FALL 2001 RAPTOR MIGRATION STUDY AT SMITH POINT, TEXAS

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Gulf Coast Bird Observatory, Lake Jackson, Texas

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INTRODUCTION

The Smith Point Raptor Migration Project in southern Texas is an ongoing effort to monitor long-term population trends of raptors using this southern portion of the Gulf Coast migratory flyway (Smith et al. 2001). The project is a collaborative venture between HawkWatch International (HWI) and the Gulf Coast Bird Observatory (GCBO). During fall 2001, HWI and GCBO conducted the fifth consecutive standardized, full-season migration count at this site on Galveston Bay. Volunteers conducted limited, peak-season counts at the site in previous years in affiliation with the Hawk Migration Association of North America (HMANA; Economidy 1993, 1997). The short duration of these counts precludes detailed comparisons with 1997–2001 full-season data; however, the previous counts provide a useful reference for identifying low counts and previous occurrences of rare species. Since 1997, 22 species of raptors have been observed migrating through the area, with annual counts ranging from about 26,000 to 115,000 migrants. This report summarizes the count results from the 2001 season.

The Smith Point project was 1 of 15 long-term, annual migration counts (12 fall, 3 spring) conducted or cosponsored by HWI in North America during 2001. The primary objective of these efforts is to track long-term population trends of diurnal raptors throughout primarily western North America (Smith and Hoffman 2000). Raptors feed atop food pyramids, inhabit most ecosystems, occupy large home ranges, and are sensitive to environmental contamination and other human disturbances. Therefore, they serve as important biological indicators of ecosystem health (Cade et al. 1988; Bednarz et al. 1990a, b; Zalles and Bildstein 2000; Bildstein 2001). Moreover, due to the remoteness and widespread distribution of most raptor populations, migration counts likely represent the most cost-effective and efficient method for monitoring the regional status and trends of multiple raptor species (Bednarz and Kerlinger 1989, Titus et al. 1989, Bildstein et al. 1995, Dunn and Hussell 1995, Dixon et al. 1998, Smith and Hoffman 2000, Zalles and Bildstein 2000).

STUDY SITE

The Smith Point project site is located in the Candy Abshier Wildlife Management Area administered by Texas Parks and Wildlife (29°31’39”N, 94°45’54”W). The site is near the southern tip of Chambers County on the east side of State Route 562 where it intersects the management area, approximately 50 km southeast of Houston (Figure 1). Observers work from atop a 7-m tower situated at the southwestern tip of a sharply tapering peninsula that juts into Galveston Bay. The terrain is predominantly coastal marsh, interspersed with weedy, fallow fields and oak mottes. Trinity Bay borders the peninsula to the north. East Bay borders the peninsula to the southeast, separated from the Gulf of Mexico by a long barrier island called the Bolivar Peninsula. Some birds migrating to the southwest along the Gulf of Mexico probably continue down the Bolivar Peninsula. A larger portion of the flight follows the mainland until it tapers towards Smith Point. On days with favorable winds, many migrants proceed directly from Smith Point across the bay to Eagle Point, the nearest landfall to the west about 12 km away, or head to the southwest across the bay towards the tip of Bolivar Peninsula. When winds are less favorable, many migrants retreat back to the east or northeast after reaching Smith Point, some returning later to try the crossing under more favorable conditions and others heading to the northwest around Trinity Bay.

METHODS

Two official or designated observers, assisted by several trained volunteers, conducted daily counts of the raptor migration through the area from a single traditional observation platform. Designated observer Bob Diebold was new to Smith Point, but had two seasons of prior migration-counting experience (see

Appendix A for a history of observer participation). This was designated observer Corrie Borgman's first season of migration counting. Dedicated and well-trained local volunteer—primarily Dick Benoit, Winnie Burkett, Bill Saulmon, and Bob Galloway—regularly assisted as substitute observers, as has been the case since the project's inception. Observations usually began between 0600 and 0800 hrs and ended between 1400 and 1600 hours Central Standard Time (CST). The flight lines at Smith Point generally follow the shorelines, which trend east–west. The observers recorded all birds seen heading to the southwest, west, or northwest as migrants, but did not count birds heading to the northeast. Migrants often retreat when faced with crossing the bay and poor weather, but it is highly likely that many make repeated attempts to cross. Thus, double counting undoubtedly occurs and it is therefore best to consider counts at this site an activity index rather than a count of distinct individuals.

The observers routinely recorded the following data:

1. Species, age, sex, and color morph of each migrant raptor, whenever possible and applicable (Appendix B lists common and scientific names for all species, information about the applicability of age, sex, and color morph distinctions, and two-letter codes used to identify species in some tables and figures).
2. Hour of passage for each migrant; e.g., 1000–1059 hrs CST.
3. Wind speed and direction, air temperature, barometric pressure, percent cloud cover, predominant cloud type(s), precipitation, visibility, and an assessment of thermal lift conditions, recorded for each hour of observation on the half hour.
4. Predominant direction, altitude, and distance from the lookout of the flight during each hour, recorded on the hour.
5. Total minutes observed and the mean number of observers present during each hour (included designated observers plus volunteers/visitors who actively contributed to the count [active scanning, pointing out birds, recording data, etc.] for more than 10 minutes in a given hour), recorded on the hour.
6. A subjective visitor-disturbance rating for each hour, recorded on the hour.
7. Daily start and end times for each official observer.

The observers used high quality 7–10x binoculars to assist in spotting and identifying birds. They also used spotting scopes (20–60x) to help identify distant birds and for counting distant kettles, but not for spotting birds. Clark and Wheeler (1987), Dunne et al. (1988), and Wheeler and Clark (1995) served as primary identification references. Assessments of wind speed, cloud type, cloud cover, and flight altitude followed guidelines published by HMANA. Assessments of thermal lift conditions as poor, fair, good, or excellent involved subjective evaluations of solar intensity, wind speed, and migrant behavior.

The observers classified as residents and excluded from daily counts any raptor that exhibited hunting, territorial display, or perching behaviors for extended periods. The observers occasionally recorded as migrants birds that were not moving in a southerly direction, if such birds otherwise displayed migrant characteristics; i.e., continuous flight without stopping or substantially changing directions for several kilometers. Such birds may be dispersing juveniles or adults dispersing relatively short-distances from their nesting territories to favored wintering grounds in the same general region. However, we also know from recent satellite telemetry work that species such as Prairie Falcons and Ferruginous Hawks frequently "migrate" in non-standard directions to take advantage of favored post-breeding and wintering grounds (Watson and Pierce 2000, K. Steenhof personal communication).

