WINTER SURVIVAL RATES OF AMERICAN WOODCOCK IN SOUTH CENTRAL LOUISIANA

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Abstract: Declines in abundance of American woodcock (*Scolopax minor*; hereafter woodcock) have led to more restrictive hunting regulations imposed by the U.S. Fish and Wildlife Service, although there is little evidence to suggest that declines were related to hunting. To estimate winter survival and document hunting mortality rates, I radiotagged 160 female woodcock on a public hunting area in south central Louisiana. Woodcock were captured in fields at night from late November through December during 1994–96 and monitored at least daily. At least 37 woodcock died, primarily from avian predators. Day of capture and condition at date of capture were not predictive of survival. Survival rates were similar across ages and years except for lower survival of juvenile birds during 1993–94. The overall survival rate for the period 1 December to 15 February (77 days) was 72 ± 5%, which was the same or higher than reported elsewhere in winter. Hunting mortality varied from 1.6 to 12.2%, which seemed relatively low given the ample public hunting opportunity and a high winter-long fidelity to the study area.

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Annual indices of American woodcock abundance have indicated significant declines in numbers of birds breeding both east and west of the Appalachians (Straw et al. 1994, Bruggink 1998). Surveys of woodcock hunters revealed decreased hunter success for 25 years (Bruggink 1998). Reacting to these declines, the U.S. Fish and Wildlife Service imposed more restrictive harvest regulations for woodcock. In the Central Region, season length and daily bag were reduced from 65 days and 5 birds in 1967–97 to 45 days and 3 birds in 1997–98. Justifying decisions to restrict harvest and developing various season frameworks continues to be hampered by the dearth of information on survival rates and hunting effects (Straw et al. 1994, Krementz and Bruggink 2000).

Many aspects of winter ecology of woodcock are unknown, but Louisiana is an important wintering area for this species. Louisiana supports high winter populations (Straw et al. 1994). It is the only southern state with a strong, albeit declining, tradition of hunting woodcock. Based on a survey of licensed Louisiana hunters, 39,000 ± 4,700 woodcock hunters harvested 300,000 ± 69,000 birds during the 1987–88 season (Olinde 1988). The Louisiana woodcock harvest may represent 75% of the total kill for the 10 most southern states in the bird's range (Whiting et al. 1985). More recent hunter surveys indicated woodcock hunting and harvest rates have declined substantially. During the 1994–95 hunting season, an estimated 7,200 ± 1,400 hunters harvested 37,000 ± 12,800 woodcock, and during 1997–98 estimates were that 6,000 ± 1,300 hunters harvested 26,000 ± 9,200 birds (Olinde 1998). Most woodcock that winter in Louisiana are produced on breeding grounds west of the Appalachian Mountains, but a substantial proportion are produced in the eastern population region (Martin et al. 1969). Hence, hunting mortality and winter survival of woodcock in Louisiana may be important to both administrative regions.

My intention was to collect information on survival of female American woodcock during winter to further our understanding of woodcock demography. Specifically, I estimated survival rates, examined factors explaining variation in those rates, and documented sources of mortality in wintering female woodcock on a public hunting area in Louisiana.

STUDY AREA

The Sherburne Wildlife Management Area and Atchafalaya National Wildlife Refuge public land complex (hereafter, Sherburne) is in 3 south central parishes of Louisiana and within the Atchafalaya River Basin Flood Control Project. Sherburne consists of about 17,000 ha of

