

- od, temperature and diet quality. *Physiol. Zool.* 66:537–560.
- NOVOA, F. F. 1993. *Ecofisiología de Zonotrichia capensis*: cambios estacionales en el gasto y la adquisición de energía. Ph.D. diss., Universidad Chile, Santiago.
- SIBLEY, R. M. 1981. Strategies in digestion and defecation, p. 109–139. In C. R. Townsend and P. Calow [eds.], *Physiological ecology: an evolutionary approach to resource use*. Blackwell, Oxford.
- STEEL, R. G. D., AND J. H. TORRIE. 1985. *Bioestadística: principios y procedimientos*. McGraw-Hill, Bogotá.
- WALSBERG, G. E., AND C. W. THOMPSON. 1990. Annual changes in gizzard size and function in a frugivorous bird. *Condor* 92:794–795.

The Condor 98:876–879
© The Cooper Ornithological Society 1996

WINTERING SWAINSON'S HAWKS IN CALIFORNIA'S SACRAMENTO-SAN JOAQUIN RIVER DELTA¹

SEBASTIAN K. HERZOG²

Department of Wildlife, Fish, and Conservation Biology, University of California at Davis, Davis, CA 95616

Key words: Swainson's Hawk; *Buteo swainsoni*; natural history; winter distribution; Sacramento-San Joaquin River Delta.

The Swainson's Hawk (*Buteo swainsoni*) is considered a summer resident breeder on large parts of North America, leaving in winter to migrate south to South America (AOU 1983, Palmer 1988). Wintering Swainson's Hawks in North America had been confirmed only from southern Florida, where some juveniles were found during most winters, and from the southwestern United States as occasional migration dropouts (Palmer 1988).

Swainson's Hawks in California breed chiefly in the Central Valley and on the Northeastern Plateau (California Department of Fish and Game 1993), and the species is listed as threatened in the state. Until 1990, few credible winter records had been reported from the state (e.g., Browning 1974, McCaskie 1985, Morlan et al. 1987, McCaskie 1989), most of which were considered to represent very late or early migrants. Several reports from California's Sacramento-San Joaquin River Delta (LeValley and Rosenberg 1984, Campbell et al. 1986, Morlan et al. 1987, Campbell et al. 1988, Yee et al. 1989, Erickson et al. 1990) suggested some Swainson's Hawks were wintering locally. During the 1990/1991 winter, 28 hawks were confirmed in the Sacramento-San Joaquin River Delta, mostly consisting of adults (Yee et al. 1991). A population of comparable size was reconfirmed in the two subsequent winters (W. Holt and D. G. Yee, unpubl. data).

Holt and Yee (unpubl. data) observed the population irregularly during all three winters. They discovered a communal roost on Andrus Island (Fig. 1) and ob-

served foraging flocks of up to 16 Swainson's Hawks on five Delta islands preying on small rodents in close association with farming operations. The objective of the present study was to systematically monitor the population to determine wintering season chronology, size, composition, distribution, and foraging ecology.

STUDY AREA AND METHODS

The study area was in the Sacramento-San Joaquin River Delta in the Central Valley of California (38°05'N, 121°35'W) (Fig. 1). Historically, the Delta was an extensive freshwater marsh. Naturally deposited levees had been forming regularly flooded islands dominated by tule (*Scirpus* spp.), cattail (*Typha* spp.), and reeds (*Phragmites* spp.) (Herbold and Moyle 1989). Since the 1850s, > 80% of the Delta's wetlands were converted to mostly agricultural lands (California Department of Water Resources 1987). The area's main crops were corn, grain, and hay. Access was limited because most Delta islands were privately owned and few public roads led through the study area. Boats could not be used because high levees and elevations below sea level limited visibility of islands.

Swainson's Hawk population surveys were conducted by car on 23 islands from 25 September 1993 to 11 March 1994. I first surveyed areas where hawks were seen previously (Holt and Yee, unpubl. data). Surveys were extended to other accessible islands and conducted 4–6 times a week by mid-October and reduced to twice a week by late February. Survey frequency was determined by logistic factors such as accessibility and remoteness. I conducted from 51 to 92 surveys per island on Andrus, Brannan, Bouldin, and Terminous, from 31 to 50 surveys per island on Empire, King, Staten, and Twitchell, from 11 to 30 surveys per island on Sherman and Venice, and from one to ten surveys per island on Bacon, Bethel, Byron, Holland, Jersey, Lower Jones, Medford, Palm, Roberts, Upper Jones, Veale, Victoria, and Webb. Potential roost sites were located during initial surveys and visited regularly from mid-November to early February in late

¹ Received 19 June 1995. Accepted 31 July 1996.