For purposes of examining long-term variation in annual counts, it is often recommended that count data be standardized for sampling period and adjusted for daily variation in observation effort because

seasonal and daily duration of observation effort can greatly affect count statistics (Hussell 1985, Kerlinger 1989, Bednarz et al. 1990b). For purposes of this report, I converted counts to passage rates on a daily basis (raptors/100 hours of observation) to adjust for daily variation in sampling effort, and present both raw counts and passage rates for comparison.

To examine the Smith Point data, I compare 2001 annual statistics against means and 95% confidence intervals (mean ± 95% CI) for 1997–2000. Here, I equate significance with a 2001 value falling outside of the 95% CI for the associated 1997–2000 mean. Note that because we have only four years of previous data, the statistical power of these comparisons is limited; nevertheless, such comparisons can highlight areas of significant annual variation.

RESULTS AND DISCUSSION

WEATHER

In 2001, observations occurred every day and inclement weather severely restricted (<4 hrs) observations on only two days (see Appendix C for 2001 daily weather records), which is similar to all previous years except 1998 (12 days hampered). However, rain and/or thunderstorms occurred on 28% of the active observation days in 2001, compared to 14–26% from 1997–2000, and a drenching, tropical storm dumped more than 20 inches (~51 cm) of rain in the area between 27 August and 2 September. Otherwise, mostly cloudy to overcast skies predominated on 24% of days, compared to 20–30% previously. Transitional weather (i.e., skies changed from primarily fair to mostly cloudy or overcast during the day) occurred on 31% of days, compared to 17–33% previously, and a relatively high percentage of these days included fog or haze (14% of all days). Fair skies prevailed on 45% of days, compared to 40–63% previously, but a moderately high proportion of these days included some fog, haze, or thundershowers during the day (18%). Light winds (<12 kph) prevailed on 87% of days and moderate winds (12–28 kph) on 13%, which is a high percentage of light-wind days (41–65% previously). In terms of wind directions, the 2001 season showed an average array, with primarily northeasterly winds prevailing on 37% of days, primarily east to southeasterly winds on 24%, and variable southeasterly to westerly winds on 23%. Daily-average (mean of hourly readings) temperatures averaged 23.0°C, ranging from 12.7 to 30.3°C. Both the average and maximum are colder (0.7° and 2.1°, respectively) than the lowest values from 1997–2000. Daily-average (mean of hourly readings) barometric pressure averaged 30.01, ranging from 29.59 to 30.40, which is typical for the site. Despite the higher prevalence of light winds, the proportion of days rated as good to excellent for thermal lift was below average (35% compared to 38–61% previously), perhaps reflecting the higher prevalence of foggy days and cooler temperatures.

In summary, the weather in 2001 was average in most respects. Exceptions included a major rainstorm in late August, a higher than average prevalence of fog and haze on days that otherwise featured either fair skies or transitional weather, more light winds than usual, poorer than usual thermal-lift conditions, and slightly cooler temperatures overall.

OBSERVATION EFFORT

The observers logged 94 days and 743.33 hours of observation between 15 August and 15 November 2001. The numbers of observation days and hours were 1% higher and 3% lower, respectively, than the 1997–1999 means, with neither difference statistically significant (Table 1). The daily-average number of observers was 1.96. This value is a statistically insignificant 7% above the 1997–2000 average of 1.84 ± 95% CI of 0.169 observers/hour, but ranks as the second highest observer-participation rate since full-season counts began in 1997.

MIGRATION SUMMARY

The observers counted 117,517 migrant raptors of 21 species during the 2001 season (Table 1, and see Appendix D for 2001 daily count records). As is typical, buteos, accipiters, and kites were the predominant species groups (Figure 2). Species that accounted for 1% or more of the total count included Broad-winged Hawk (88%), Mississippi Kite (3%), Sharp-shinned Hawk (3%), Turkey Vulture (2%), Cooper's Hawk (1%), and American Kestrel (1%). Harris's Hawk was recorded as a migrant for the first time since full-season counts began in 1997. Sightings of two Ferruginous Hawks and three Rough-legged Hawks constituted only the third and second seasons, respectively, that these species were recorded as migrants since 1989.

The 2001 count of 103,612 Broad-winged Hawks nearly tripled the previous full-season high count and was 274% above average for the site (Table 1). The 2001 count also nearly doubles the previous, all-time high count 56,864 Broad-winged Hawks recorded at the site in 1994. Other all-time record-high counts were established for Black Vulture, Turkey Vulture, Swallow-tailed Kite, White-tailed Kite, Cooper's Hawk, Swainson's Hawk, White-tailed Hawk, and Crested Caracara (Table 1). When translated to passage rates, 11 commonly encountered species showed significantly above average activity, whereas no species showed significantly below average activity (Table 2).

No obvious variations in predominant, local weather conditions appear to explain the prevalence of high counts in 2001, especially the huge influx of Broad-winged Hawks. However, days with fair skies and light, especially northerly winds tend to produce the largest flights of Broad-winged Hawks at Smith Point (Smith et al. 2001), and more detailed analysis may eventually reveal an unusual correspondence in 2001 of such weather conditions and the peak passage period for the species. In fact, the largest single-day count of Broad-winged Hawks in 2001 (49,992 birds; 15,000+ more than the season totals for the previous four years!) occurred on 25 September, a day of fair skies and light, northeast winds (Appendix C). Other species may respond most favorably to slightly different sets of conditions. For example, on 16 October 2001, a day that featured fair skies and some of the strongest (average 20 kph) northeast winds of the season, the observers recorded peak counts for Turkey Vultures and Swainson's Hawks, and unusually large, late waves of Cooper's Hawks, Sharp-shinned Hawks, and American Kestrels.

