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Seasonal Occurrence of Blackbird Species (*Icteridae*) in Wild Rice (*Zizania*): A Response to Rice Stage or Breeding Phenology?

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ABSTRACT: Blackbird species (*Icteridae*) are considered a primary cause of yield loss prior to harvest in wild rice, which equaled about \$3 million in 2007. Although rice consumption should be a null model of bird damage to yield, data from cage traps and point counts indicate that blackbird flocks arrive in wild rice fields 3 to 4 weeks before rice was available for consumption, but coincidental with the time when blackbird form post-breeding flocks. Wild rice plants appear to be attractive habitat from the time the wild rice begins heading until it is harvested (*c.* 6 weeks), even though wild rice is a food source only for the last 2 to 3 weeks (milk stage to harvest of mature grains). The onset of occurrence in wild rice fields appears to be a function of breeding season of red-winged blackbird and Brewer's blackbird, specifically they arrive shortly after the time when young-of-the-year become independent of parental care (first week of July). Hence, nesting phenology is the best predictor of blackbird occurrence and their potential damage to wild rice.

KEY WORDS: *Agelaius phoeniceus*, blackbirds, breeding season, red-winged blackbird, wild rice, yield loss, *Zizania*

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INTRODUCTION

Yield loss prior to harvest is considered the primary problem of wild rice producers in California, and blackbird species (*Icteridae*) are considered to be the most likely cause (California Wild Rice Board 2008). Growers estimate up to a 10% reduction in yield (Marcum and Gorenzel 1994), which in 2007 would have equaled about 3 million dollars. Unfortunately, little is known about the relationship between wild rice development and blackbird life history.

Cultivated wild rice (*Zizania palustris* L.) is an annual crop grown in continuously flooded fields. Ideal production locations are near wetlands and riparian areas with poorly drained soils or high water tables (Marcum 2007). California is the largest producer of wild rice (5 million kg finished, on 6,500 ha in 2006; CA Wild Rice Board 2008). About 45% of the crop is produced in northeastern California, where it can be grown from seed left in the field after the prior season's harvest (volunteer). Wild rice matures in 93-107 days, depending upon date of germination; but it is in an edible form for blackbirds (milk stage to dark kernels) for only the final 2 to 3 weeks before harvest. Most growers feel that blackbirds use wild rice as food, but the rice fields also provide insect prey and protection from predators.

Four species of blackbirds (*Icteridae*) are commonly found in wild rice fields in California: the red-winged blackbird (*Agelaius phoeniceus*), Brewer's blackbird (*Euphagus cyanocephalus*), brown-headed cowbird (*Molothrus ater*), and yellow-headed blackbird (*Xanthocephalus xanthocephalus*) (USDA Wildlife Services California, Northern Section, unpubl. data 2000-06). Red-winged and Brewer's blackbirds are two of the most widely distributed species of songbirds in North America; red-winged blackbirds nest in wetlands, while Brewer's blackbirds tend to nest in a wide variety of woodlands, non-native habitats, and suburban/rural structures (Yasukawa and Searcy 1995, Martin 2002). Yellow-headed blackbirds breed primarily in the northern plains states, with populations in eastern Oregon and northeastern Nevada. They breed in wetland areas (Twedt and Crawford 1995). Brown-headed cowbirds have expanded their distribution across California over the past 100 years. Like Brewer's and red-winged blackbirds, they have an extremely wide range across North America (Bent 1958). Cowbirds lay eggs in other birds' nests (nest parasitism), typically parasitizing birds nesting in wetlands and riparian areas.

Egg records from the UC Berkeley Museum of Vertebrate Zoology and Western Foundation of Vertebrate Zoology ($n = 600$) suggest that the breeding season for these species begins in June and continues through July (Table 1). The 3 blackbird species follow a typical pattern of passerines: 11 to 14 days of incubation, 11 to 15 days of development in the nest, and then 7 to 14 days of parental care and feeding before the young become independent (Martin 2002, Nero 1984, Yasukawa and Searcy 1995). The breeding season of cowbirds tends to

Table 1. Median date of museum egg records for 3 species of blackbird (Icteridae). Typical days to hatch (12), leave the nest (12), and to become independent (7 to 14), provide a means of suggesting when blackbirds may abandon their breeding territories to join flocks.

