# Susitna-Watana Hydroelectric Project Document
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# Susitna-Watana Hydroelectric Project
# (FERC No. 14241)

# Waterbird Migration, Breeding, and Habitat Use
# Study Plan Section 10.15

# Initial Study Report
# Part B: Supplemental Information (and Errata) to Part A (February 3, 2014 Draft Initial Study Report)

Prepared for

Alaska Energy Authority

SUSITNA-WATANA HYDRO

*Clean, reliable energy for the next 100 years.*

Prepared by

ABR, Inc.—Environmental Research & Services

Anchorage and Fairbanks, Alaska, and Forest Grove, Oregon

June 2014

## PART B: SUPPLEMENTAL INFORMATION (AND ERRATA) TO PART A (FEBRUARY 3, 2014 DRAFT INITIAL STUDY REPORT)

| Part A Reference | Description |
|---|---|
| Passim | As explained in the ISR Overview and depicted in Figure 1, following release of the draft ISR in February 2014, AEA added a new north-south transmission and access corridor alignment from the dam site to the Denali Highway. This new alignment is referred to as the Denali East Option. For clarity, the north-south alignment studied to date (and historically referred to as the Denali Corridor) is now referred to as the Denali West Option. Hence, all references in Part A to the "Denali Corridor" are referencing the newly designated Denali West Option. |
| Figure 5.2-2, Page 118 | Dates of prenesting surveys for Harlequin Ducks are incorrect in map legend. Legend is revised to read: "1–5 June and 14–17 June." |
| New Appendix to ISR 10.15, Part B | Supplemental information (Appendix T: Summary of 2013 Avian Migration Studies for the Susitna-Watana Hydroelectric Project) is presented to summarize different bird migration survey tasks conducted in 2013 for Study 10.14 and Study 10.15, as discussed at the wildlife technical meetings on March 6, 2014 (see http://www.susitna-watanahydro.org/wp-content/uploads/2014/03/2014-03-06TT_Wildlife_MeetingNotes.pdf) and April 9, 2014 (see http://www.susitna-watanahydro.org/wp-content/uploads/2014/05/Wildlife-Technical-Meeting-Notes_04092014.pdf). This information was prepared to assist the reader in interpreting the migration data collected in 2013 and to compare results with other, similar studies conducted on interior and Southcentral Alaska. |

# PART B – APPENDIX T: SUMMARY OF 2013 AVIAN MIGRATION STUDIES FOR THE SUSITNA-WATANA HYDROELECTRIC PROJECT

# Susitna-Watana Hydroelectric Project
# (FERC No. 14241)

# Waterbird Migration, Breeding, and Habitat Use
# Study Plan Section 10.15

# Initial Study Report
# Part B - Appendix T:
# Summary of 2013 Avian Migration Studies for the Susitna-Watana Hydroelectric Project

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# 1 INTRODUCTION AND SUMMARY OF METHODS

Surveys of migrating birds were conducted during spring and fall 2013 as part of two Project studies—Surveys of Eagles and Other Raptors (RSP Section 10.14) and Waterbird Migration, Breeding, and Habitat Use (RSP Section 10.15)—as described in Part A of ISR 10.14 and ISR 10.15. This appendix summarizes the highlights of the various migration survey tasks conducted for those two studies in a single location to help the reader interpret the overall results. This appendix supplements the information that is presented in greater depth in those two ISRs.

Following the standard hawk migration counting protocol described in Appendix C of the *Draft Eagle Conservation Plan Guidance* (USFWS 2011), raptor migration surveys were conducted at 18 points along potential transmission line corridors during the peak migration seasons in spring (April 12–May 11) and fall (September 16–October 15). Aerial surveys of waterbirds on water bodies within a 3-mi buffer of the proposed reservoir and Project area alignments were conducted at five-day intervals during the spring (late April to late May) and fall (mid-August to mid-October) migration periods, resulting in 7 surveys in spring and 11 surveys in fall. Using a combination of visual and radar methodologies, observers also conducted surveys throughout the day and night from a single sampling site (hereafter "Dam site") established at the peak elevation of the benchland northwest of the proposed Watana Dam site. These data were collected from April 20 to June 3 (spring migration) and from August 16 to October15 (fall migration) in 2013. Diurnal visual observations using binoculars and spotting scopes were conducted daily from sunrise to sunset, while radar data were collected from sunset to sunrise each night and for 3 hours during daylight hours each day, with variable starting times. Nocturnal audiovisual surveys were conducted during the first 2–3 h of nocturnal radar sampling in both spring and fall to supplement radar data with identification of taxa composing radar targets; however, few birds were observed during these surveys, particularly in fall, and the results will not be summarized here. All bird species were recorded during raptor surveys and surveys at the Dam site. Additional details on the methods and data collected for each of these surveys are presented in Table 1, as well as in RSP Sections 10.14 and 10.15 and in ISR Studies 10.14 and 10.15.

## 1.1 Summary and Discussion of Results

### 1.1.1 Abundance and Species Composition

Diurnal visual surveys conducted at the Dam site resulted in observations of 8,188 birds (representing 89 species) in 2,366 groups during the spring and 6,445 birds (representing 51 species) in 1,234 groups in the fall. During raptor migration surveys, 969 individual birds (representing 32 species) in 309 groups were recorded during the spring survey period and 3,205 individual birds (representing 37 species) in 598 groups were recorded during the fall. A total of 32 waterbird species (27 each season) were recorded during spring and fall aerial surveys of water bodies. In spring, waterfowl and passerines were the most abundant species groups observed during both migration surveys at the Dam site (32 percent and 40 percent, respectively) and raptor surveys (42 percent and 39 percent, respectively). In the fall, passerines (predominantly redpolls [*Carduelis* spp.]) were the most abundant species group (59 percent during surveys at the Dam site and 69 percent during raptor surveys). At the Dam site, Sandhill Cranes composed 27 percent of all birds recorded in the fall, but no other group accounted for

>10 percent of birds during either survey. Shorebirds (1,181 birds; 14 percent) were the third most common species group observed in the spring at the Dam site but were not observed in the fall or during raptor surveys in either season. Ptarmigan were frequently observed at the higher elevations of the raptor surveys, particularly in spring (accounting for 14 percent of all birds), but were rare in fall and only seen on one occasion at the Dam site. Smaller numbers of Common Ravens, loons, woodpeckers, gulls, terns, and jaegers also were reported. Total counts and percentages of each species are presented in Table D-1 of ISR Study 10.14 and Appendices B and C of ISR Study 10.15.

Visual migration surveys provided counts and rates of the number of birds observed flying through the survey area (movement rates, expressed as birds/h) during diurnal hours, whereas radar surveys provided a spatial component to rates (passage rates, expressed as birds/km/h) for both diurnal and nocturnal migrants. The overall mean movement rate of all birds during diurnal visual sampling at the Dam site was 11.30 ± 2.06 birds/h during the spring and 9.43 ± 2.56 birds/h during the fall. During raptor surveys, overall mean movement rates were 2.08 ± 0.43 birds/h in the spring and 8.03 ± 1.33 birds/h in the fall. Differences in numbers and rates between the two ground-based surveys are largely attributed to the differences in the range of survey dates each season as well as the hours sampled within survey days.

Mean spring passage rates of radar targets at the Dam site ranged from 0.3 to 380 targets/km/h during nocturnal sampling (mean ± SE = 31.2 ± 7.8 targets/km/h; sunset until sunrise) and from 0 to 287 targets/km/h (mean = 98.9 ± 17.0 targets/km/h) during diurnal hours. Mean fall passage rates ranged from 0.4 to 771 targets/km/h (mean = 95.1 ± 17.4 targets/km/h) during nocturnal sampling and from 0 to 111 targets/km/h (mean = 10.9 ± 2.4 targets/km/h) during daylight hours. Higher nocturnal rates reflect the prevalence of nocturnal passerine migrants.

*Waterfowl and Cranes*

Waterfowl accounted for 32 percent of birds observed in spring at the Dam site, but the total number of individuals (2,658) was lower than reported in nearly all other studies (Table 2). Waterfowl were the most abundant species-group (403 birds; 42 percent of individuals) during spring raptor surveys. Waterfowl numbers in fall (372 [6 percent of all birds] during surveys at the Dam site; 280 [9 percent of all birds] during raptor surveys) were substantially lower (Table 3). Swans accounted for 41 percent of waterfowl observed in the spring and 81 percent of waterfowl observed in the fall at the Dam site. During raptor surveys, swans accounted for 93 percent of spring waterfowl but only 10 percent of waterfowl in the fall.

In general, waterfowl were far more prevalent on water bodies (Appendix B of ISR Study 10.15) than observed flying through the Project area during the ground-based surveys. Results of aerial surveys (in 2013, as well as earlier surveys in 1981 and 1982) indicated that fewer waterfowl used water bodies of the upper Susitna River basin for stopover in the spring than in the fall; however, the results of ground-based surveys conducted in 2013 suggest that more birds fly through the region in the spring than in the fall. During spring 2013, swans (47 percent) and scoters (23 percent) accounted for the majority of identifiable waterfowl observed, but only accounted for 1 percent and 8 percent, respectively, of waterfowl seen during aerial surveys of the area in spring 1981 (Kessel et al. 1982) and 4 percent and 2 percent, respectively, of

waterfowl seen during aerial surveys of the area in spring 2013. These results suggest that some species primarily migrate through the basin without stopping at local water bodies.