Although local weather conditions may have contributed to the high 2001 counts, comparison of counts from Smith Point and elsewhere along the Gulf Coast suggested that larger-scale influences were at work, at least for some species. Similar to Smith Point, counts of Broad-winged Hawks, Swallow-tailed Kites, Mississippi Kites, and Swainson's Hawks were also generally higher than average in the Florida Keys, at Corpus Christi, Texas, and in Veracruz, Mexico (Smith 2002, HWI and partners, unpublished data). Whether these consistently high counts along the Gulf Coast flyway in 2001 are indicative of population expansion or weather effects is unclear at this time. Data from Veracruz, Mexico, collected since 1992, currently indicate increasing patterns for each of these species, except for Broad-winged Hawks, which have shown a fluctuating but relatively stable pattern since 1995 (HWI and partners unpublished data). Five-years of data are insufficient to render robust assessments of long-term trends at Smith Point, but increasing trends are currently indicated for Mississippi and Swallow-tailed kites and Swainson's Hawks (as well as White-tailed Hawks and Crested Caracaras; Table 2). In contrast, the only species that may be showing a distinct increasing or decreasing trend along the Corpus Christi flyway is the Mississippi Kite (Smith 2002).

It is also noteworthy that, as during past seasons, the 2001 counts at Corpus Christi and Smith Point showed very different patterns for most other species. In fact, compared to averages for 1997–2000, 14 species showed opposite patterns of abundance at the two sites (Smith 2002). This continues to suggest that for many species the two sites may sample different migratory populations that are showing different trends (Smith et al. 2001). The Corpus Christi project likely samples a continuation of the Smith Point flight (primarily eastern-flyway and eastern central-flyway origins) plus much larger numbers of birds

originating from central flyways and potentially as far west as the eastern flanks of the Rocky Mountain Flyway (*sensu* Hoffman et al. in press). However, it is also possible that regional and/or local weather patterns affect counts at the two sites differently and contribute to the differences in count trends (Smith et al. 2001). Additional years of comparative data and appropriate statistical modeling will be necessary to clearly elucidate the relative influence of such factors.

The highest single-day count for 2001 occurred on 25 September and totaled 50,445 (mostly Broad-winged Hawks; Appendix D). The date of this event fell in between dates for the previous four years (Figure 3). Similarly, the 2001 median passage date for all species combined of 21 September was an insignificant 3 days later than average (Table 3). The only species that showed significantly later than average timing were Swallow-tailed (9 days late) and Mississippi (7 days) kites, and only five species (Black Vulture, White-tailed Kite, Cooper's Hawk, Red-tailed Hawk, and Crested Caracara) were significantly earlier than average in 2001. Thus, other than late passage of two of the three kites species, there were no distinct multi-species patterns of variation in seasonal timing in 2000. Late passage of Swallow-tailed Kites is particularly noteworthy, because this is almost certainly a primary reason for the high count recorded in 2001. This species typically begins migrating in late July and early August (Meyer 1995), such that in most years our monitoring misses at least the first half of the species' migration.

RESIDENT RAPTORS

The local raptor community included permanent residents, transient residents that settled only for short periods, and winter residents that arrived during October and November. Groups of 12–18 Turkey Vultures and fewer Black Vultures were routinely seen throughout most days milling about on the north and west horizons. A communal roost of about 150 Turkey Vultures and 100 Black Vultures existed throughout the season about 7 km northeast of the count site. Other apparently year-round residents included at least one and possibly two White-tailed Kites and an immature Red-shouldered Hawk. Three Red-tailed Hawks appeared as transient residents between late August and mid-September, and three winter residents arrived in late October and early November. A pair of American Kestrels and at least two immature Northern Harriers also appeared to settle in for the winter in late October and November.

VISITOR PARTICIPATION AND PUBLIC OUTREACH

Documented visitation in 2001 totaled 350 visitors from five states (KY, PA, NM, LA, TX), the United Kingdom, Switzerland, and Costa Rica. Organized events included a three-day Hawk Watch and Nature Workshop, and an Elder Hostel field trip organized by GCBO and Texas A & M – Galveston.

Beginning in fall 2001, HWI adopted a new approach to quantifying the influence of visitors on counts at all of its project sites. Encouraging visitation and achieving positive public education and outreach are important goals for all HWI and GCBO projects; however, during migration counts, visitors can represent a distraction for the official observers that may compromise the integrity of the count. Tolerating a certain level of distraction in the interest of positive outreach is a tradeoff that we gladly accept as part of our operations; however, because the distraction potential fluctuates considerably through time, it is important that the data we record include a means of quantifying the distraction potential through statistical modeling. Previously, we had the observers estimate the number of visitors present during each hour of active counts, but two primary problems confounded use of this system for quantifying the visitor-distraction factor.

First, during busy periods (in terms of either birds to count or visitors present) tracking visitor numbers often became a difficult task for the observers. This difficulty led to both inconsistent estimation and, in some cases, in and of itself represented an unnecessary distraction. Second, careful reflection over the years suggested that simply recording the number of visitors often failed to capture the true effect of

specific situations. For example, a single, highly curious, and talkative individual often represents more of a distraction for the observers than a large group of relatively quiet visitors.

To overcome these limitations, we have adopted a new system for recording visitor effects, whereby the observers simply record a subjective, visitor-distraction rating for each hour (none, low, moderate, or high). The new system still requires that the observers keep track of the effects of visitors through the hour, but the task is much easier without having to specify numbers. Furthermore, the new rating system allows the observers to incorporate a broader range of input to generate a more representative index of true visitor effects on their performance. Thus, although data-recording protocol changes such as this can be troublesome with regard to analysis of long-term trends, we believe that in the end this new approach to estimating visitor-distraction effects will significantly improve the integrity of our count systems.

In 2001 at Smith Point, 774 hourly assessments of visitor disturbance resulted in the following ratings: 68% none, 24% low, 6% moderate, and 2% high.

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Table 1. Observation effort and raptor counts by species: 1997–2001.