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bottomland hardwood habitat and old fields. There are 7 major bayous, numerous sloughs, and many minor watercourses. A north–south road near the western boundary, a levee road near the eastern boundary, and a few interior roads constructed to access oil and gas leases or private in-holdings provide the only vehicle access to the property. Dominant forest types are cottonwood (*Populus* spp.)-sycamore (*Platanus occidentalis*), oak (*Quercus* spp.)-gum (*Nyssa* spp. and *Liquidamber styraciflua*)-sugarberry(*Celtis laevigata*)-ash (*Fraxinus* spp.), willow(*Salix* spp.)-cypress(*Taxodium disticum*), and overcup oak (*Quercus lyrata*)-bitter pecan (*Carya aquatica*). Typical understory species include blackberry (*Rubus* spp.), elderberry (*Sambucus canadensis*), rattan vine (*Berchemia scandens*), trumpet creeper (*Campsis radicans*), and Virginia creeper (*Parthenocissus quinquefolia*). Ferns (Pteridophyta) frequently dominate the understory. There are about 300 ha of old field habitats concentrated in the north central portion of the area. Old fields were formerly in agriculture, but about 100 ha were planted to trees near the start of this project. The remaining acreage is managed to maintain early succession condition (a grass and forb-dominated community). Approximately 80–120 ha of the old fields are burned annually during fall or early winter to maintain open areas for nocturnal woodcock habitat. In addition to burning, 10-m strips spaced about 50 m apart were mowed in banding fields to facilitate bird capture.

METHODS

In south central Louisiana, woodcock frequently move from daytime cover to feed and roost at night in agricultural fields, burned areas, and pastures (Glasgow 1953). From late November through December, I captured woodcock at nocturnal feeding sites using lights and nets (Merovka 1939, Glasgow 1953). Captured birds were classified as after hatch year (AHY; >1 yr old) or hatch year (HY; <1 yr old), and male or female according to plumage characteristics (Martin 1964). All birds were banded with a U.S. Fish and Wildlife Service leg bands and weighed (±1 g). A wing cord (±1 mm) of each bird was measured along the anterior edge from the notch at the bend in the wing to the tip of the longest primary (Artmann and Schroeder 1976). Females were fitted with a 3.5-g, single belly loop, backpack radio transmitters (McAuley et al. 1993) and immediately released at capture sites. Radios were equipped with motion-sensitive mortality switches, which aided the timely detection of mortality and reduced disturbance of birds because I did not have to flush birds to verify their status. All birds were monitored daily for status (live, dead, or missing). Upon detecting a radio in mortality mode, a tracker would locate the radio and look for evidence of mortality. After considering available signs, radio appearance, and the presence of remains, fates were classified as false mortality signals (bird still alive and radio still attached), deaths, or slipped radios. Deaths were attributed to avian or mammalian predators, hunting, capture stress, or unknown causes. Avian predation was differentiated from mammalian predation based on transmitter condition. Based on recoveries with abundant evidence, experience suggested that if the predator was unable to puncture the enamel coating of the radio the predator was likely avian, whereas mammalian predators usually left tooth marks. I used Fisher's exact test (Bishop et al. 1980) to test the independence of mortality sources and age of bird.

Because its age, body size, and date of capture (Pace et al. 2000) may affect the body mass of a woodcock, I examined the relationship of body mass to year, capture date, and wing cord. I also calculated a body condition index as weight/wing cord.

I used Cox's hazards regression (PROC PHREG of SAS; Allison 1995) to model the survival of radiotagged birds and to test for differences in relation to age, year, and their interaction. I also examined body mass at capture, body condition index at capture, and capture date as predictors of hazard. To allow birds to adjust to radiotags, I excluded the first 5 days after capture. I used the counting process style of input (SAS Institute 1996:830) to account for delayed entry of birds into the risk set (Allison 1995:161), used the exact procedure to handle ties, and used 1 December as the origin (Allison 1995). I coded a bird as censored on the last day of the field season if it was alive when the field season ended. I coded any bird that disappeared from within the study area (e.g., radio failure, emigration) before the end of the field season as censored on the last day it was known to be alive. To arrive at a final model, I used backward stepwise elimination of non-significant ($P > 0.1$) terms. After deriving a final model, I used the product-limit method to calculate periodic survival rates (Allison 1995).

Table 1. Number of female woodcock radio tagged (number of known deaths) and sources of mortality during a 3-yr study of winter survival in south central Louisiana, 1992–95. Although 169 woodcock were originally marked, 9 were excluded because in <5 days after marking they slipped their radio (4), the radio failed or the animal went out of range (4), or death (1).