Migration studies in 2013 recorded low numbers of Sandhill Cranes migrating through the study area during spring (23 and 10 birds, respectively at Dam site and during raptor surveys) and fall (1,754 and 172 birds, respectively at Dam site and during raptor surveys), relative to other studies in the region, particularly those located north of the Alaska range (Tables 2 and 3).

*Eagles and Other Raptors*

During the spring, raptors represented 6 percent of birds observed at the Dam site and 16 percent of birds observed during raptor migration surveys. In spring, Golden Eagles were the most common raptor species observed during both the avian migration surveys at the Dam site (101 birds) and raptor migration surveys (91 birds). During both surveys, Bald Eagles were the second most frequently seen raptor, with 94 birds observed at the Dam site and 35 birds observed during raptor surveys; followed by Northern Harriers (48 birds at the dam site and 14 birds during raptor surveys). In the fall, raptors represented 3 percent of birds observed at the Dam site and 4 percent of birds observed during raptor surveys. During fall surveys at the Dam site, Bald Eagles were the most common raptor species observed during raptor surveys in the fall (37 birds), followed by Peregrine Falcons (25 birds) and Sharp-shinned Hawks (22 birds). During fall raptor surveys, Golden Eagles were the most common raptor species observed during raptor surveys in the fall (38 birds), followed by Bald Eagles (31 birds) and Rough-legged Hawks (7 birds). Raptors had relatively low mean movement rates overall, however. Seasonal movement rates of eagles were 0.33 (spring) and 0.09 (fall) at the Dam site and 0.29 (spring) and 0.20 (fall) during raptor surveys. Other raptors had mean fall movement rates of 0.37 (spring) and 0.18 (fall) at the Dam site and 0.08 (spring) and 0.07 (fall) during raptor surveys.

Raptor numbers, particularly eagles, include both migrating and locally breeding individuals. Migration surveys at the Dam site extended past the migratory time period for raptors in the spring and started well before the onset of the primary raptor migration period in the fall. Golden Eagles likely were the most frequently observed raptor during raptor migration surveys because observation zones were primarily in alpine areas and many were within or adjacent to occupied eagle territories. Movement rates of raptors in the Project generally were within the range of rates observed elsewhere in Alaska during spring (Table 2) and lower than rates observed elsewhere during the fall (Table 3).

### 1.1.2 Temporal and Spatial Variation

During spring 2013, diurnal and nocturnal radar passage rates at the Dam site remained low until May 9, with higher rates occurring afterward until May 30 (Figure 1). In the fall, nocturnal radar passage rates were highest in late August and early September before falling to very low levels by the end of September. Diurnal passage rates in the fall fluctuated extensively until October 4, after which rates remained very low (Figure 1).

*Waterfowl and Cranes*

During spring 2013, waterfowl first appeared in low numbers during the last week of April. Movement rates of swans increased and peaked during the first week of May, although numbers on water bodies continued to increase until later in the month (Table 4 and Figure 2). Other waterfowl (primarily geese) also had an early May pulse of movement during visual observation at the Dam site and then increased again and peaked in late May when relatively large numbers of diving ducks (primarily scoters) flew through the area (Figure 3). Numbers of ducks and geese on water bodies also peaked in late May (Table 4 and Figure 3), although no scoters were observed, in contrast to the visual migration surveys. Numbers of geese and swans observed during spring raptor surveys were very low.

In the fall, waterfowl movement rates were very low, with peak numbers of swans and other waterfowl concentrated during a few days at the end of September (Table 4 and Figures 4 and 5). Numbers of swans on water bodies remained consistent through the first week of October, however, before decreasing to lower levels during the last two surveys of the season (Figure 4). Numbers of ducks and geese observed during aerial surveys declined gradually throughout the fall season before also dropping to much lower levels during the last two surveys (Figure 5).

Overall, numbers and patterns of waterfowl on water bodies during aerial surveys did not correlate with those observed in flight during ground-based surveys. As mentioned previously, these differences suggest that some waterfowl migrate through the area without stopping at local water bodies. In addition, fairly large numbers of birds apparently remained on water bodies (either for breeding or post-breeding) and were not observed moving during diurnal ground-based surveys. Some nocturnal movements of waterfowl were detected, but it is unclear to what extent these occurred.

In spring, the distribution of waterfowl on water bodies in the study area was dependent on the availability of open water and suitable staging habitats. The first water available and occupied was located at some beaver ponds and at the outlets of a few large lakes. Most ducks in the study area were found in the Chulitna Corridor survey area in late April and early May because of the occurrence of open-water on beaver ponds. Most of the ducks in mid-May occurred on the Susitna River. Warm temperatures between aerial surveys on May 23–24 and May 28–29 resulted in rapid snow melt, high-velocity flows in streams, and most lower-elevation water bodies having open water. As a result, most waterbirds (78 percent) were found on water bodies other than streams, which had high velocity and muddy water during the final spring aerial survey.

In fall, Stephan Lake (dabblers and swans) and Murder Lake (all species), in the Gold Creek Corridor survey area, were two of the most heavily used water bodies during fall migration, remaining largely ice-free throughout the study period. Cumulative numbers of ducks and swans throughout the study area were highest in the Denali Corridor through mid-September and higher subsequently in the Gold Creek Corridor. Refer to Section 2.1.1 and Appendix B of ISR Study 10.15 for details of the use of specific water bodies within the study area.

Sandhill Cranes moved through the Project area in very low numbers in the spring, with only a single flock of >3 birds observed (8 birds at the Dam site on May 9). In the fall, crane

movements were recorded at the Dam site only during a 3-day period (September 23–25), with peak rates of 148 birds/h and flocks of up to 500 birds occurring on September 24 (Table 4). Two smaller flocks also were observed during raptor surveys on October 1.

*Eagles and Other Raptors*

During spring 2013, Golden Eagle numbers and rates peaked during the first week of raptor surveys in mid-April and fluctuated during subsequent weeks during both raptor and Dam site surveys, but did not exhibit any temporal pattern of occurrence (Table 4 and Figure 6). Bald Eagle movements during raptor surveys peaked during the first week of May but otherwise did not exhibit any temporal pattern of occurrence for either spring survey (Table 4 and Figure 7). Numbers of other raptors increased during the second week of May (during the last week of raptor surveys) and remained elevated during surveys at the Dam site until the end of May (Figure 8).

In the fall, numbers of both eagle species increased in the latter half of September (Figures 6 and 7). Bald Eagle numbers declined after the first week of October, but mean movement rates of Golden Eagles remained near their peak levels through the end of surveys. Observations of Peregrine Falcons and Merlins resulted in relatively high numbers of other raptor species at the Dam site in August (Figure 8). Rates declined during early September and increased again late in the month with increasing numbers of *Buteo* hawks.

In spring but not fall, mean passage rates of raptors tended to be higher in the lower Susitna and Nenana drainages, with fewer raptors in the upper reaches of the Denali corridor. Higher numbers of Golden Eagles were observed at raptor survey sites along the Denali Highway and near Portage Creek. Bald Eagles were most frequently observed from sites along the Denali Highway and along the Susitna River and Portage Creek. Other raptors were most commonly observed at sites near Portage Creek, the Susitna River, and the Seattle/Brushkana Creek drainages. In the fall, Golden Eagle observations were scattered widely throughout the study area but most frequent near Devil Creek. Bald Eagle observations were most frequent at sites near Deadman Creek and Brushkana Creek; and other raptor species were observed most commonly near Portage Creek and Brushkana Creek.

### 1.1.3 Flight Directions

In the spring, flight directions of the majority of radar targets during both diurnal (66 percent) and nocturnal (76 percent) survey periods were westerly (between 225° and 315°). Flight directions of diurnal radar targets in the fall were somewhat bimodal towards the east (36 percent) and the west (33 percent), while flight directions of nocturnal radar targets were generally easterly (63 percent between 45° and 135°).

In the spring, most flocks (64 percent of 1,132 groups exhibiting straight-line flight) observed at the Dam site flew in a westerly direction, whereas overall flight directions of groups during fall surveys ($n$ = 412) were variable, but with the largest percentage of flights (48 percent) oriented in an easterly direction.

Raptor movement through the study area exhibited no discernible pattern of directionality during spring ($n$ = 90 groups) or fall ($n$ = 77 groups) raptor surveys, although directional movements of eagles and other raptors were strongly oriented toward the west in spring ($n$ = 157 groups) and east in fall ($n$ = 46 groups) at the Dam site.

Swan movements were strongly oriented toward the west in spring ($n$ = 119 groups) and east in fall ($n$ = 27 groups) at the Dam site; however other waterfowl were overall much less directional in overall flight patterns. Flight directions of geese and ducks at the Dam site in spring ($n$ = 146 groups) were strongly bimodal to the east and west, as most dabbling ducks were observed flying in a westerly direction while many flocks of diving ducks (particularly scoters during the last week in May) were observed flying easterly. Numbers of geese and ducks observed during ground-based surveys in the fall were too low to warrant analysis of directionality.

### 1.1.4 Flight Altitudes

The mean flight altitudes of spring radar targets were 349.7 ± 8.1m agl ($n$ =1,375 targets) during nocturnal sampling and 451.3 ± 3.6 m agl ($n$ = 6,608 targets) during diurnal sampling. The percentage of targets flying ≤100 m agl was 22 percent during nocturnal sampling and 9 percent during diurnal periods. At the Dam site, the mean minimal flight altitude of birds observed during diurnal visual sampling was 76.7 ± 3.7 m ($n$ = 1,064 groups), with 64 percent flying ≤50 m agl. The mean minimal flight altitude of all birds during spring raptor surveys was 128.0 ± 25.8 m ($n$ = 189 groups), with 64 percent flying ≤40 m above ground level (agl).