	1997	1998	1999	2000	Mean ± 95% CI	2001	% Change
Start date	17-Aug	15-Aug	15-Aug	12-Aug		15-Aug	
End date	20-Nov	15-Nov	12-Nov	15-Nov		15-Nov	
Observation days	94	91	90	94	92 ± 2.0	93	+1
Observation hours	860.11	677.25	696.68	823.08	764.28 ± 89.075	743.33	-3
Species				Counts			
Black Vulture	130	105	341	4	145 ± 138.7	379	+161
Turkey Vulture	1,225	581	1,295	1,059	1,040 ± 315.2	2,488	+139
Total vultures	1,355	686	1636	1,063	1,185 ± 398.6	2,867	+142
Osprey	54	68	54	60	59 ± 6.5	62	+5
Northern Harrier	445	262	537	372	404 ± 113.9	472	+17
Swallow-tailed Kite	40	34	52	46	43 ± 7.6	74	+72
White-tailed Kite	11	25	18	17	18 ± 5.6	26	+46
Mississippi Kite	2,124	2,362	2,975	4,788	3,062 ± 1,181.0	3,253	+6
Total kites	2,175	2,421	3,045	4,851	3,123 ± 1,184.6	3,353	+7
Sharp-shinned Hawk	4,780	3,231	3,896	1,484	3,348 ± 1,367.2	3,878	+16
Cooper's Hawk	1,137	1,136	1,207	1,088	1,142 ± 48.0	1,281	+12
Unidentified accipiter	49	170	113	14	87 ± 67.7	15	-83
Total accipiters	5,966	4,537	5,216	2,586	4576 ± 1420.5	5,174	+13
Harris's Hawk	0	0	0	0	0 ± 0.0	2	–
Red-shouldered Hawk	45	36	34	61	44 ± 12.1	54	+23
Broad-winged Hawk	30,417	16,137	34,243	29,956	27,688 ± 7,778.2	103,612	+274
Swainson's Hawk	137	56	129	255	144 ± 80.7	321	+123
White-tailed Hawk	0	1	2	11	4 ± 5.0	12	+243
Red-tailed Hawk	331	35	204	77	162 ± 131.1	273	+69
Ferruginous Hawk	0	0	2	0	1 ± 1.0	2	+300
Rough-legged Hawk	0	0	2	0	1 ± 1.0	3	+500
Unidentified buteo	86	26	31	3	37 ± 34.5	4	-89
Total buteos	31,016	16,291	34,647	30,363	28,079 ± 7,920.0	104,283	+271
Golden Eagle	3	0	1	1	1 ± 1.2	0	-100
Bald Eagle	2	0	2	7	3 ± 2.9	2	-27
Total eagles	5	0	3	8	4 ± 3.3	2	-50
Crested Caracara	6	3	4	9	6 ± 2.6	16	+191
American Kestrel	1,297	1,334	1,938	1,311	1,470 ± 306.1	1,140	-22
Merlin	88	26	47	43	51 ± 25.8	70	+37
Peregrine Falcon	65	92	85	79	80 ± 11.2	77	-4
Unidentified falcon	25	13	9	5	13 ± 8.5	1	-92
Total falcons	1,475	1,465	2,079	1,438	1,614 ± 304.0	1,288	-20
Unidentified raptor	496	91	116	16	180 ± 210.8	0	-100
Grand Total	42,993	25,824	47,337	40,766	39,230 ± 9,157.7	117,517	+200
Total w/o BW	12,576	9,687	13,094	10,810	11,542 ± 1,544.8	13,905	+20

Table 2. Passage rates (raptors / 100 hrs of observation) by species: 1997–2001.

SPECIES	1997	1998	1999	2000	MEAN ± 95% CI	2001	% CHANGE
Black Vulture	15.1	15.5	48.9	0.5	20.0 ± 20.11	51.0	+155
Turkey Vulture	142.4	85.8	185.9	128.7	135.7 ± 40.42	334.7	+147
TOTAL VULTURES	157.5	101.3	234.8	129.1	155.7 ± 56.38	385.7	+148
Osprey	6.3	10.0	7.8	7.3	7.8 ± 1.56	8.3	+6
Northern Harrier	51.7	38.7	77.1	45.2	53.2 ± 16.47	63.5	+19
Swallow-tailed Kite	4.7	5.0	7.5	5.6	5.7 ± 1.22	10.0	+75
White-tailed Kite	1.3	3.7	2.6	2.1	2.4 ± 0.99	3.5	+45
Mississippi Kite	246.9	348.8	427.0	581.7	401.1 ± 138.36	437.6	+9
TOTAL KITES	252.9	357.5	437.1	589.4	409.2 ± 139.00	451.1	+10
Sharp-shinned Hawk	555.7	477.1	559.2	180.3	443.1 ± 175.67	521.7	+18
Cooper's Hawk	132.2	167.7	173.3	132.2	151.3 ± 21.78	172.3	+14
Unidentified accipiter	5.7	25.1	16.2	1.7	12.2 ± 10.36	2.0	-83
TOTAL ACCIPITERS	693.6	669.9	748.7	314.2	606.6 ± 193.77	696.1	+15
Harris's Hawk	0.0	0.0	0.0	0.0	0.0 ± 0.00	0.3	–
Red-shouldered Hawk	5.2	5.3	4.9	7.4	5.7 ± 1.13	7.3	+27
Broad-winged Hawk	3,536.4	2,382.7	4,915.2	3,639.5	3,618.5 ± 1,014.62	13,938.9	+285
Swainson's Hawk	15.9	8.3	18.5	31.0	18.4 ± 9.25	43.2	+134
White-tailed Hawk	0.0	0.1	0.3	1.3	0.4 ± 0.60	1.6	+265
Red-tailed Hawk	38.5	5.2	29.3	9.4	20.6 ± 15.60	36.7	+79
Ferruginous Hawk	0.0	0.0	0.3	0.0	0.1 ± 0.14	0.3	+275
Rough-legged Hawk	0.0	0.0	0.3	0.0	0.1 ± 0.14	0.4	+462
Unidentified buteo	10.0	3.8	4.4	0.4	4.7 ± 3.91	0.5	-88
TOTAL BUTEOS	3,606.1	2,405.5	4,973.2	3,688.9	3,668.4 ± 1,028.10	14,029.2	+282
Golden Eagle	0.3	0.0	0.1	0.1	0.2 ± 0.14	0.0	-100
Bald Eagle	0.2	0.0	0.3	0.9	0.3 ± 0.35	0.3	-21
TOTAL EAGLES	0.6	0.0	0.4	1.0	0.5 ± 0.39	0.3	-46
Crested Caracara	0.7	0.4	0.6	1.1	0.7 ± 0.28	2.2	+207
American Kestrel	150.8	197.0	278.2	159.3	196.3 ± 56.99	153.4	-22
Merlin	10.2	3.8	6.7	5.2	6.5 ± 2.70	9.4	+45
Peregrine Falcon	7.6	13.6	12.2	9.6	10.7 ± 2.63	10.4	-4
Unidentified falcon	2.9	1.9	1.3	0.6	1.7 ± 0.96	0.1	-92
TOTAL FALCONS	171.5	216.3	298.4	174.7	215.2 ± 57.91	173.3	-19
Unidentified raptor	57.7	13.4	16.7	1.9	22.4 ± 23.84	0.0	-100
GRAND TOTAL	4,998.5	3,813.1	6,794.7	4,952.9	5,139.8 ± 1,207.39	15,809.5	+208
TOTAL W/O BW	1,462.1	1,430.3	1,879.5	1,313.4	1,521.3 ± 242.25	1,870.6	+23

Table 3. First and last observation, bulk passage, and median passage dates by species for 2001, with a comparison of 2001 and 1997–2000 average median passage dates.