				Mortality source			
Year	Age[a]	No. marked	Exposure days	Bird	Mammal	Hunting	Unknown
1992–93	HY	21 (4)	1099	2	1	1	
	AHY	5 (0)	296				
	Subtotal	26 (4)	1395	2	1	1	
1993–94	HY	43 (15)	2272	7	2	5	1
	AHY	22 (5)	1242	2		1	2
	Subtotal	50 (30)	3514	9	2	6	3
1994–95	HY	39 (7)	2127	4	2		1
	AHY	30 (6)	1532	5			1
	Subtotal	63 (13)	3659	9	2		2
	Total	160 (37)	8568	20	5	7	5

[a] HY = Hatch year; AHY = After hatch year.

Similarly, I used Cox's hazard regression to compare the hazard due to hunting between ages and among years. In this analysis, I coded all other types of mortality as censored on their discovery dates and reran Cox models. I estimated mortality from hunting as 1—$\hat{S}$, where $\hat{S}$ was the estimated period survival rate from the Cox regression. As a contrast, I re-coded hunting deaths as censored while keeping all other deaths as in the first analysis. To facilitate comparisons among studies of woodcock survival, I calculated modified Kaplan-Meier product moment survival estimate (Pollock et al. 1989) for a 77-day period 1 December to 15 February. To be comparable to Krementz and Berdeen (1997), I calculated survival for the 45-day period 24 December to 7 February. Unless otherwise noted, all estimated means, rates, and proportions are reported as estimate ±1 standard error.

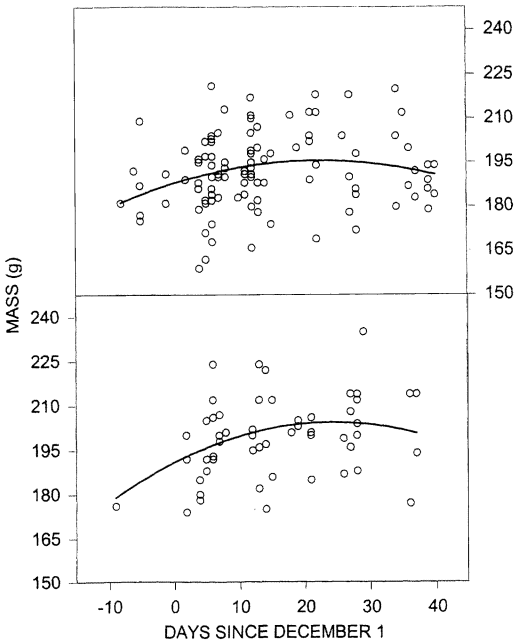

Fig. 1. Variation in body mass of hatch year (HY) and after hatch year (AHY) over time among 160 female woodcock captured at night in banding fields during 3 winters in south central Louisiana during 1992–95. Curves are least square fits to body mass = $\alpha + \beta$ days + γ days^2.

RESULTS

Of 169 female woodcock marked with radios during 3 winter field seasons from November 1992 to March 1995, fates of 160 were used to estimate survival rates and document mortality sources in south central Louisiana (Table 1). I excluded 9 woodcock from analyses because, within 5 days of marking, they either slipped from their radio (4), they left the study site or their radio failed (4), or they died (1). Of 160 monitored for >5 days at least 37 (23 ± 3%) died, primarily from avian predators (Table 1). Twenty-two birds disappeared prior to 1 February and another 19 were lost between 1 and 15 February and were classed as censored for the overall analysis. The frequency of mortality sources was independent of age (χ^2 = 1.80, P = 0.18, df = 1). Body mass at capture varied with capture date ($F_{1, 154}$ = 7.15, P = 0.008), capture date squared ($F_{1, 154}$ = 5.41, P = 0.021), and wing chord ($F_{1, 154}$ = 5.81, P = 0.017). AHY woodcock averaged 6.7 ± 2.2 g heavier ($F_{1, 154}$ = 9.55, P = 0.002) than HY birds (Fig. 1). However, body mass at capture, condition index at capture, and capture date did not (P > 0.1) predict survival rate. The only discernable difference among hazards was that