² Current address: Foundation for Tropical Research and Exploration, P.O. Box 74431, Davis, CA 95617, e-mail: 103230.130@compuserve.com

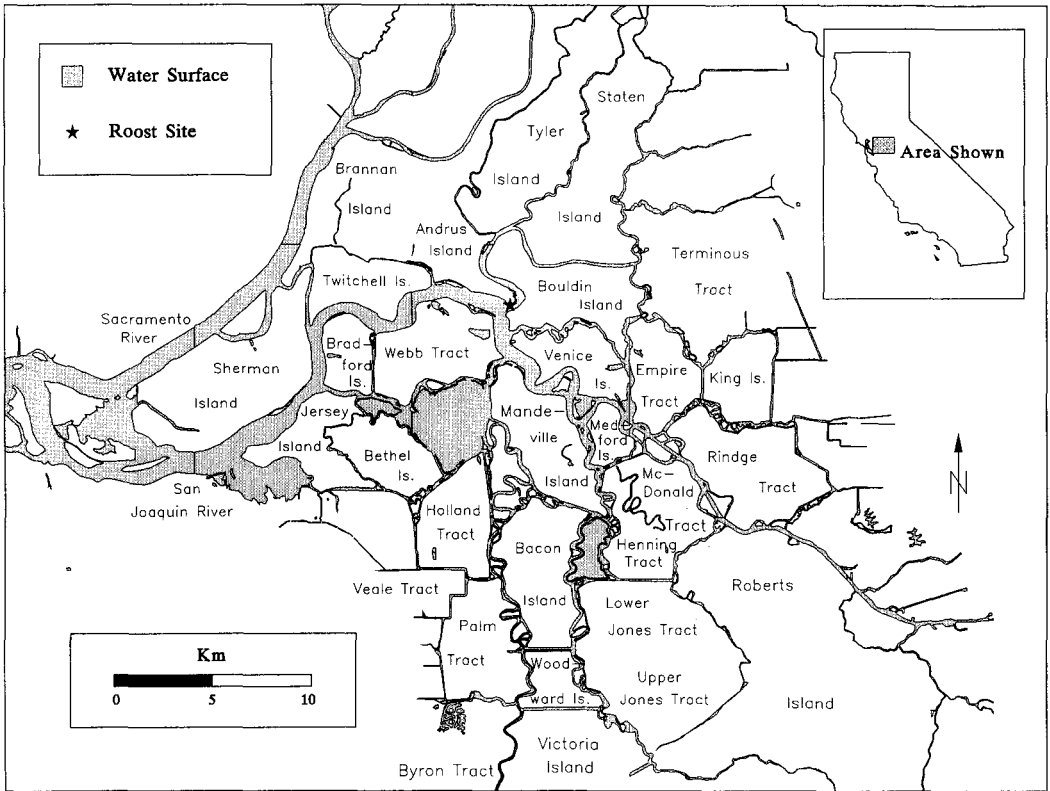


FIGURE 1. Study area and location of the Swainson's Hawk roost site in the central Sacramento-San Joaquin River Delta, California.

afternoon. One roost used by Swainson's Hawks in previous years on Andrus Island (Fig. 1) was intensively monitored from late November to late February.

Numbers, locations, and behavior were recorded, as well as color morphs and age classes (juvenile, immature, adult). Whenever hawks were observed foraging, I also recorded foraging techniques, prey items, numbers of other buteos present, interspecific interactions with other buteos, field conditions, and farming operations.

Prey populations were sampled for presence/absence on Terminous Tract from 8–12 February 1994. I captured rodents using 36 Sherman live-traps set 15 m apart on a square grid. They were checked at dawn and dusk. Two grids were placed randomly on two adjacent wheat fields flooded after harvest and drained in early winter. The first grid was placed on a field that was tilled four days previously, the second on the adjacent, untilled field. Swainson's Hawks were foraging extensively over both fields during the till.