	2001				1997–2000
	First Observed	Last Observed	Bulk (80%) Passage Dates[1]	Median Passage Date[2]	Median Passage Date[2] Mean ± 95% CI
Black Vulture	10-Sep	13-Nov	20-Sep – 5-Nov	19-Oct	24-Oct ± 3.2
Turkey Vulture	10-Sep	12-Nov	15-Oct – 3-Nov	24-Oct	28-Oct ± 6.2
Osprey	3-Sep	7-Nov	11-Sep – 18-Oct	27-Sep	26-Sep ± 4.7
Northern Harrier	20-Aug	15-Nov	20-Sep – 7-Nov	18-Oct	15-Oct ± 6.9
Swallow-tailed Kite	16-Aug	17-Sep	15-Aug – 11-Sep	4-Sep	26-Aug ± 4.0
White-tailed Kite	15-Aug	10-Nov	16-Aug – 25-Oct	15-Sep	4-Oct ± 12.5
Mississippi Kite	15-Aug	16-Oct	23-Aug – 24-Sep	11-Sep	4-Sep ± 5.2
Sharp-shinned Hawk	17-Aug	15-Nov	21-Sep – 25-Oct	30-Sep	1-Oct ± 4.8
Cooper's Hawk	17-Aug	15-Nov	12-Sep – 26-Oct	1-Oct	8-Oct ± 4.2
Harris's Hawk	17-Sep	7-Nov	–	–	–
Red-shouldered Hawk	15-Aug	10-Nov	21-Aug – 4-Nov	21-Sep	22-Sep ± 8.7
Broad-winged Hawk	15-Aug	15-Nov	15-Sep – 15-Oct	24-Sep	22-Sep ± 4.7
Swainson's Hawk	19-Aug	11-Nov	11-Sep – 25-Oct	15-Oct	19-Oct ± 5.7
White-tailed Hawk	30-Sep	7-Nov	17-Oct – 4-Nov	24-Oct	16-Oct [3]
Red-tailed Hawk	16-Aug	14-Nov	21-Sep – 7-Nov	26-Oct	3-Nov ± 5.2
Ferruginous Hawk	27-Sep	22-Oct	–	–	–
Rough-legged Hawk	16-Oct	8-Nov	–	–	–
Bald Eagle	14-Oct	26-Oct	–	–	–
Crested Caracara	15-Aug	13-Nov	21-Sep – 3-Nov	14-Oct	28-Oct ± 9.0[4]
American Kestrel	18-Aug	15-Nov	23-Sep – 25-Oct	5-Oct	7-Oct ± 5.4
Merlin	8-Sep	4-Nov	17-Sep – 19-Oct	24-Sep	29-Sep ± 5.1
Peregrine Falcon	10-Sep	11-Nov	16-Sep – 20-Oct	4-Oct	1-Oct ± 3.3
All Species	15-Aug	15-Nov	14-Sep – 15-Oct	24-Sep	21-Sep ± 4.5
All w/o BW	15-Aug	15-Nov	11-Sep – 29-Oct	1-Oct	27-Sep ± 4.2

[1] Dates between which the central 80% of the flight passed through; calculated only for species with annual counts ≥5 birds.

[2] Date by which 50% of the flight had passed through. Unless otherwise noted, values were calculated only for species with counts ≥5 birds for ≥3 years.

[3] Based on data for 2000 only.

[4] Based on data for 1997 and 2000 only.