The mean flight altitudes of fall radar targets were 402.9 ± 3.3 m agl ($n$ =7,114 targets) during nocturnal sampling and 240.3 ± 11.6 m agl ($n$ = 313 targets) during diurnal sampling. The percentage of targets flying ≤100 m agl was 12 percent during nocturnal sampling and 28 percent during diurnal periods. At the Dam site, the mean minimal flight altitude of birds observed during diurnal visual sampling was 76.7 ± 3.7 m ($n$ = 1,064 groups), with 64 percent flying ≤50 m agl. The mean minimal flight altitude of all birds during fall raptor surveys was 32.7 ± 3.4 m ($n$ = 338 groups), with 80 percent flying ≤40 m above ground level (agl).

Flight altitudes of radar targets were higher at night than during diurnal hours. Significantly higher mean flight altitudes of radar targets relative to visually observed birds reflect the greater detectability of high-flying birds (particularly passerines) with radar as well as limitations of the radar for detecting birds at very low levels due to ground clutter. Flight altitudes for most species-groups observed during visual surveys in the Project area were generally higher than those reported during other studies in the region (Table 5).

During spring raptor surveys, the majority of all bird groups crossing the proposed transmission line corridor were observed at low (35.6 percent; 1–40 m agl) or intermediate heights (26.7 percent; 41–125 m agl). The majority of all bird groups crossing the proposed corridors during the fall also were observed at low (59.4 percent) or intermediate heights (29.3 percent).

*Waterfowl and Cranes*

Swans had the highest mean minimal flight altitude of any species-group during raptor surveys (530 ± 195 m agl, $n$ = 9 groups in spring; insufficient observations for fall), while flight altitudes

of swans were lower at the Dam site (249 ± 38 m agl, *n* = 21 groups in spring; 149 ± 80 m agl, *n* = 10 groups in fall). The highest mean minimal flight altitudes at the Dam site were those of loons (529 ± 291 m agl; *n* = 5 flocks) observed during the spring. Cranes had the highest mean minimal altitudes of any species-group during fall surveys both at the Dam site (335 ± 142 m agl; *n* = 5 flocks) as well as during fall raptor surveys (108 ± 8 m agl; *n* = 3 groups).

*Eagles and Other Raptors*

Mean minimal flight altitudes of Golden Eagles were similar during spring raptor surveys (265 ± 78 m agl, *n* = 53 groups) and visual surveys at the Dam site (264 ± 34 m agl, *n* = 24 groups). Mean minimal flight altitudes were lower during both fall surveys (91 ± 22 m agl, *n* = 21 groups during raptor surveys; 126 ± 30 m agl, *n* = 9 groups during surveys at the dam site). The mean altitudes of Golden Eagles observed over proposed transmission corridors were 411 ± 131 m agl (*n* = 32 groups) in the spring and 123 ± 40 m agl (*n* = 8 groups) in the fall.

Mean minimal flight altitudes of Bald Eagles also were similar during spring raptor surveys (127 ± 44 m agl, *n* = 15 groups) and visual surveys at the Dam site (123 ± 24 m agl, *n* = 23 groups). In the fall, mean minimal flight altitudes were lower than those observed during the spring for raptor surveys (58 ± 21 m agl; *n* = 25 groups) but higher than spring altitudes for surveys at the Dam site (263 ± 94 m agl; *n* = 12 groups). The mean altitudes of Bald Eagles observed over proposed transmission corridors were 160 ± 43 m agl in the spring and 134 ± 51 m agl (*n* = 9 groups) in the fall.

Other raptors had lower mean minimal flight altitudes than eagles during both spring (81 ± 21 m agl; *n* = 22 groups) and fall (19 ± 4 m agl; *n* = 22 groups) raptor surveys. Minimal flight altitudes also were lower for other raptors than for eagles during spring (105 ± 14 m agl; *n* = 101 groups) and fall (66 ± 16 m agl; *n* = 51 groups) surveys at the Dam site. The mean altitudes of raptors other than eagles that were observed over proposed transmission corridors were 110 ± 34 m agl (*n* = 12 groups) in the spring and 46 ± 16 m agl (*n* = 14 groups) in the fall.

# 2 TABLES

**Table 1. Overview of Avian Migration Surveys Conducted for the Susitna–Watana Project in 2013.**

| | Survey Type | | | | |
|---|---|---|---|---|---|
| | **Raptor Migration Surveys** | **Waterbird Aerial Surveys** | **Dam Site Visual Surveys** | **Diurnal Radar Surveys** | **Nocturnal Radar Surveys** |
| **Study Number** | 10.14 | 10.15 | 10.15 | 10.15 | 10.15 |
| **Spring Survey Period (days/hours)** | Apr 12–May 11 (29/293) | Apr 23–May 29 (7/na) | Apr 20–Jun 3 (45/651) | Apr 20–Jun 3 (42/88) | Apr 20–Jun 3 (42/184) |
| **Fall Survey Period (days/hours)** | Sep 17–Oct 13 (25/299) | Aug 14–Oct 18 (11/na) | Aug 16–Oct 15 (61/652) | Aug 16–Oct 15 (53/94) | Aug 16–Oct 15 (59/367) |
| **Survey Area** | Transmission line corridors | Water bodies within 3-mi (5-km) buffer of Project area | Within 10 km of proposed dam site | Within 6 km of proposed dam site | Within 6 km of proposed dam site |
| **Number of Survey Points** | 18 | na | 1 | 1 | 1 |
| **Species Recorded** | All | Waterbirds | All | All (undifferentiated) | All (undifferentiated) |
| **Key Results** | Abundance, species composition, movement rates, flight altitude, flight behavior, flight direction, distribution, seasonal variation | Abundance, species composition, distribution, seasonal variation, relative importance of waterbodies | Abundance, species composition, movement rates, flight altitude, flight behavior, flight direction, seasonal and daily variation | Passage rates, flight altitude, flight direction, seasonal and daily variation, landscape patterns | Passage rates, flight altitude, flight direction, seasonal and daily variation, landscape patterns |

Notes:
na = not available.

**Table 2. Relative Abundance (Total Number of Birds) and Peak Dates of Occurrence (in Parentheses) of Avian Species Groups Recorded in Selected Alaska Spring Migration Studies.**

| Species Group | Study Location | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Susitna–Watana Dam Site[1] | Susitna–Watana Raptor Surveys[2] | Eva Creek[3] | Tok[4] | Gulkana[5] | Delta River[6] | Delta Junction[7] | GVEA Intertie[8] | Fire Island[9] |
| **Waterfowl** | 2,658 (5/5) | 403 (5/5) | 1,797[10] (nr) | 20,248–33,883 (nr) | 2,177–13,647 (nr) | 15 (nr) | 23, 795 (nr) | 11,331[10] (nr) | 22,684 (4/19) |
| Swans | 1,086 (5/5[11]) | 374 (5/5) | 1,622 (4/26) | 3,994–14,369 (4/24–4/27) | 1,289–8,907 (4/23–4/26) | 2 (nr) | 13,851 (nr) | 3,236 (5/15) | 100 (4/23) |
| Geese | 308 (5/7) | 25 (5/5) | nr | 6,827–15,428 (4/24–4/26) | 127–978 (4/23–4/26) | 0 (nr) | 6,921 (nr) | 5,055 (nr) | 22,407 (4/19) |
| Ducks | 1,136 (5/28) | 4 (5/7) | nr | 3,239–7,771 (4/25–4/27) | 761–3,762 (4/28–4/29) | 13 (nr) | 252 (nr) | 5,357 (nr) | 125 (5/11) |
| **Raptors** | 468 (5/21) | 157 (5/3) | nr | 797–1,196 (4/22–4/29) | 201–563 (4/28–4/29) | 49 (4/30) | 156 (nr) | 159 (4/25) | 362 (4/28) |
| Eagles | 215 (5/21) | 132 (5/3) | 26 (nr) | nr | nr | 9 (nr) | 20 (nr) | 56 (nr) | 243 (nr) |
| Other Raptors | 218 (5/9) | 25 (5/10) | 102 (nr) | nr | nr | nr | nr | 79 (nr) | 91 (nr) |
| **Cranes** | 23 (5/9) | 10 (5/7) | 12,757 (5/4) | 31,311–113,167 (5/4– | nr | 339 (5/5) | 31,163 (5/6) | 30,509 (5/11) | 83 (4/23) |
| **Shorebirds** | 1,181 (5/17) | 0 | 44 (nr) | 668–4,115 (5/15–5/18) | 69–147 (5/10–5/11) | 8 (nr) | 50 (nr) | 37 (nr) | 502 (5/11) |
| **Passerines** | 3,369[12] (5/17) | 188[12] (5/11) | 493[12] (nr) | 7,030–9,290 (4/30–5/11) | 357–912 (4/29–5/6) | 270 (5/7) | 911 (nr) | 797[12] (nr) | 1,967[12] (4/24) |

Notes:
nr = not recorded.
[1] Susitna–Watana Hydroelectric Project, ISR 10.15: Waterbird Migration, Breeding, and Habitat Use (April 20–June 3, 2013; 42 days).
[2] Susitna–Watana Hydroelectric Project, ISR 10.14: Surveys of Eagles and Other Raptors (April 12–May 11, 2013; 29 days).
[3] Shook et al. 2011 (April 25–May 16, 2010; 21 days).
[4] Cooper et al. 1991 (April 20–May 24, 1987; 45 days; April 5–May 21, 1988; 47 days; April 5–May 25, 1989; 50 days); values are ranges across 3 years of study.
[5] Cooper et al. 1991 (April 16–May 15, 1987; 26 days; April 16–May 13, 1988; 28 days; April 16–May 15, 1989; 30 days); values are ranges across 3 years of study.
[6] ABR 2010 (April 30–May 9, 2009; 10 days).
[7] Parrett and Day 2009 (April 27–May 6, 2009; 9 days).
[8] Day et al. 2011 (April 23–May 15, 2000; 18 days).
[9] Day et al. 2005 (April 17–May 13, 2004; 22 days).
[10] Excluding swans.
[11] More flocks heard on May 3; individual count lower due to poor visibility.
[12] Excluding ravens.