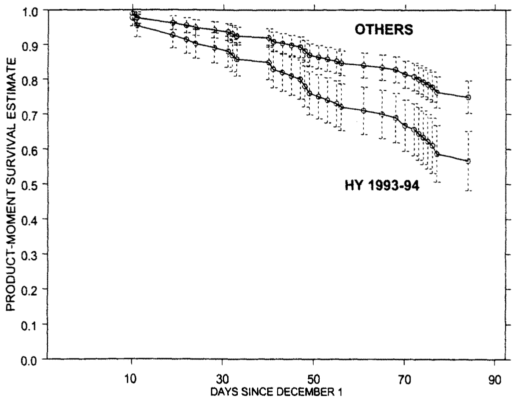

Fig. 2. Model-based, product-moment survival estimates and standard errors for 160 female woodcock captured at night in banding fields during 3 winters in south central Louisiana during 1992–95. Groups are hatch year (HY) birds caught 1993–94 and all other birds combined (OTHERS).

HY birds during the winter of 1993–94 had a hazard ratio nearly twice (1.97, 95%CI = [1.02–3.82], P = 0.044) that of other age by year groups. The overall product moment estimate of survival rate was 72 ± 5% for the period 1 December to 15 February (77 days) and was 84 ± 3% for the 45-day period 24 December to 7 February. Group-specific 77-day survival rates were 58.7 ± 8.1% for HY birds during the winter of 1993–94 and 76.3 ± 4.7% for the rest (Fig. 2). Group-specific 45-day survival rates were 65.3 ± 7.8% for HY birds during 1993–94 and 80.1 ± 4.0% for the rest.

Hunting caused 7 of 37 (19%) known deaths. The only predictor of hunting mortality as a hazard was a year effect for 1993–94 (odds ratio = 8.42, 95%CI = [1.0–70.6], P = 0.049). Rates for surviving hunting during the period 1 December to 15 February were 87.8 ± 4.7% for 1993–94 and 98.4 ± 1.5% for 1992–93 and 1994–95 combined, which implied mortality rates from hunting of 12.2% and 1.6 %, respectively. A contrasting analysis that examined hazards for non-hunting mortality (hunting mortalities were coded as censored) revealed no evidence that hazards for non-hunting mortality varied between these 2 periods (χ^2 = 0.96, P = 0.33, df = 1).

DISCUSSION

There is little debate that woodcock abundance in both Eastern and Central Regions declined during the 1990's (Bruggink 1998). It is unclear how much of that decline was caused by hunting (Straw et al. 1994, Krementz et al. 1994, Krementz and Berdeen 1997), because no relationship between harvest rate and survival or population size has been demonstrated. Some research has suggested that hunting mortality is relatively low. Based solely on birds banded and recovered in northern states, Dwyer and Nichols (1982) reported direct recovery rates of female woodcock in the Central Region to be 4.7 ± 0.8% during 1969–77. They concluded that hunting mortality comprised a small amount of total annual mortality. Likewise, Martin et al. (1969) observed a 1% direct recovery rate for female woodcock banded in Louisiana from 1948–49 to 1968—69 and concluded that shooting was not a major cause of mortality in the overall population. In contrast, Krementz and Berdeen (1997) were surprised when 2 of the 5 deaths that they observed among radio-tagged woodcock wintering in central Georgia were from hunting, and they suggested that hunter harvest on wintering woodcock needed further study.