Species	Median Date of Egg Records ¹	Probable Range of Hatching Dates ²	Young Leave Nests	Young Become Independent
Red-winged Blackbird (<i>n</i> = 138)	6 Jun	9 June to 15 June	21 June to 27 June	27 June to 11 July
Yellow-headed Blackbird (<i>n</i> = 33)	11 Jun	14 June to 21 June	26 June to 3 July	3 July to 17 July
Brewer's Blackbird (<i>n</i> = 68)	23 May	26 May to 2 June	8 June to 15 June	15 June to 29 June

¹ Median date of egg records (Museum of Vertebrate Zoology, UC Berkeley; Western Foundation of Vertebrate Zoology) from locations with similar climates and geographic locations.

² Median date has error associated with unknown stage of incubation; an assumption of a normal distribution clutch completion dates suggests a range of probable hatch dates.

Figure 1. Bird decoy trap (Bureau of Sport Fisheries & Wildlife 1964, Dolbeer 1994), with modifications by J. Shuler, USDA Wildlife Services. The major improvements are 1) welded 1-inch wire to prevent escapes previously allowed by chicken wire, 2) 1-inch steel square tubing for frame strength, 3) a clear plastic catch box that allow birds to visualize an exit, 4) a small (8-inch) exit tube that limits the ability of birds to fly up out of the mesh bag, and 5) a deep bucket with a plywood float in water to stop birds from spilling water or drowning.

match their host species. Their development, including length of time for parental care is approximately similar to the blackbird species (Lowther 1993).

Herein we report data from observations of both wild rice maturity and the presence of blackbirds using both point counts and decoy traps. Our report evaluates the strength of the hypothesis that blackbird occurrence in wild rice fields coincides with the development of edible wild rice.

METHODS

Area Suffering Damage

The study area is in northeastern California within a 50-km radius of the town of McArthur, in the Fall River Valley (Shasta, Lassen, and Modoc Counties, 1,000 m elevation, N 41° 2' 60.00", W 121° 23' 60.00", average rainfall of 50 cm in snow and rain). There are approxi-

mately 12,000 ha of wetlands within a 50-km radius of the town of McArthur. Rice production covers about 2,500 ha of this area, with over half at Goose Valley, about 40 km west of McArthur.

Cage Trap Sampling

We placed traps (Figure 1) at areas with rice fields at Goose Valley (40° 54'6", 121°39'10") and Fall River Valley (41° 2' 58", 120° 28' 38") in spring 2006. Traps were also placed at a third location, Alturas, Modoc County, (41° 23'21", 120° 33'49") with 1,200 ha of rice fields, but only for 1 week during harvest. Ten traps were placed along the edges of rice fields at each location, based on 1) a history of success in prior years in trapping blackbirds, and 2) a minimum distance of 500 m between traps. The maximum distance between traps was 3,000 m. Decoy traps were managed by USDA Wildlife Services under permits from the U.S. Fish and Wildlife Service. USDA personnel visited each trap at least twice weekly to replenish corn and water and to remove birds. Birds were euthanized (under USDA protocols) and then identified to species, noting sex and age group. Traps at Fall River Valley were started on 1 April 2006; traps at Goose Valley were started 15 April 2006. Each trap was initiated with a small number of captured blackbirds (following USDA protocol). Traps were checked every 3 days and closed one week after harvest of the adjacent rice field.

Point Counts of Blackbirds

In 2007, we incorporated fixed-radius point counts of blackbirds in rice fields (see Ralph et al. 1995, Cyr 1995) to better estimate the occurrence and abundance of red-winged and yellow-headed blackbirds in wild rice fields. This second sampling technique was used because these species were trapped at densities far lower than incidental observations would predict in 2006, possibly because of interactions with cowbirds in traps (see discussion below). Point counts were undertaken at 5 locations in natural wetlands (5 points per location; *n* = 25), and at the 3 wild rice areas (variable numbers per location; *n* = 65). Points in natural areas were measured twice: in late May, and 2 weeks later in early June. Point counts in Goose Valley (*n* = 29) and Fall River (*n* = 21) wild rice areas were counted on approximately 2-week

intervals from late May until mid July; Alturas point counts ($n = 15$) were measured only in July. A subset (5%) of points at Fall River was measured in September. Each count was conducted for a 5-minute interval to standardize survey efforts across counts (Ralph et al. 1995); observers counted blackbirds within 100 m of the observation points, recording species, sex, and age. We attempted to conduct counts in the first 4 hours after sunrise, but some counts were completed in the afternoon (c. 15%). In addition to bird data, observers recorded the stage of rice development (floating, heading, flowering, milk stage, mature [dark kernels]).