RESULTS

Swainson's Hawks wintered in the Delta from at least 19 November to 20 February. The arrival of the bulk of the winter population was marked by the sighting of 13 Swainson's Hawks on Bouldin Island on 19 November and of 8–9 at the Andrus Island roost on 21

November. Previously, I observed ≤ 30 possibly transient Swainson's Hawks per day from 25 September to 17 October, whereas only ≤ 5 were located from 18 October to 18 November, with no birds present at the Andrus Island roost. Thereafter, numbers observed per day varied from zero to a maximum of 29 at the Andrus Island roost on 28 January. The population consisted mostly of adults colored light to dark rufous, with only one immature and two juveniles observed. The last group of wintering Swainson's Hawks was sighted on 20 February on Andrus Island. Afterwards, only one wintering bird was seen, a juvenile at the roost on 22 February. The first spring migrants, which differed in plumage color from all wintering birds, were observed on 3 March on Terminous Tract.

As in previous years, Swainson's Hawks used a communal roost at the southeastern tip of Andrus Island, a 240 m row of approximately 18–20 m tall eucalyptus (*Eucalyptus* sp.) on a breakwater surrounding a boat marina. Even though the number of birds observed at the roost varied from a few up to 29, and despite the presence of tall stands of eucalyptus on other Delta islands, I found no roosting Swainson's Hawks elsewhere. They were seen at the roost at all times of day, but mid-day sightings mostly coincided with fog. Departure and arrival times from and to the roost were variable and seemed to be affected by weather condi-

tions. Hawks usually arrived singly, in pairs, or rarely in groups of ≤ 5 from mid-afternoon to sunset. Morning departures were more irregular. Occasionally, I found no birds during early morning visits (about 08:00), suggesting they had already left the roost. For unknown reasons, 29 Swainson's Hawks departed in mass from 08:22–08:25 on 28 January, and 20 departed within one minute at 11:32 on 30 January. The roost was shared by several Red-tailed Hawks (*Buteo jamaicensis*) and ≤ 120 Great Egrets (*Casmerodius albus*).

Swainson's Hawks were observed 52 times from 19 November to 20 February on nine islands outside the immediate vicinity of the roost. Of these, 36 (69%) were of foraging birds. Thirty (83%) foraging observations of Swainson's Hawks were of mixed species flocks including Red-tailed Hawks and Rough-legged Hawks (*Buteo lagopus*), which varied in size from 4 to > 60 buteos and typically consisted of about 27 birds. Swainson's Hawks varied from 1 to 16, Red-tailed Hawks from 3 to about 50, and Rough-legged Hawks, which occurred in 18 of the 30 flocks, from 1 to 4 individuals per flock. Nonforaging and foraging Swainson's Hawks not associated with other *Buteo* species occurred either singly or in groups of ≤ 5 birds. Nonforaging birds were found on all islands with foraging observations (see below), as well as on Staten and Upper Jones.

Swainson's Hawk foraging activities were directly related to farming operations and located mainly on Terminus ($n = 14$) and Bouldin ($n = 13$), as well as on Andrus ($n = 3$), Empire ($n = 3$), Twitchell ($n = 1$), Venice ($n = 1$), and Mandeville ($n = 1$, D. Gifford, pers. comm.). The birds used corn and wheat residue that was being tilled ($n = 12$ each), recently tilled corn and flooded fields with corn stubble ($n = 5$ each), and recently tilled wheat fields ($n = 1$). The foraging "habitat" of the hawks on Mandeville Island was not recorded. The diet of wintering Swainson's Hawks consisted almost exclusively of small rodents. Larger insects, which make up the bulk of the species' diet outside the breeding season (e.g., Johnson et al. 1987, White et al. 1989, Jaramillo 1993), do not occur in the Delta during winter. During all foraging observations, hawks preyed on small rodents made easily available by tilling and flooding. On Terminus Tract I trapped 34 house mice (*Mus musculus*) and 3 California voles (*Microtus californicus*) on the untilled wheat field. Neither species was trapped on the previously tilled field.