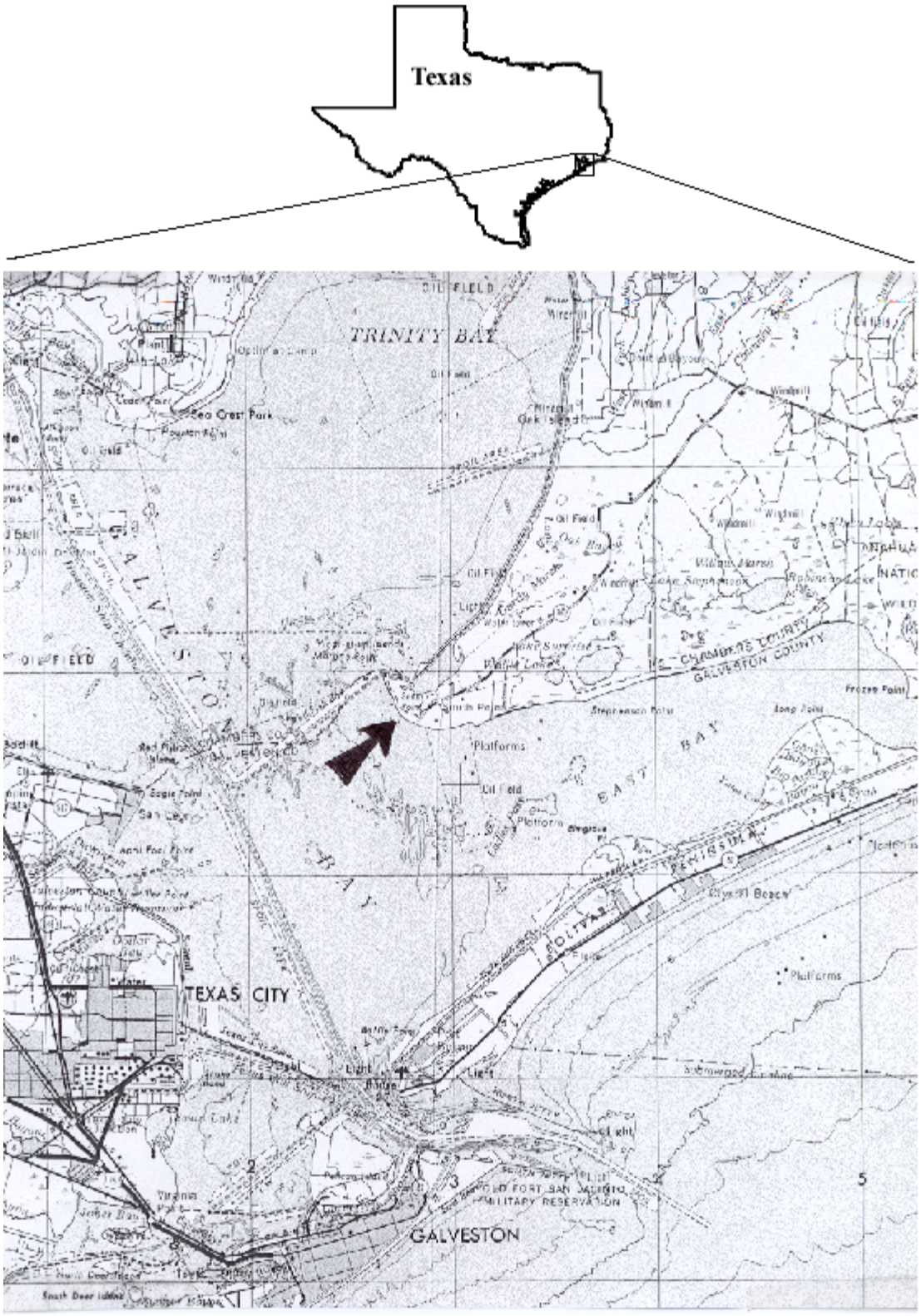

Figure 1. Location of Smith Point Hawk Watch site near Houston, Texas.

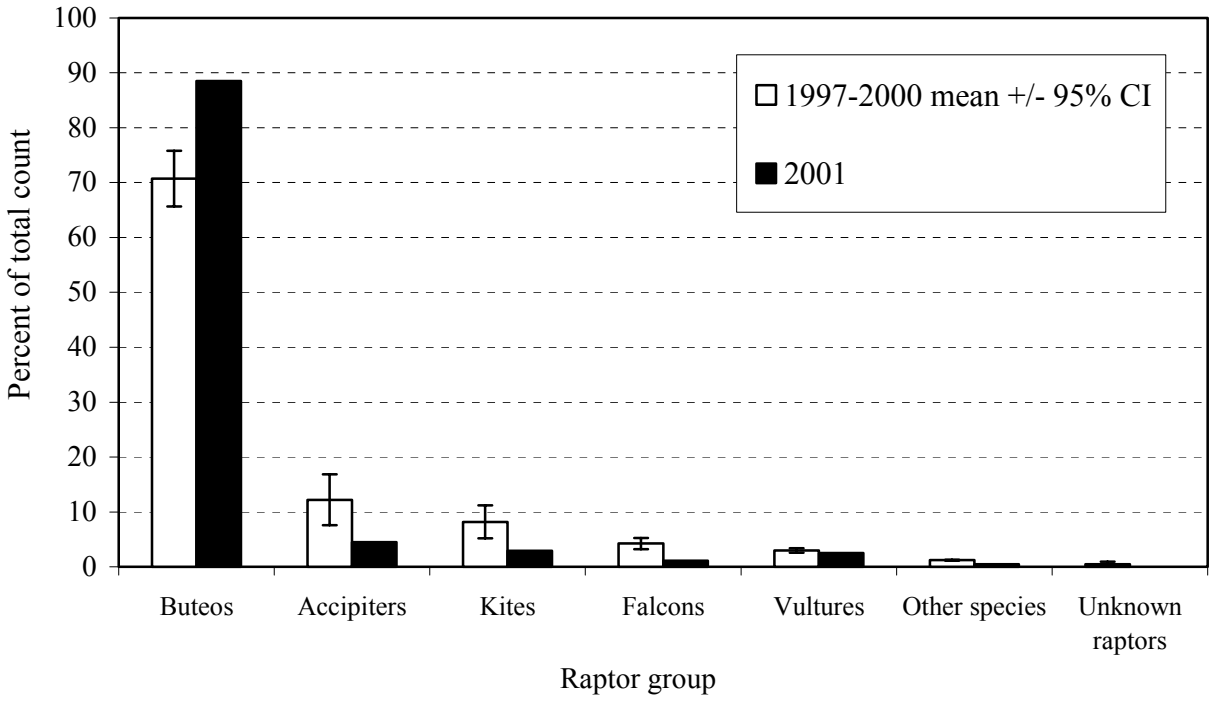

Figure 2. Group composition of raptor flights: 1997–2000 versus 2001.