**Table 3. Relative Abundance (Total Number of Birds) and Peak Dates of Occurrence (in Parentheses) of Avian Species Groups from Selected Alaska Fall Migration Studies.**

| Species Group | Study Location | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Susitna–Watana Dam Site[1] | Susitna–Watana Raptor Surveys[2] | Eva Creek[3] | Tok[4] | Gulkana[5] | Delta River[6] | GVEA Intertie[7] | Fire Island[8] |
| **Waterfowl** | 372 (9/23) | 280 (9/23) | 1,958 (nr) | 31,392–37,212 (nr) | 919–2,975 (nr) | 100 (10/2) | 1,186[8] (nr) | 3,636 (10/16) |
| Swans | 301 (9/30) | 28 (9/24) | 1,693 (9/7) | 7,836–20,440 (9/28–10/11) | 853–2,383 (10/8– | 100 (nr) | 12,304 (9/11) | 206 (10/16) |
| Geese | 19 (9/23) | 116 (9/23) | nr | 9,434–28,511 (8/20–9/8) | 3–230 (8/22– | 0 (nr) | 139 (nr) | 3,218 (10/16) |
| Ducks | 3 (10/2) | 124 (9/24) | nr | 683–2,325 (9/8–10/11) | 63–362 (9/9–10/5) | 0 (nr) | 961 (nr) | 171 (10/17) |
| **Raptors** | 173 (9/28) | 121 (10/09) | 275 (9/11) | 1,237–1,787 (9/13–9/16) | 179–279 (9/28–9/30) | 99 (9/30) | 442 (9/11) | 351 (9/14) |
| Eagles | 52 (9/28) | 90 (10/09) | 57 (nr) | nr | nr | 17 (nr) | 132 (nr) | 163 (nr) |
| Other Raptors | 108 (9/28) | 25 (9/18) | nr | nr | nr | nr | 259 (nr) | 134 (nr) |
| **Cranes** | 1,754 (9/24) | 172 (10/01) | 48,276 (9/10) | 43,442–97,988 (9/13–9/15) | nr | 200 (9/10) | 84,979 (9/23) | 111 (9/23) |
| **Shorebirds** | 0 | 0 | 8 (nr) | 31–54 (8/27–10/8) | 2–15 (9/8–10/5) | 0 (nr) | 6 (nr) | 32 (nr) |
| **Passerines** | 3,913[10] (9/12) | 2,208[10] (10/05) | 1,252[10] (9/10) | 5,959–9,318 (8/29–10/14) | 600–866 (9/4–10/13) | 460 (9/15) | 2,116[10] (nr) | 2,546[10] (9/11) |

Notes:
[1] Susitna–Watana Hydroelectric Project, ISR 10.15: Waterbird Migration, Breeding, and Habitat Use (August 16–October 15, 2013; 61 days).
[2] Susitna–Watana Hydroelectric Project, ISR 10.14: Surveys of Eagles and Other Raptors (September 17–October 13, 2013; 25 days).
[3] Shook et al. 2011 (August 26–October 7, 2010; 43 days).
[4] Cooper et al. 1991 (August 16–October 6, 1987; 52 days; August 16–October 17, 1988; 33 days; August 16–October 18, 1989; 64 days); values are ranges across 3 years of study.
[5] Cooper et al. 1991 (September 1–October 23, 1987; 46 days; September 3–October 19, 1988; 47 days; September 6–October 18, 1989; 43 days ); values are ranges across 3 years of study.
[6] ABR 2010 (September 9–19 and September 30–October 6, 2009; 18 days).
[7] Day et al. 2011 (September 9–19 and September 29–October 9, 1999; 22 days).
[8] Day et al. 2005 (September 2–October 17, 2004; 31 days).
[9] Excluding swans.
[10] Excluding ravens.

**Table 4. Mean and Peak Numbers and Movement Rates from Susitna–Watana Avian Migration Surveys in 2013.**

| Season / Species Group | Survey Type | | | | |
|---|---|---|---|---|---|
| | **Raptor Migration[1]** | **Waterbird Aerial Surveys[2]** | **Dam Site Visual[2]** | **Diurnal Radar[2]** | **Nocturnal Radar[2]** |
| | Mean birds/h (peak rate; date) | Mean birds/survey (peak number; date) | Mean birds/h (peak rate; date) | Mean targets/h (peak rate; date) | Mean targets/h (peak rate; date) |
| **Spring** | | | | | |
| Swans | 0.58 (8.40; May 5) | 39 (72; May 23–24) | 1.80 (20.82; May 5) | n.a. | n.a. |
| Other Waterfowl | 0.01 (0.15; May 7) | 891 (2,156; May 23–24) | 2.31 (19.98; May 28) | n.a. | n.a. |
| Loons and Grebes | 0 | 3 (17; May 28–29) | 0.03 (0.27; June 3) | n.a. | n.a. |
| Eagles | 0.29 (1.50; April 15) | n.a. | 0.33 (1.30; May 21) | n.a. | n.a. |
| Golden Eagle | 0.22 (1.50; April 15) | n.a. | 0.15 (0.71; May 21) | n.a. | n.a. |
| Bald Eagle | 0.06 (0.45; May 3) | n.a. | 0.15 (0.63; May 27) | n.a. | n.a. |
| Other Raptors | 0.08 (0.83; May 10) | n.a. | 0.37 (1.37; May 9) | n.a. | n.a. |
| Sandhill Crane | 0 | 0 | 0.03 (0.69; May 9) | n.a. | n.a. |
| Gulls, Terns, Jaegers | 0 | 36 (112; May 11) | 0.46 (4.93; May 20) | n.a. | n.a. |
| Passerines | 0.82 (6.00; April 13) | n.a. | 4.00 (39.92; May 17) | n.a. | n.a. |

| Season / Species Group | Survey Type | | | | |
|---|---|---|---|---|---|
| | **Raptor Migration[1]** | **Waterbird Aerial Surveys[2]** | **Dam Site Visual[2]** | **Diurnal Radar[2]** | **Nocturnal Radar[2]** |
| | Mean birds/h (peak rate; date) | Mean birds/survey (peak number; date) | Mean birds/h (peak rate; date) | Mean targets/h (peak rate; date) | Mean targets/h (peak rate; date) |
| All Birds | 2.08 (9.23; May 5) | n.a. | 11.30 (81.76; May 17) | 31 (287; May 21) | 99 (380; May 16) |
| **Fall** | | | | | |
| Swans | 0.01 (0.19; Sep 23) | 84 (126; Sep 22–23 & 27–29) | 0.52 (9.08; Sep 30) | n.a. | n.a. |
| Other Waterfowl | 0.38 (7.50; Sep 23) | 1,771 (2,803; Aug 14–18) | 0.12 (5.09; Sep 23) | n.a. | n.a. |
| Loons and Grebes | 0 | 29 (66; Aug 26–31) | <0.01 (0.33; Aug 30) | n.a. | n.a. |
| Eagles | 0.20 (0.51; Sep 25) | n.a. | 0.09 (0.94; Sep 28) | n.a. | n.a. |
| Golden Eagle | 0.08 (0.30; Oct 4) | n.a. | 0.02 (0.21; Sep 30 & Oct 1) | n.a. | n.a. |
| Bald Eagle | 0.08 (0.34; Sep 25) | n.a. | 0.06 (0.83; Sep 28) | n.a. | n.a. |
| Other raptors | 0.07 (0.30; Oct 3) | n.a. | 0.18 (1.04; Sep 28) | n.a. | n.a. |
| Sandhill Crane | 0.40 (8.85; Oct 1) | 1 (16; Sep 27–29) | 2.86 (148.32; Sep 24) | n.a. | n.a. |
| Gulls, Terns, Jaegers | <0.01 (0.15; Oct 29) | 1 (11; Aug 14–18) | <0.01 (0.16; Aug 22) | n.a. | n.a. |
| Passerines[3] | 6.25 (19.95; Oct 1) | n.a. | 5.31 (23.02; Sep 12) | n.a. | n.a. |

| Season / Species Group | Survey Type | | | | |
|---|---|---|---|---|---|
| | **Raptor Migration[1]** | **Waterbird Aerial Surveys[2]** | **Dam Site Visual[2]** | **Diurnal Radar[2]** | **Nocturnal Radar[2]** |
| | Mean birds/h (peak rate; date) | Mean birds/survey (peak number; date) | Mean birds/h (peak rate; date) | Mean targets/h (peak rate; date) | Mean targets/h (peak rate; date) |
| All Birds | 8.03 (29.40; Oct 1) | n.a. | 9.43 (150.34; Sep 23) | 11 (111; Aug 18) | 95 (771; Aug 23) |

Notes:
n.a = not applicable.
[1] ISR 10.14.
[2] ISR 10.15.
[3] Excludes ravens.