RESULTS

Trapping

Traps captured 4,300 blackbirds from 25 March to 23 August 2006 (Figure 2). Brown-headed cowbirds were collected in large numbers (65% of captures) with discernable changes in captures over time. Yellow-headed blackbirds (12%) and Brewer's blackbirds (11%) were the next-most-commonly trapped species; but yellow-headed blackbirds were caught primarily at one trap, the closest to their breeding colony. Red-winged blackbirds were trapped at much lower rates (5%), even though their numbers appeared to be comparable to cowbirds and greater than Brewer's blackbirds.

Numbers of captured Brewer's blackbirds peaked during the last week of June, but high numbers young (20 captures/trap/day) were trapped for approximately 1 month. Brown-headed cowbirds abruptly appeared in large number at traps (≥ 20 captures/day) in the middle of July and were captured in high numbers for approximately 5 weeks. Three times as many birds (30 captures/day) were caught in fields with milk stage rice, than in fields with $>10\%$ of rice in darkening or mature stage, although the result was among relatively small sample sizes (5 trapping bouts in rice at milk stage; 25 in mature stage). The highest capture rates of brown-headed cowbirds occurred in Alturas, when traps were not set until the wild rice was edible. However, the success rates in Alturas dropped by 80% after the traps were open for 3 days.

Results of Point Counts

A total of 226 point counts were conducted over the months of May (30), June (53), July (132), and September (11). In general, counts in May and June recorded

relatively low and uniform numbers of blackbirds in both the natural areas and rice fields (Table 2), suggesting that most locations were occupied by breeding populations. We typically recorded 2 to 4 territorial male red-winged blackbird at each point count, with slightly variable numbers of breeding females (4 to 8) for an average of 12.6 ± 8.9 (SD) blackbirds/count (Figure 3). Counts increased dramatically in the last week of June and first week of July in wild rice areas, with individual counts ranging to 200 blackbirds, with a mean of 47.0 ± 42.3 (SD). By the third week of July, blackbird counts (combined species) exceeded 500 birds, with a mean of 169.1 ± 263.2 (SD). The mean-to-variance ratios of these late-July counts ranged between 1.5 and 2.0, indicating the presence of flocks in rice fields (clustered distribution with large numbers of birds at a few counts). Point counts increased to over 1,500 birds in September. Although the number of blackbirds increased geometrically after early July, the number of blackbirds at fields with edible rice remained comparable to those at fields with inedible rice on all dates of survey (Table 2). Twenty percent (16) of counts in the third week of July had 1 or no birds present, suggesting that breeding might have ended for the year at those points. It should be noted, however, that red-winged blackbird breeding behaviors (adults feeding young or territorial males) were observed at 3 other points during this time period.

Although point counts increased over the season, grouping data by stage of rice at point counts did not explain the increase (Kruskal-Wallis test, $\alpha = 0.05$). Counts at fields with edible rice were not significantly different from fields with non-edible (early) rice during all sampling periods (Table 2). The average date of rice maturity was August 18 ± 18.5 days (SD) for the 120 point counts where rice stage was verified. This means that the average date when fields developed edible rice was approximately August 3. Using the distribution of these data, we estimate that 95% of the fields we sampled did not have edible rice when birds began to arrive in the first week of July. In the second week of July, when numbers reached the size of large flocks, we estimate that only about 15% of the rice fields had edible rice in the milk stage or more mature. Unlike the breeding season counts, observers (Marcum, Scott, Lee, Shuler) had little confidence that point counts could estimate birds occurring in flocks that exceeded 60 birds. It may be that we underestimated the size of blackbird flocks in late July.

Table 2. The difference between numbers of birds observed at fields with edible and inedible (early) wild rice. Comparable numbers of blackbirds were counted at fields with edible and inedible wild rice at all sampling periods.