Swainson's Hawk foraging areas averaged (\pm SD) 4.8 ± 3.1 km from the roost. Foraging hawks were usually observed soaring at a wide range of altitudes or on the ground. As noted by Yee et al. (1991), they often soared right behind moving farm equipment and sometimes captured prey < 0.5 m from rotating discs. Swainson's Hawks used a variety of foraging techniques. Prey were obtained from flight, the ground, and corn stubble perches on flooded fields. Prey often were so abundant that Swainson's Hawks hopped short distances across the field until a rodent was encountered and captured. During > 43 hr of foraging observations, Swainson's Hawks showed aggression towards other buteos only three times. These interactions lasted ≤ 2 min. Intraspecific competition occurred only once.

DISCUSSION

A population of about 30 Swainson's Hawks regularly winters in the Sacramento-San Joaquin River Delta. It probably does not migrate because corn and wheat farming present foraging opportunities almost continuously from fall to spring. Fallow fields of corn or wheat stubble provide suitable habitat for small rodent populations. Interestingly, the foraging behavior of wintering Swainson's Hawks closely resembled that of breeding conspecifics in California's Central Valley (e.g., Estep 1989). Among other similarities, breeding birds regularly formed foraging groups and spent $> 50\%$ of their foraging time hunting in response to farming activities such as tilling and harvesting (Estep 1989).

Swainson's Hawks varied in number at the Andrus Island roost, suggesting some birds regularly spent the night elsewhere. Alternate roost sites might have been used on islands I was unable to access, or hawks might have roosted on the ground. There also were time gaps as long as 20 days in December and January, during which I was unable to locate foraging Swainson's Hawks. A period of frequent, dense, low-lying fog from mid-December to mid-January and occasional foggy days until the end of January were partially responsible for these gaps. Swainson's Hawks might have been foraging in the study area but were not seen in the fog. Dense fog also may have prevented foraging, forcing much of the population temporarily out of the Delta into areas where there have been sightings of Swainson's Hawks in December and January (e.g., McCaskie 1985, 1989, 1993, Morlan et al. 1987, Erickson et al. 1990, Yee et al. 1993).

Thanks to D. Anderson for enabling me to conduct this study and to R. Anderson, J. Estep, and W. Holt for advice and field assistance. R. Cole provided spotting scope and mammal traps. P. Moreno helped generating the GIS map. I am indebted to landowners and farm managements for allowing access to Bouldin, Staten, Venice, and Medford Island and Webb Tract. Thanks to D. Gifford for his support. This study was partially funded by the Hawk Migration Association of North America. D. Anderson, J. Estep, W. Holt, and M. Kessler commented on earlier drafts of this paper.

LITERATURE CITED

- AMERICAN ORNITHOLOGISTS' UNION. 1983. Checklist of North American birds, 6th ed. Washington, DC.
- BROWNING, R. M. 1974. Comments on the winter distribution of the Swainson's Hawk (*Buteo swainsoni*) in North America. *Am. Birds* 28:865–867.
- CALIFORNIA DEPARTMENT OF FISH AND GAME. 1993. Five-year status review: Swainson's Hawk (*Buteo swainsoni*). Calif. Dept. Fish and Game, Wildl. Manage. Div., Nongame Bird and Mammal Program, Sacramento, CA.
- CALIFORNIA DEPARTMENT OF WATER RESOURCES. 1987. Sacramento-San Joaquin Delta Atlas. Calif. Dept. Water Resources, Sacramento, CA.
- CAMPBELL, K. F., A. D. BARRON, S. F. BAILEY, AND R. A. ERICKSON. 1986. The winter season. Middle Pacific coast region. *Am. Birds* 40:324–329.
- CAMPBELL, K. F., R. A. ERICKSON, AND S. F. BAILEY.