**Table 5. Flight Altitudes (mean ± SE m agl) of Avian Species Groups from Visual Observations during Selected Alaska Migration Studies.**

| Season / Species Group | Study Location (Year) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Susitna–Watana Dam Site[1] (2013) | Susitna–Watana Raptor Surveys[2] (2013) | Eva Creek[3] (2010) | Tok[4] (1987) | Tok[4] (1988) | Tok[4] (1989) | Fire Island[5] (2004) |
| **Spring** | | | | | | | |
| **Waterfowl** | 161 ± 30 (41)[7] | | 319 ± 1 (9)[7] | nr | nr | nr | nr |
| Swans | 249 ± 38 (21) | 640 ± 235 (7) | 267 ± 2 (29) | 126 ± 10 (60) | 138 ± 11 (73) | 89 ± 8 (147) | 142 ± 138 (353) |
| Geese | nr | | nr | 170 ± 11 (91) | 147 ± 11 (59) | 109 ± 9 (83) | 47 ± 25 (9) |
| Ducks | nr | | nr | 63 ± 9 (139) | 56 ± 9 (162) | 47 ± 7 (231) | 159 ± 139 (308) |
| **Raptors** | nr | | nr | 82 ± 10 (365) | 67 ± 10 (309) | 52 ± 9 (252) | 16.9 ± 25 (34) |
| Eagles | 205 ± 23 (51) | 361 ± 106 (40) | 149 ± 2 (26) | nr | nr | nr | 47 ± 56 (275) |
| Other Raptors | 105 ± 14 (101) | 110 ± 34 (12) | 49 ± 7 (66) | nr | nr | nr | nr |
| **Cranes** | 100 (1) | | 364 ± 7 (103) | 173 ± 10 (127) | 201 ± 11 (44) | 113 ± 10 (43) | 77 ± 41 (19) |
| **Shorebirds** | 77 ± 10 (90) | | nr | 53 ± 8 (182) | 32 ± 7 (192) | 30 ± 7 (626) | 25 ± 34 (17) |
| **Passerines** | 51 ± 3 (677)[8] | 37 ± 9 (16) | 28 ± 15 (100)[8] | 17 ± 5 (1,567) | 21 ± 5 (1,362) | 17 ± 5 (2,466) | 16 ± 34 (189) |
| **Fall** | | | | | | | |
| **Waterfowl** | 100 (1)[6] | 300 (1)[6] | 620 ± 247 (5)[6] | nr | nr | nr | 59 ± 81 (118) |
| Swans | 149 ± 80 (10) | | 249 ± 35 (36) | 143 ± 11 (48) | 204 ± 13 (317) | 150 ± 13 (125) | 126 ± 142 (10) |
| Geese | nr | | nr | 353 ± 16 (73) | 354 ± 16 (61) | 294 ± 15 (120) | 77 ± 80 (67) |
| Ducks | nr | | nr | 49 ± 8 (12) | 108 ± 13 (72) | 27 ± 7 (30) | 14 ± 21 (36) |

| Season / Species Group | Study Location (Year) | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Susitna–Watana Dam Site[1] (2013)** | **Susitna–Watana Raptor Surveys[2] (2013)** | **Eva Creek[3] (2010)** | **Tok[4] (1987)** | **Tok[4] (1988)** | **Tok[4] (1989)** | **Fire Island[5] (2004)** |
| **Raptors** | nr | | nr | 80 ± 12 (664) | 123 ± 14 (609) | 63 ± 11 (533) | 30 ± 57 (286) |
| Eagles | 204 ± 56 (21) | 116 ± 24 (24) | 364 ± 62 (41) | nr | nr | nr | nr |
| Other Raptors | 66 ± 16 (51) | 46 ± 1 (14) | 108 ± 15 (139) | nr | nr | nr | nr |
| **Cranes** | 335 ± 142 (5) | 217 ± 92 (3) | 249 ± 15 (287) | 224 ± 13 (61) | 349 ± 16 (23) | 155 ± 11 (25) | 107 ± 41 (3) |
| **Shorebirds** | [7] | | nr | 71 ± 12 (19) | 59 ± 12 (18) | 12 ± 4 (20) | nr |
| **Passerines** | 27 ± 2 (401)[8] | 29 ± 6 (38) | 38 ± 4 (164)[8] | 32 ± 8 (1,001) | 23 ± 6 (1,534) | 27 ± 6 (2,251) | 19 ± 20 (613) |

Notes:
nr = not recorded.
[1] Susitna–Watana Hydroelectric Project, ISR 10.15: Waterbird Migration, Breeding, and Habitat Use (Spring: April 20–June 3, 2013; 42 days; Fall: August 16–October 15, 2013; 61 days). Minimum altitudes based on birds observed within 1 km of observer.
[2] Susitna–Watana Hydroelectric Project, ISR 10.14: Surveys of Eagles and Other Raptors (Spring: April 12–May 11, 2013; 29 days; Fall: September 17–October 13, 2013; 25 days). Altitude of birds crossing potential transmission-line corridors was estimated.
[3] Shook et al. 2011 (Spring: April 25–May 16, 2010; 21 days; Fall: August 26–October 7, 2010; 43 days).
[4] Cooper and Ritchie 1995 (Spring: April 10–May 24, 1987; 45 days; April 5–May 21, 1988; 47 days; April 5–May 25, 1989; 50 days; Fall: August 16–October 6, 1987; 52 days; August 16–October 17, 1988; 33 days; August 16–October 18, 1989; 64 days).
[5] Day et al. 2011 (Spring: April 17–May 13, 2004; 22 days; Fall: August 2–October 17, 2004; 31 days).
[6] Excluding swans.
[7] None present.
[8] Excluding ravens.

# 3 FIGURES

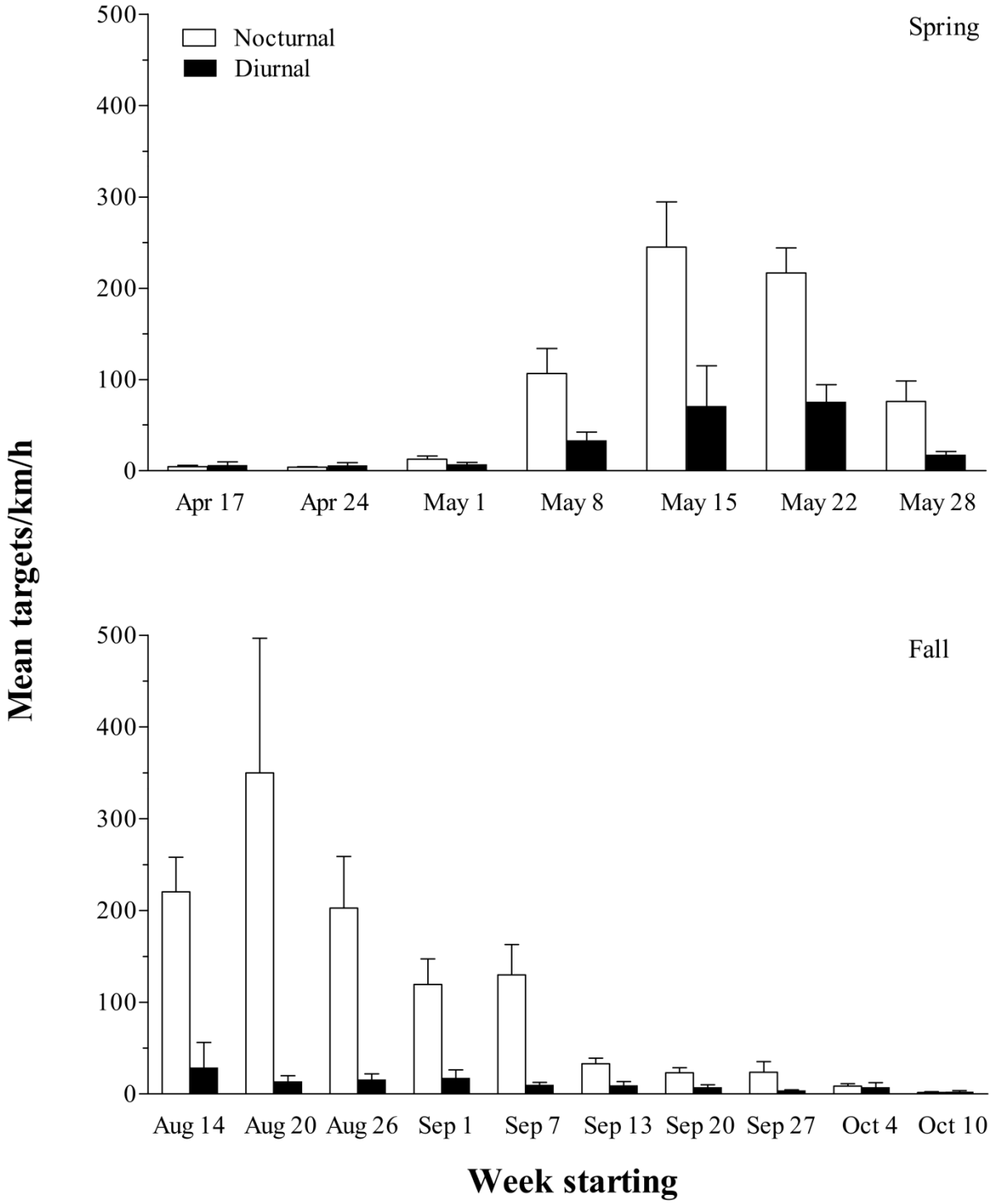


**Figure 1. Mean passage rates (radar targets/km/h) from diurnal and nocturnal radar surveys at the proposed Watana Dam site, by week, during spring and fall migration, 2013.**