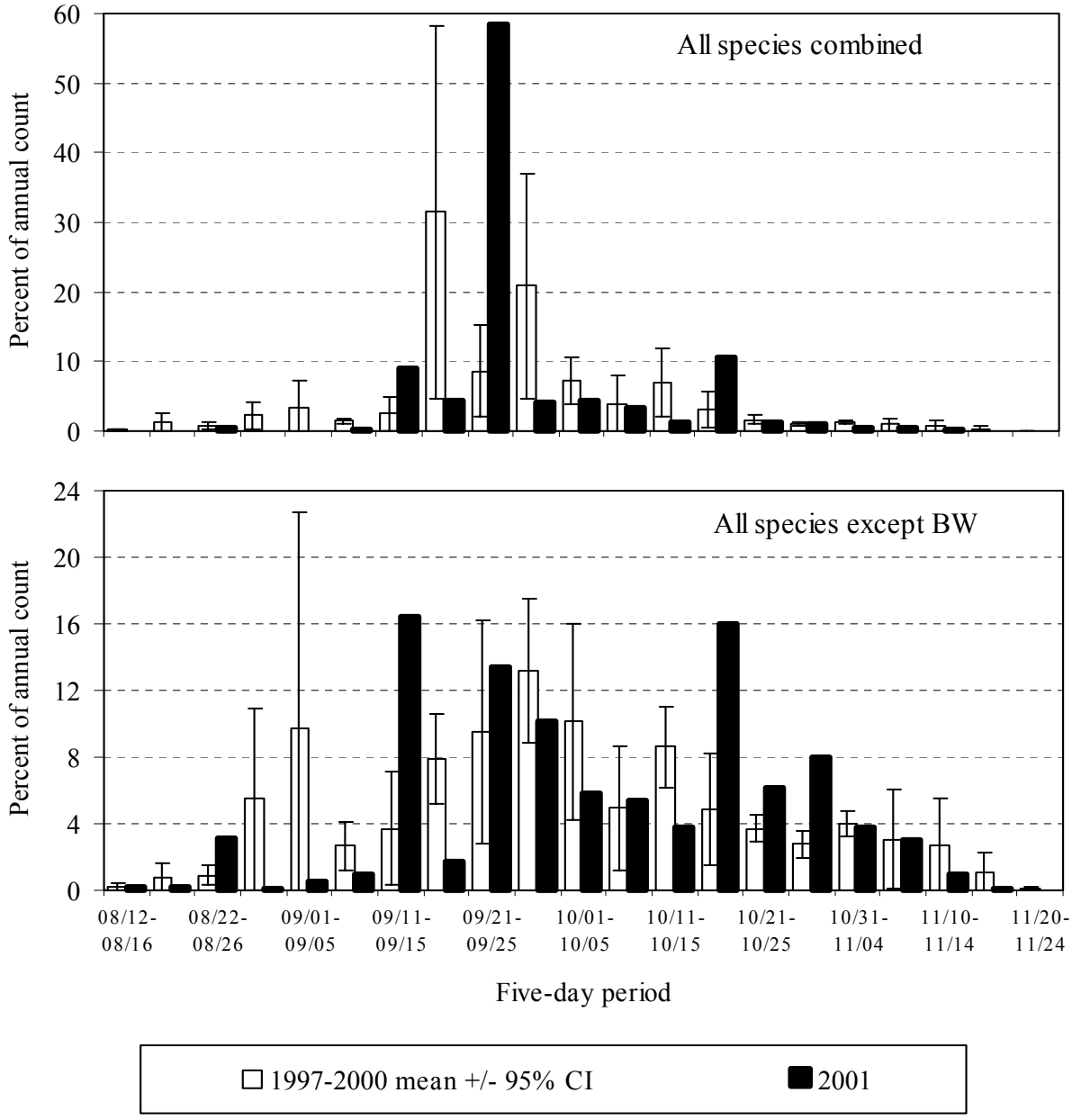

Figure 3. Combined-species flight volume by five-day periods with and without Broad-winged Hawks: 1997–2000 versus 2001.

Appendix A. History of official observer participation: 1997–2001.

1997: One designated observer throughout plus participation by many local, experienced volunteers in an effort to ensure the presence of two observers most of the season: designated observers—Doug Cooper (0; first 2.5 weeks), Bob Gallaway (~1; middle 3 weeks), Robin Lawford (0; last 8 weeks).

1998: Two designated observers throughout: Rebecca Smith (0), Steve Seibel (0; first half), Richard Gibbons (0; second half), regularly assisted by various local, experienced volunteers as substitutes.

1999: One designated observer throughout plus participation by many local, experienced volunteers in an effort to ensure the presence of two observers most of the season: designated observer, Kyle McCarty (2).

2000: Two designated observers throughout: Zach Smith (2+), Wendy Beard (0), regularly assisted by various local, experienced volunteers as substitutes.

2001: Two designated observers throughout: Bob Diebold (2) and Corrie Borgman (0), regularly assisted by various local, experienced volunteers as substitutes.

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[1] Numbers in parentheses indicate the number of previous full-seasons of experience counting migratory raptors.

Appendix B. Common and scientific names, species codes, and regularly applied age, sex, and color-morph classifications.

Common Name	Scientific Name	Species Code	Age[1]	Sex[2]	Color Morph[3]
Black Vulture	*Coragyps atratus*	BV	U	U	NA
Turkey Vulture	*Cathartes aura*	TV	U	U	NA
Osprey	*Pandion haliaetus*	OS	U	U	NA
Northern Harrier	*Circus cyaneus*	NH	A I Br U	M F U	NA
Swallow-tailed Kite	*Elanoides forficatus*	SK	U	U	NA
White-tailed Kite	*Elanus leucurus*	WK	U	U	NA
Mississippi Kite	*Ictinia mississippiensis*	MK	A I U	U	NA
Sharp-shinned Hawk	*Accipiter striatus*	SS	A I U	U	NA
Cooper's Hawk	*Accipiter cooperii*	CH	A I U	U	NA
Northern Goshawk	*Accipiter gentilis*	NG	A I U	U	NA
Unknown accipiter	*Accipiter* spp.	UA	U	U	NA
Harris's Hawk	*Parabuteo unicinctus*	HH	A I U	U	NA
Red-shouldered Hawk	*Buteo lineatus*	RS	A I U	U	NA
Broad-winged Hawk	*Buteo platypterus*	BW	A I U	U	D L U
Swanson's Hawk	*Buteo swainsoni*	SW	U	U	D L U
White-tailed Hawk	*Buteo albicaudatus*	WT	A I U	U	NA
Red-tailed Hawk	*Buteo jamaicensis*	RT	A I U	U	D L U
Ferruginous Hawk	*Buteo regalis*	FH	A I U	U	D L U
Rough-legged Hawk	*Buteo lagopus*	RL	U	U	D L U
Unknown buteo	*Buteo* spp.	UB	U	U	D L U
Golden Eagle	*Aquila chrysaetos*	GE	A S I NA U[4]	U	NA
Bald Eagle	*Haliaeetus leucocephalus*	BE	A S2 S1 I NA U[5]	U	NA
Unknown eagle	*Aquila* or *Haliaeetus spp.*	UE	U	U	NA
Crested Caracara	*Caracara cheriway*	CC	U	U	NA
American Kestrel	*Falco sparverius*	AK	U	M F U	NA
Merlin	*Falco columbarius*	ML	AM Br	AM U	NA
Peregrine Falcon	*Falco peregrinus*	PG	A I U	U	NA
Unknown falcon	*Falco* spp.	UF	U	U	NA
Unknown raptor	Falconiformes	UU	U	U	NA

[1] A = adult, I = immature (HY), Br = brown (adult female or immature), U = unknown age.