I expected that a localized study at an area with abundant hunting opportunity, such as Sherburne, would demonstrate high hunting mortality on woodcock. I found hunting mortality was low (2%) in 2 years and modest (12%) in 1 year, despite ample public hunting opportunity (Olinde et al. 2000) and a high winter-long fidelity to the study area (R. M. Pace, Louisiana Cooperative Fish and Wildlife Research Unit, Baton Rouge, Louisiana, USA, unpublished data). A banding study conducted on Sherburne from 1990–91 to 1995–96 reported that 1992–93 and 1994–95 produced low (<4%) direct recovery rates and 1993–94 had only a modest recovery rates (HY 10.2% and AHY 4.4%) among the 6 years examined (Olinde et al. 2000). Also, woodcock demonstrate relatively strong among-year fidelity to Sherburne (M. W. Olinde, Louisiana Department of Wildlife and Fisheries, Baton Rouge, Louisiana, USA, unpublished data). Other banding studies show that the birds that winter at Sherburne were likely exposed to hunting hazards on the breeding grounds and in migration (Glasgow 1958, Martin et al. 1969, M. W. Olinde, Louisiana Department of Wildlife and Fisheries, Baton Rouge, Louisiana, USA, unpublished data). Woodcock banding at Sherburne has continued through 1999, and woodcock appear as abundant in the banding fields as before this study started. This impression was based on the number of new captures per night of banding effort in 1990–99 (M. W. Olinde, Federal Aid Performance Reports: W-55-5 through W-55-13, VI-6, Woodcock Banding, Louisiana Department of Wildlife and Fisheries, Baton Rouge, Louisiana, USA). Thus, despite the cumulative effect of hunting mortality from breeding grounds through migration to a wintering ground and strong fidelity to a wintering ground with high hunting activity, Sherburne woodcock seem unaffected by this level of hunting pressure.

The overall survival rate for wintering female woodcock was higher than has been reported elsewhere for wintering woodcock, but is low relative to other seasons. In a telemetry study of woodcock wintering in the piedmont of Georgia, Krementz and Berdeen (1997) reported a 45-day survival rate for the period 24 December–7 February as 72%, which agreed with the findings of Krementz et al. (1994) for birds wintering along the Atlantic coast. I used the same methods as Krementz and Berdeen (1997) and calculated a period survival rate of 84 ± 3%. My 45-day period survival rate extrapolates to an annual survival rate of 24% assuming that this observed daily rate is constant throughout the year. This rate is well below annual survival rates of 52.5% and 31.3% for AHY and HY Central Region female woodcock estimated by Dwyer and Nichols (1982). My observed survival rate was also much lower than 93% for HY females in Maine during 1 April to 31 August (Dwyer et al. 1988) or 90% and 69% for AHY and HY female woodcock, respectively, in Maine from 15 June to 20 October (Derleth and Sepik (1990). Therefore, I agree with Krementz and Berdeen (1997) that winter is the time of the year of lowest survival for female woodcock, although information about survival rates during migration is poor.

My telemetry results were consistent with the banding study at Sherburne in that hunting mortality was higher during 1993–94. I observed only 7 hunting deaths and was unable to detect a difference in hazard due to hunting between ages, which is in agreement with Dwyer and Nichols (1982). The only variation in survival detected among radio-tagged birds was a decrease in survival (increase in hazard) for HY birds during 1993–94. However, no differences in survival rate among years were evident when deaths due to hunting were treated as censored. There were 33 and 90% more hunter efforts (1 individual hunting ≥ 1 hr on a single day = 1 hunter effort) during 1993–94 than during 1992–93 and 1994–95, respectively (Olinde et al. 2000). The reported bag per hunter effort was also somewhat higher during 1993–94 than during 1992–93 or 1994–95 (Olinde et al. 2000). Whatever the reasons for increased hunting effort and efficiency reported during 1993–94, these increases produced higher total per capita death rate at Sherburne than during other winters, at least for HY females.

Throughout most of the wintering grounds, it is believed that woodcock do not face high hunting pressure (Martin et al. 1969, Wood et al. 1985). Louisiana has traditionally had the largest woodcock hunter participation among southern states. Additionally, there has been a tremendous decline in bottomland-hardwood forest cover (MacDonald et al. 1979), a prime woodcock winter habitat in south central Louisiana (Dyer and Hamilton 1977). This later condition might tend to force woodcock onto fewer acres and possibly increase hunting pressure. However, most woodcock winter habitat is on private land with limited access to woodcock hunters. Woodcock hunter numbers have declined rapidly in Louisiana probably in response to reduced access and competing recreational opportunities. Therefore, I believe that hunting pressure is not very high for the region as a whole, and Sherburne represents a local area with some of the highest hunting pressure winter woodcock might face. Survival studies on places like Sherburne are opportunities to see how mortality might be partitioned as hunting pressure increases.