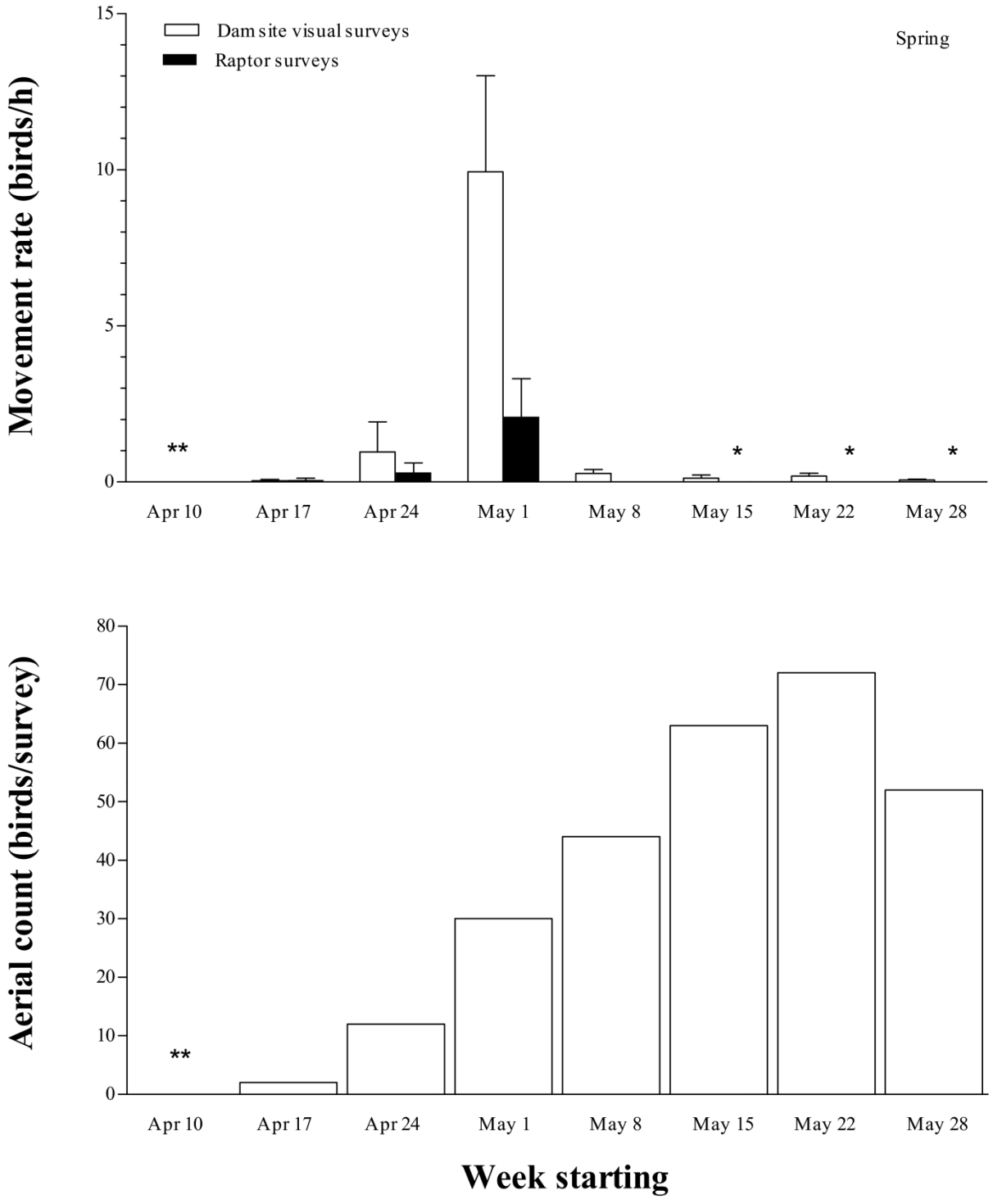


**Figure 2. Mean movement rates (birds/h) of swans from ground-based migration surveys (top) and aerial survey counts of swans at water bodies (bottom), by week, during spring migration, 2013. Single asterisks (*) indicate weeks in which no raptor surveys occurred; double asterisks (**) indicate that no surveys occurred that week.**

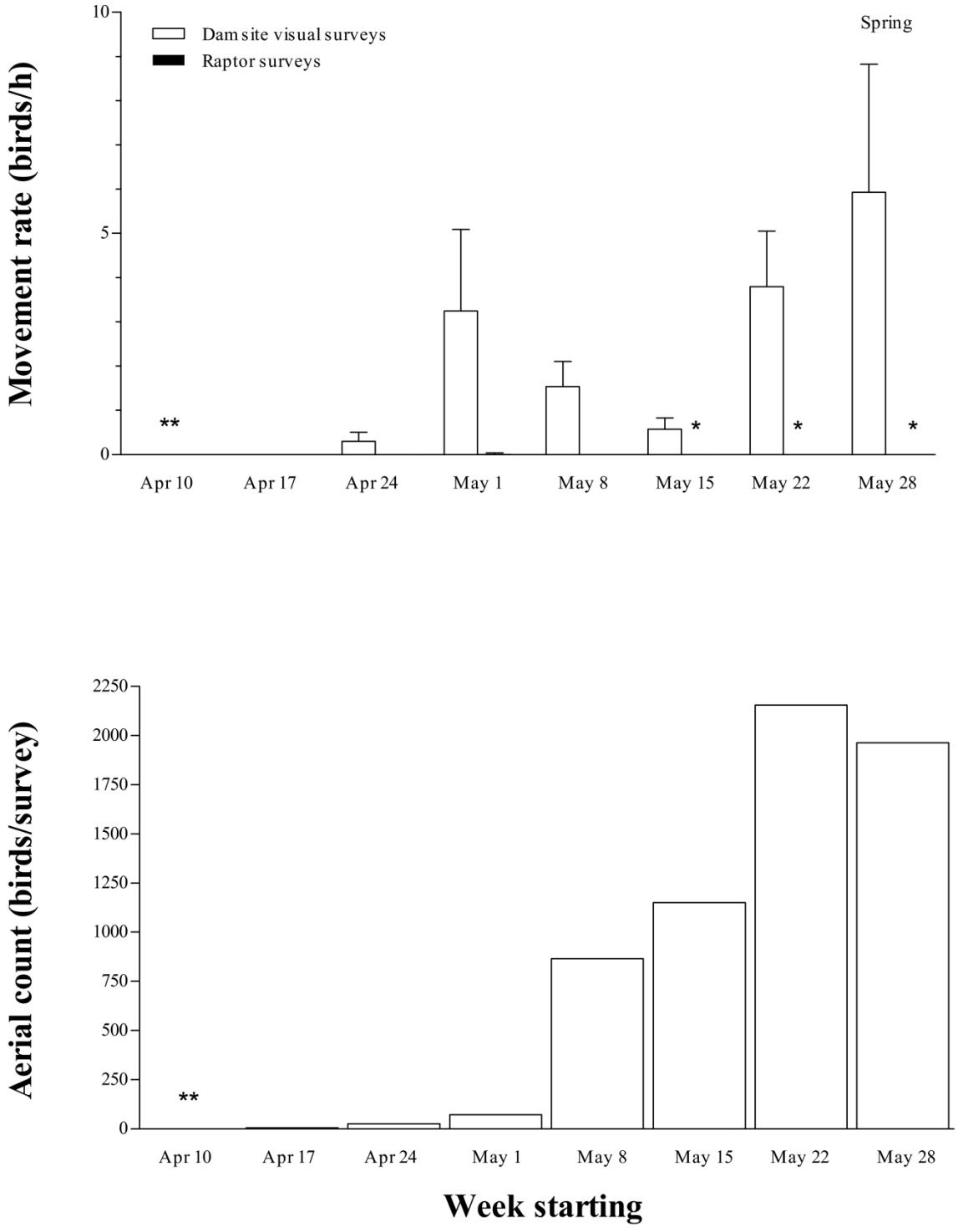


**Figure 3. Mean movement rates (birds/h) of ducks and geese from ground-based migration surveys (top) and aerial survey counts of ducks and geese at water bodies (bottom), by week, during spring migration, 2013. Single asterisks (*) indicate weeks in which no raptor surveys occurred; double asterisks (**) indicate that no surveys occurred that week.**

