450.

CAMERON, E. S. 1908. Changes of plumage in *Buteo swainsoni*. Auk 25:468–471.

FISHER, A. K. 1893. The hawks and owls of the United States in their relation to agriculture. U.S. Dept. Agric., Div. Ornithol. Mamm. Bull. 3:72–79.

FITZNER, R. E. 1980. Behavioral ecology of the Swainson's Hawk (*Buteo swainsoni*) in Washington. Pacific Northwest Lab., Prepared for the U.S. Dept. of Energy, DOE contract #DE-AC06-76RLO 1830.

SCHMUTZ, J. K., S. M. SCHMUTZ, AND D. A. BOAG. 1980. Coexistence of three species of hawks (*Buteo* spp.) in the prairie-parkland ecotone. Can. J. Zool. 58:1075–1089.

SMITH, N. G. 1980. Hawk and vulture migrations in the Neotropics, p. 51–65. *In* A. Kast and E. S. Morton [eds.], Migrant birds in the Neotropics: ecology, behavior, distribution and conservation Smithsonian Inst. Press, Washington, DC.

TAYLOR, W. P. 1946. Swainson's Hawks working on grasshoppers again. Condor 48:95.

WOFFINDEN, N. D. 1986. Notes on the Swainson's Hawk in central Utah: insectivory, premigratory aggregations, and kleptoparasitism. Great Basin Nat. 46:302–304.