MANAGEMENT IMPLICATIONS

Participation in small game hunting, particularly woodcock hunting, has declined dramatically in Louisiana. It is not known whether the recent reduction in woodcock bag limits or hunting season length and therefore hunting opportunity has influenced decreasing participation. Many hunters support reducing bag limits to save a resource if the reduction is supported by sound research. Results from my research on Sherburne, a relatively heavily hunted wintering area, implied that hunting mortality, although not the most frequent source of mortality, may be additive to non-hunting mortality during winter. I cannot conclude that the added mortality due to increased hunting effort during winter would not be compensated for by a reduction in non-hunting mortality later, or resulted from a greater surplus of woodcock arriving at Sherburne. I do believe my research coupled with the banding study of Olinde et al. (2000) show that reducing season length or bag might influence woodcock population dynamics by reducing total mortality during winter on areas with moderate hunting pressure. Because Sherburne may be a special case relative to most wintering areas (Olinde et al. 2000), further investigation of the influence of hunting on wintering woodcock is necessary to understand the implications of reducing season length. The connection between reducing season length or bag and benefit to the resource is essential for increasing support of woodcock hunting enthusiasts for wildlife management agencies.

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DETERMINANTS OF LEAD SHOT, RICE, AND GRIT INGESTION IN DUCKS AND COOTS

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Abstract: We investigated the relationships between lead shot ingestion, grit size selection, bill morphology, and diet in a community of 8 duck species and common coot (*Fulica atra*) wintering in the Ebro Delta, Spain. There were no intraspecific differences related to sex or age in grit composition, lead shot, and rice-grain ingestion. Strong interspecific differences were recorded for all these variables and for the density of bill lamellae. The proportion of grit of size >1 mm (especially >2–3 mm) was positively correlated with the prevalence of lead shot ingestion, as well as with rice ingestion. Rice ingestion was also positively correlated with the prevalence of lead shot ingestion. Those duck species feeding on rice had larger grit and higher prevalences of lead shot than herbivorous species. Contrary to the predictions of a straining model for food or grit ingestion, lamellar density did not explain interspecific differences in grit selection, rice ingestion, or prevalence of lead shot ingestion. These findings contradict previous claims in the literature, and suggest that mechanisms other than straining are used by ducks for grit selection and lead shot ingestion.

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Key words: Bill morphology, contamination, coot, duck, Ebro Delta, grain, grit, lamellae, lead shot, Spain.

Lead poisoning of Anatidae and other waterbirds, resulting from the ingestion of lead (Pb) shot discharged by hunters, is a conservation problem world-wide. It is particularly severe in coastal wetlands in Spain (Mateo et al. 1997, 1998) and other parts of the Mediterranean region (Pain 1990). However, the mechanisms underlying the ingestion of Pb shot remain unclear. Field and experimental studies suggest that Anatidae ingest Pb shot intentionally, confusing it with grit. Moore et al. (1998) observed similar prevalences of Pb shot ingestion in species of diving ducks with different foraging behaviors, and interpreted it as evidence that ducks actively selected shot as grit, as opposed to ingesting shot accidentally with food. Many authors have observed relatively high prevalences of shot ingestion in species that consume grit of a size (2–3 mm in diameter) similar to shot (Hall and Fisher 1985, Pain 1990). Trost (1981) observed that captive mallards (*Anas platyrhynchos*) could differentiate between shot and grain mixed in a feeder, but this ability was less evident for shot and grit. Similar conclusions were obtained when offering grit, shot, and grain mixed with mud and water to mallards to mimic field conditions (Mateo and Guitart 2000).

However, the methods used by waterbirds to find and select grit are unclear. Some species,