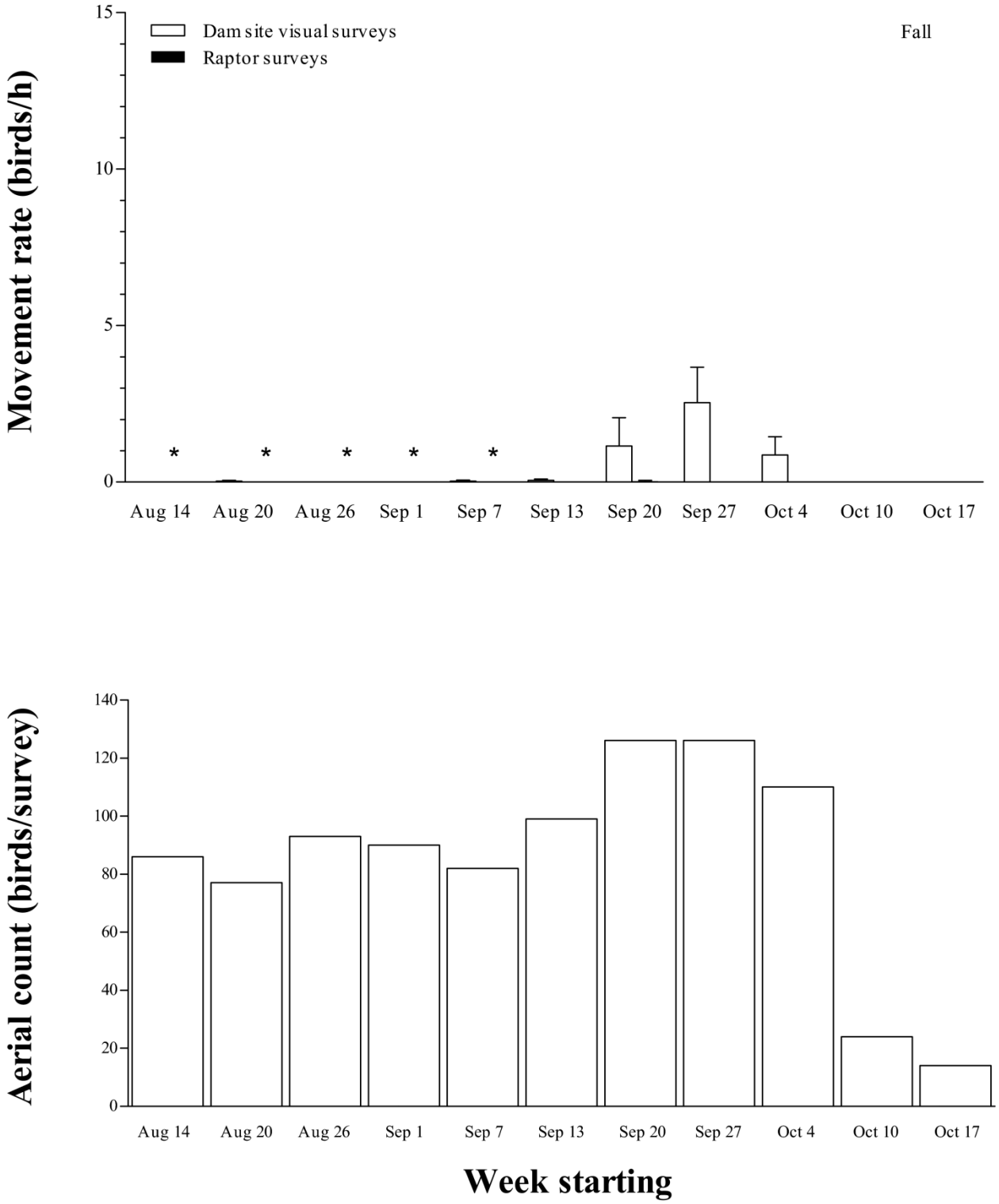


**Figure 4. Mean movement rates (birds/h) of swans from ground-based migration surveys (top) and aerial survey counts of swans at water bodies (bottom), by week, during fall migration, 2013. Asterisks (*) indicate weeks in which no raptor surveys occurred.**

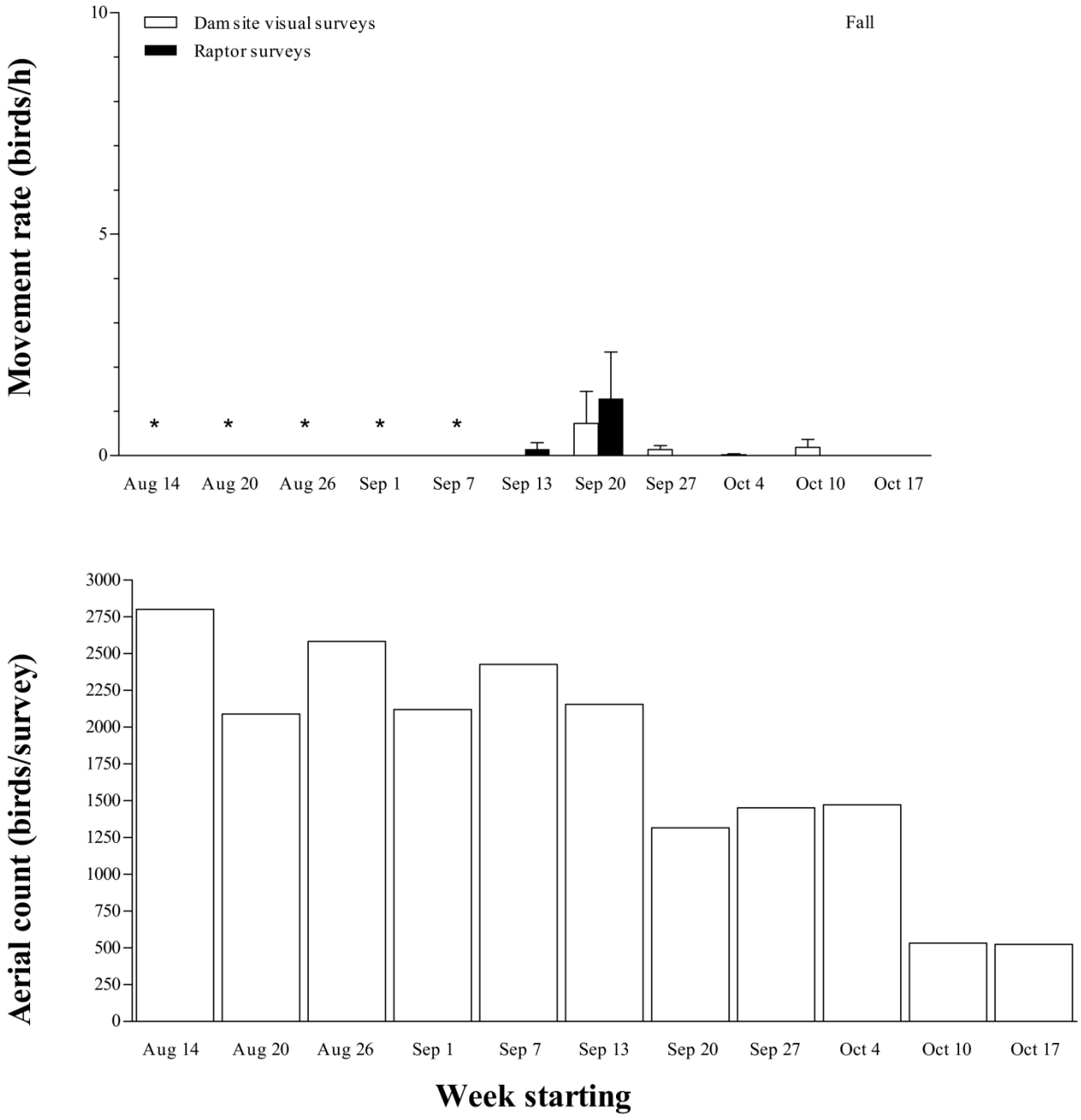


**Figure 5. Mean movement rates (birds/h) of ducks and geese from ground-based migration surveys (top) and aerial survey counts of ducks and geese at water bodies (bottom), by week, during fall migration, 2013. Asterisks (*) indicate weeks in which no raptor surveys occurred.**

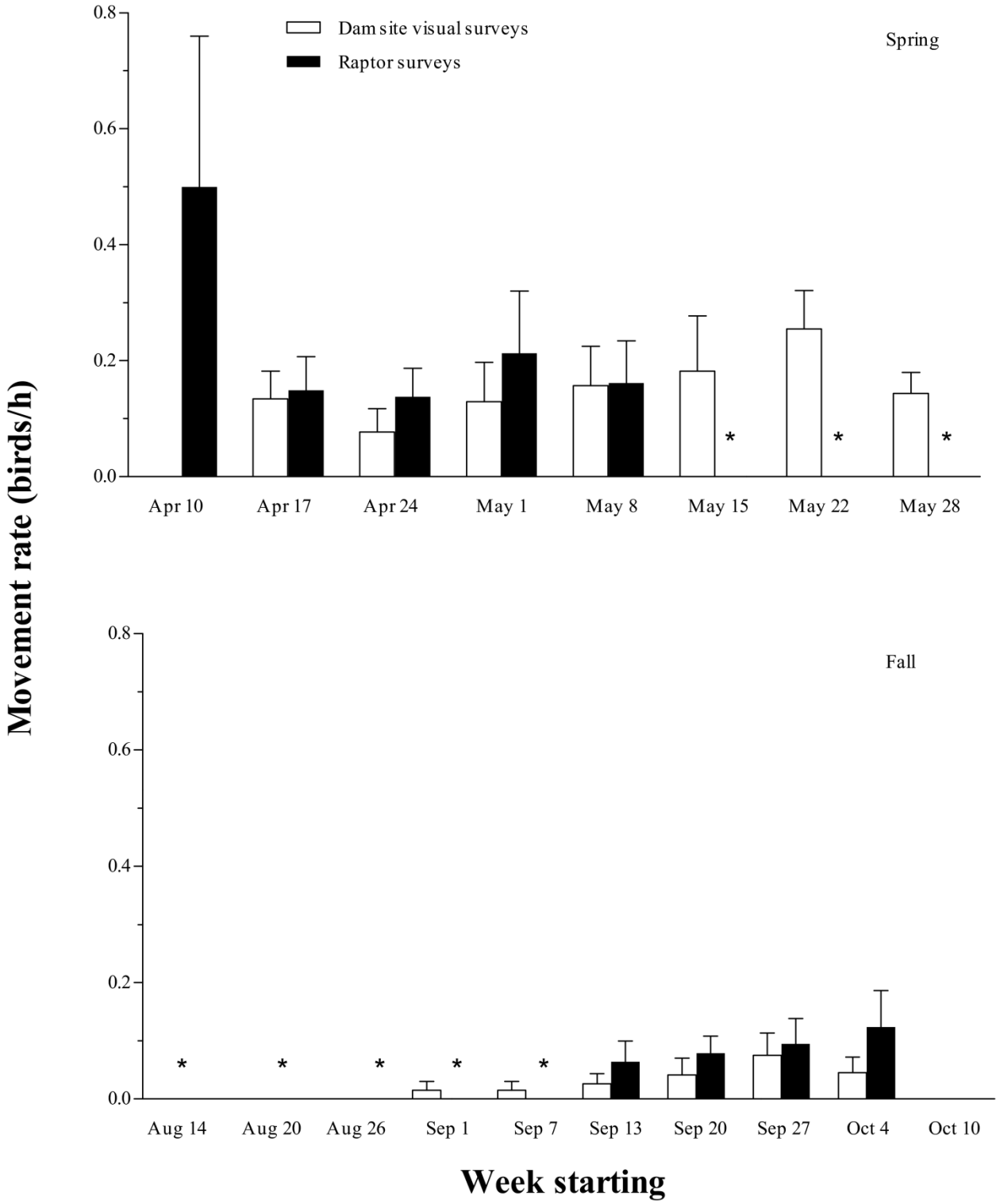


**Figure 6. Mean movement rates (birds/h) of Golden Eagles from raptor and diurnal visual migration surveys, by week, during spring and fall migration, 2013. Asterisks (*) indicate weeks in which no raptor surveys occurred.**