Wild Rice Growth Stage	Number of Birds Observed ¹			
	June	Early July	Late July	September
Inedible ²	7.7 ± 7.2	47.1 ± 40.6	121.6 ± 187.9	na
Edible ³	8 ± 2.6	55.4 ± 57.7	105.0 ± 130.8	568.5 ± 537

¹ Mean and standard deviation

² Up to and including flowering stage

³ Milk stage through dark mature seed ready for harvest

Figure 2. The number of blackbirds trapped at 3 wild rice areas (10 traps/area) in 2006. Traps in Alturas were only run for a week, while the traps in Goose Valley and Fall River were run for 20 weeks. Traps were open for check every 3 days; however, not all traps were opened every week during the sampling period (see gaps in figure).

Figure 3. The number of blackbirds observed in point counts at wild rice fields in 2007. Numbers of red-winged blackbirds (*Agelaius phoeniceus*), Brewer's blackbird (*Euphagus cyanocephalus*), and brown-headed cowbirds (*Molothrus ater*) counted in early June are a function of the number of breeding territories within count radius (100 m); counts in early July reflect the formation of flocks after young become independent of parental care.

DISCUSSION

Both cage traps and point count data suggest that bird flocks occurred in wild rice fields 3 to 4 weeks before rice was available for consumption, but coincidental with the time when blackbird form post-breeding flocks (Table 1). Birds occurring in wild rice fields before wild rice is edible appear to do so because the breeding season has ended. Cowbird captures by cage traps when wild rice was edible may be a function of greater cage trap efficiency in capturing cowbirds.

Brewer's blackbirds nested away from rice fields, but red-winged blackbirds nested in cattails (*Typha* spp.) at the edges of fields and canals in wild rice areas. Both species appear to arrive at wild rice fields when they complete nesting. Red-winged blackbird typically start to incubate eggs in the first week of June, and complete nesting 4 to 5 weeks later, when the young become independent of parental care (Yasukawa and Searcy 1995). The time period coincides with the arrival of red-winged blackbirds in wild rice fields (Figure 3). Brewer's blackbirds start breeding about 2 weeks earlier, with approximately the same number of days to produce independent young. Trapping data suggests that they also arrive in wild rice fields shortly after the end of their breeding season (mid-June). Trapping data for brown-headed cowbirds suggests that some adult are present from May through August, but the peak of trapping for young as well as adults occurred at approximately the same time as red-winged blackbirds. Yellow-headed blackbirds were uncommon in both years of the study, with insufficient data to examine seasonal pattern of occurrence in wild rice fields.

The density of territorial red-winged blackbird males in, and next to, wild rice fields was 1.55 ± 0.28 (SD) per acre, high enough to account for most of the birds present in wild rice before harvest. This number is at the low end of territorial males/acre reported from studies of natural habitats (Yasukawa and Searcy 1995). In most cases, male red-winged blackbirds are polygamous; so the number of nesting females was probably higher than 1.55 per acre, ranging somewhere between 1.5 and 2 breeding females per breeding male. Assuming typical breeding success of red-winged blackbirds, a nesting female should produce approximately 1.5 independent young/year, to bring the total number of blackbirds/acre between 7 and 9 birds (males, females, and independent young). So, blackbird populations in a 20-acre field should range from 140 to 180 birds, and 7,000 and 9,000 birds could be present in 1,000 acres of fields.

Red-winged blackbirds are fairly evenly distributed across wild rice growing areas during the breeding season, but their distribution and those of other blackbirds become clustered when they form flocks later in the season. Flocking causes a wide variation in the presence of blackbirds, which is reflected in yield loss variation among fields and within fields (observation, Marcum). Arrival of blackbirds in wild rice fields also coincides with the onset of post-breeding molt, when birds should seek cover because their flight abilities are compromised by gaps in flight feathers. The 8-ft- (2.4-m) tall wild rice

plants are an attractive habitat from the time the wild rice begins heading until it is harvested (approximately 6 weeks), even though wild rice is a food source only for the last 2 to 3 weeks (milk stage to harvest of mature grains). Our data suggest blackbird arrivals at wild rice field are linked to breeding behavior followed by flocking behavior, which occurs naturally when birds leave breeding territories.

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