1988. The winter season. Middle Pacific coast region. *Am. Birds* 42:314-320.
- ERICKSON, R. A., S. F. BAILEY, AND D. G. YEE. 1990. The winter season. Middle Pacific coast region. *Am. Birds* 44:322-326.
- ESTEP, J. A. 1989. Biology, movements, and habitat relationships of the Swainson's Hawk in the Central Valley of California, 1986-1987. *Calif. Dept. Fish and Game, Nongame Bird and Mammal Sec. Rep.*
- HERBOLD, B., AND P. B. MOYLE. 1989. The ecology of the Sacramento-San Joaquin Delta: a community profile. U.S. Fish Wildl. Serv. Biol. Rep. 85(7.22).
- JARAMILLO, A. P. 1993. Wintering Swainson's Hawks in Argentina: food and age segregation. *Condor* 95:475-479.
- JOHNSON, C. G., L. A. NICKERSON, AND M. J. BECHARD. 1987. Grasshopper consumption and summer flocks of non-breeding Swainson's Hawks. *Condor* 89:676-678.
- LEVALLEY, R., AND K. V. ROSENBERG. 1984. The winter season. Middle Pacific coast region. *Am. Birds* 38:352-356.
- MCCASKIE, G. 1985. The winter season. Southern Pacific coast region. *Am. Birds* 39:209-212.
- MCCASKIE, G. 1989. The winter season. Southern Pacific coast region. *Am. Birds* 43:364-369.
- MCCASKIE, G. 1993. The winter season. Southern Pacific coast region. *Am. Birds* 47:299-302.
- MORLAN, J., S. F. BAILEY, AND R. A. ERICKSON. 1987. The winter season. Middle Pacific coast region. *Am. Birds* 41:322-327.
- PALMER, R. S. 1988. *Handbook of North American birds*, Vol. 5. Yale Univ. Press, New Haven, CT.
- WHITE, C. M., D. A. BOYCE, AND R. STRANECK. 1989. Observations on *Buteo swainsoni* in Argentina, 1984, with comments on food, habitat alteration and agricultural chemicals, p. 79-87. *In* B. U. Meyburg and R. D. Chancellor [eds.], *Raptors in the modern world*. World Working Group on Birds of Prey and Owls. Berlin.
- YEE, D. G., R. A. ERICKSON, A. D. BARRON, AND S. F. BAILEY. 1989. The winter season. Middle Pacific coast region. *Am. Birds* 43:361-364.
- YEE, D. G., S. F. BAILEY, AND B. E. DEUEL. 1991. The winter season. Middle Pacific coast region. *Am. Birds* 45:315-318.
- YEE, D. G., S. F. BAILEY, AND B. E. DEUEL. 1993. The winter season. Middle Pacific coast region. *Am. Birds* 47:296-299.

The Condor 98:879-884
© The Cooper Ornithological Society 1996

DELAYED EFFECT OF MONSOON RAINS INFLUENCES LAYING DATE OF A PASSERINE BIRD LIVING IN AN ARID ENVIRONMENT¹

JERRAM L. BROWN AND SHOU-HSIEN LI

Department of Biological Science, State University of New York, Albany, NY 12222
e-mail: JLB81@cnsvox.albany.edu

Key words: Mexican Jay; climate; laying date; *Aphelocoma ultramarina*; monsoon.

Much work has established that early spring temperatures modulate the onset of egg laying in resident birds of the north Temperate Zone. Most of this work has been done on the Great Tit (*Parus major*) and other parids in Holland (Kluiver 1951, VanBalen 1973), England (Lack 1958, Perrins and McCleery 1989) and other European countries (Dhondt et al. 1984, Barba et al. 1995). Little is known, however, about yearly variation in factors that affect the timing of laying in resident passerine species that inhabit different climatic regimes (but see Lambrechts and Dias 1993). We report here on some climatic correlates of laying date in a natural population of the Mexican Jay that

has been studied for 24 years in the mountains of south-eastern Arizona.

This region has a monsoonal climate that differs greatly from that in Europe and much of North America. A hot, dry spring with almost no precipitation is followed by heavy monsoon rains in July and August (39% of annual total, range 18-73%) and a cold winter, including snow. Annual precipitation on the study area averaged 562.1 mm ($SD = 131.5$, range 252.0-780.5). The pattern of leaf fall and regrowth in southeastern Arizona also differs considerably from that in north-western Europe. The vegetation on the study area is Madrean evergreen woodland (Brown 1982). Nearly all trees on our study area are evergreen. In particular, the oaks, except in extreme drought years, retain their leaves through winter and grow new ones immediately after dropping the old ones in spring. In a first attempt to identify ecological factors that influence the date of laying and the frequency of second clutches in a natural population of the Mexican Jay, we examine here the importance of certain climatic factors.

¹ Received 20 March 1996. Accepted 16 July 1996.