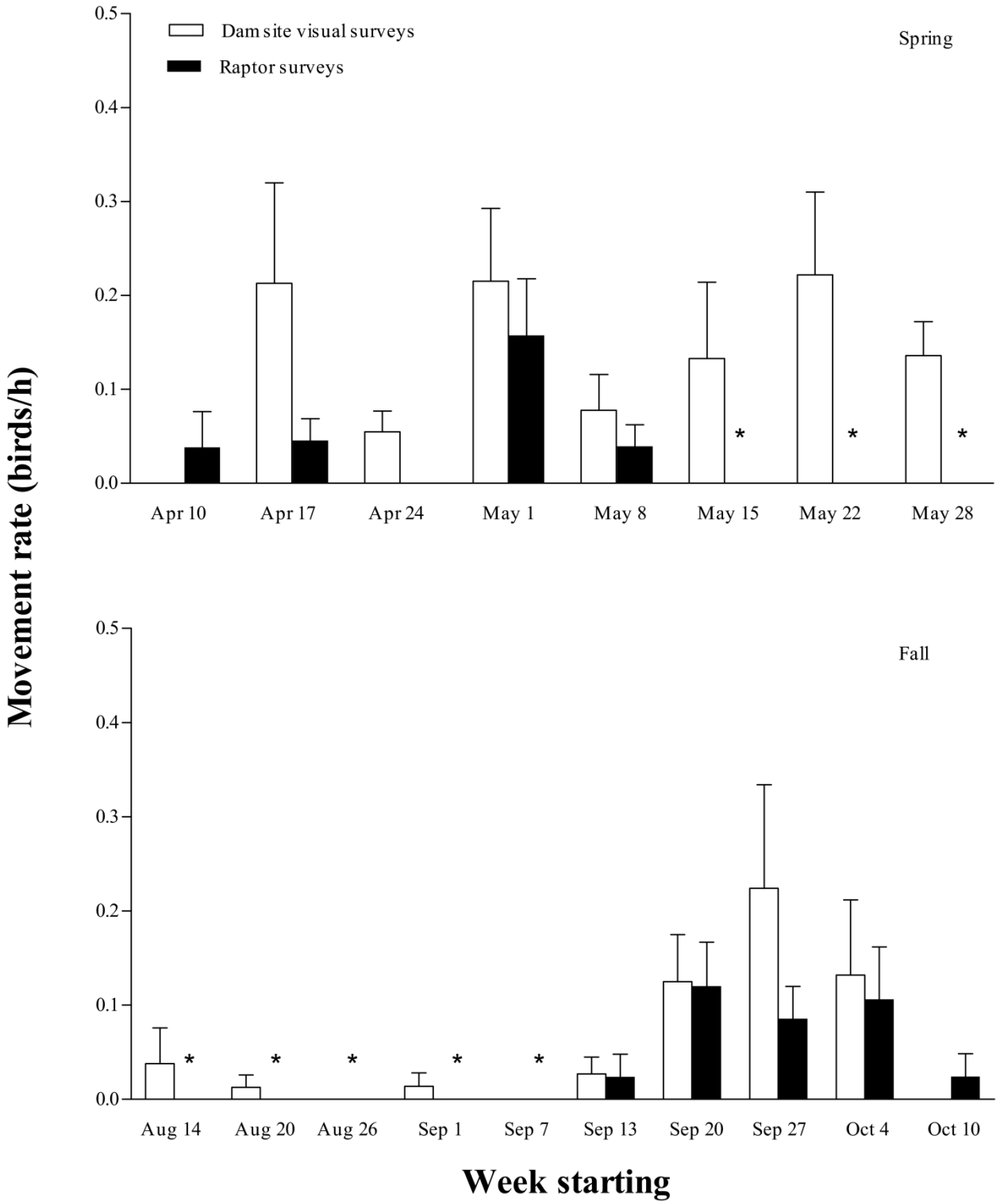


**Figure 7. Mean movement rates (birds/h) of Bald Eagles from raptor and diurnal visual migration surveys, by week, during spring and fall migration, 2013. Asterisks (*) indicate weeks in which no raptor surveys occurred.**

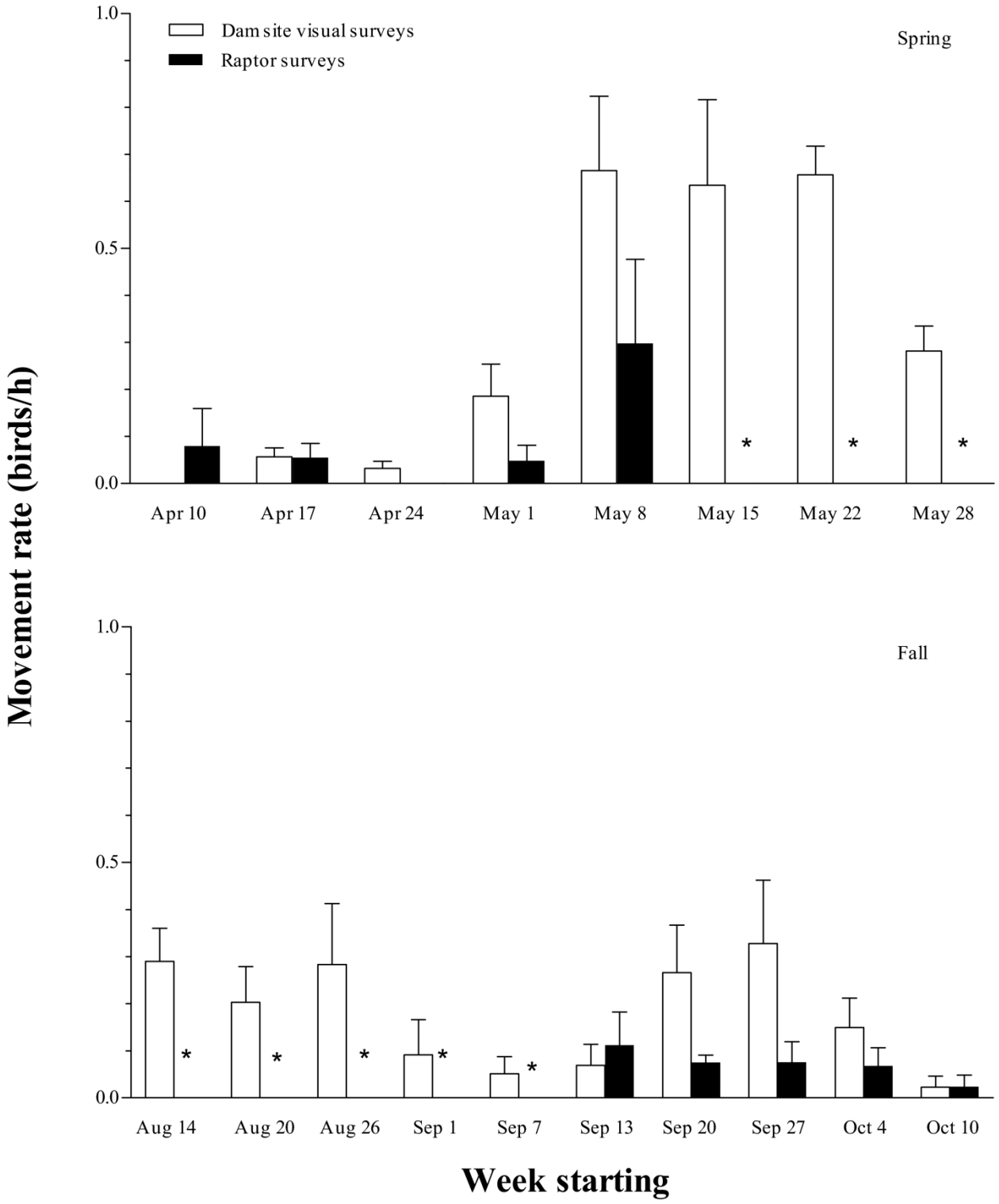


**Figure 8. Mean movement rates (birds/h) of other (non-eagle) raptors from raptor and diurnal visual migration surveys, by week, during spring and fall migration, 2013. Asterisks (*) indicate weeks in which no raptor surveys occurred.**