[2] M = male, F = female, U = unknown.

[3] D = dark or rufous, L = light, U – unknown, NA = not applicable.

[4] Golden Eagle age codes: I = immature, first-year bird, bold white wing patch visible below (small patch may be visible above), bold white in the tail, no molt; S = subadult, white wing patch variable or absent, obvious white in the tail, molt or tawny bar on upper wing visible; NA = not adult, unknown age immature/subadult, obvious white in wing or tail, but rest of plumage not adequately observed.; A = adult, no obvious white on wing or tail; U = plumage not adequately observed to make an age determination.

[5] Bald Eagle age codes: I = immature, first-year bird, dark breast and tawny belly; S1 = young subadult, Basic I and II plumages, light belly or upside-down white triangle on the back; S2 = older subadult, Basic III plumage, head mostly white with osprey-like dark eye line and dark band on tail; NA = not adult, unknown age immature/subadult; A = adult, includes near-adult with dark flecks in head and dark tip to tail (may be hard to see in field) and adult with pure white head and tail; U = plumage not adequately observed to make an age determination.

Appendix C. Daily observation effort, visitation, weather, and raptor passage rates: 2001.

Date	Obs. Hours	Number Obsrvrs[1]	Visitor Disturb[2]	Sky Condition[3]	Wind Speed (kph)[1]	Wind Direction	Thermal Lift[4]	Temp. (°C)[1]	Baro. Press. (in Hg)[1]	Visib. East (km)[1]	Visib. West (km)[1]	Flight Dist.[5]	Raptors / Hour
15-Aug	8.00	1.0	0	mc-ovc, fog/haze, scat rain	4.1	s, var, s	2	28.7	29.67	17	30	2	15.0
16-Aug	7.00	1.0	0	pc-mc, scat rain	10.4	s-ssw	2	30.1	29.97	30	30	4	23.0
17-Aug	7.50	1.0	0	pc, AM haze	3.6	s-ssw	2	29.3	30.05	30	30	2	5.0
18-Aug	8.00	1.7	0	pc	11.1	ssw	2	27.7	30.03	30	30	4	7.0
19-Aug	7.00	1.8	0	pc-ovc/ts-rain	13.5	s-ssw, nw/var	2	27.3	29.95	29	29	2	7.0
20-Aug	8.00	1.0	0	mc-clr	2.2	nw, var	2	29.6	29.98	30	30	2	30.0
21-Aug	8.00	1.3	0	clr	3.5	se	2	28.8	30.00	30	30	2	19.0
22-Aug	7.75	1.0	0	clr	2.8	nne-se	2	28.8	30.01	30	30	3	27.0
23-Aug	7.50	1.0	0	pc-mc, haze	1.1	se-sw	2	30.3	29.97	25	18	3	10.0
24-Aug	8.50	1.0	0	pc, AM mc/haze	2.2	se-ssw	2	28.5	29.94	30	30	3	433.0
25-Aug	8.25	3.4	0	pc-ovc	6.3	calm, se	3	29.7	29.92	30	30	3	83.0
26-Aug	8.33	2.6	0	pc-ovc, ts	8.4	s-sw	2	28.0	29.94	29	29	2	76.0
27-Aug	8.00	1.9	0	mc-ovc, ts-rain	8.9	calm/sw-var	3	28.0	29.92	28	26	3	26.0
28-Aug	1.50	2.0	0	ovc, ts-rain	12.7	var	4	22.7	29.93	22	17	-	0.0
29-Aug	5.00	2.0	0	ovc, ts-rain	17.4	s	4	22.4	29.95	18	13	-	0.0
30-Aug	6.00	2.0	0	ovc, ts-rain	7.1	ese-se	4	22.8	29.86	21	19	1	2.0
31-Aug	6.50	2.0	0	mc-ovc, ts-rain	3.5	calm/var	4	24.3	29.82	20	16	1	1.0
1-Sep	4.00	2.0	0	mc-ovc, ts-rain	5.8	ese-s	4	24.9	29.77	21	14	-	0.0
2-Sep	4.00	2.5	1	mc-ovc, ts-rain	11.6	sse-ssw	4	24.9	29.77	11	17	2	8.0
3-Sep	7.50	2.4	0	mc-ovc, ts-rain	6.0	s-w	3	25.8	29.81	27	21	1	5.0
4-Sep	7.50	2.0	0	pc-ovc, AM ts	7.9	se-sw	3	27.0	29.87	28	24	3	17.0
5-Sep	8.00	2.0	0	pc	5.8	sse	2	28.4	29.92	30	25	2	43.0
6-Sep	8.00	2.0	2	clr-pc, scat ts-rain	9.6	sse-s	2	27.6	29.93	30	30	3	14.0
7-Sep	8.00	2.0	0	clr-pc	23.9	s	3	27.9	29.79	30	30	1	8.0
8-Sep	8.00	1.5	0	pc, AM ts-rain	25.2	s	3	27.3	29.73	25	25	1	7.0
9-Sep	5.50	2.0	0	ovc/ts-rain	13.0	nw-n	3	24.8	29.87	13	26	-	0.0
10-Sep	8.00	2.0	1	clr-mc, AM haze	6.3	ne, var, se	2	25.8	30.04	29	28	3	377.0
11-Sep	9.50	1.8	1	clr-pc	7.5	n-ne	2	25.8	30.02	30	30	3	1011.0
12-Sep	10.00	2.0	0	clr, scat haze	3.8	ne, w	3	25.4	29.94	30	30	1	4759.0
13-Sep	8.75	2.0	0	clr-mc, haze	4.8	n-nne, sse	3	26.6	29.83	23	22	2	1821.0
14-Sep	8.00	2.3	1	clr-mc, haze	3.3	ne-e, s	2	27.9	29.94	24	25	4	690.0
15-Sep	8.00	2.0	2	pc-mc, fog/haze	2.2	ne, s-sw	2	28.7	29.93	11	11	2	3687.0
16-Sep	8.50	2.1	1	clr-mc, haze	2.0	ne, se-s	1	28.4	29.95	18	21	3	3901.0
17-Sep	8.50	2.0	0	pc, PM haze	10.5	se	2	27.9	29.96	28	26	3	616.0
18-Sep	9.00	1.7	0	clr-mc, PM ts	9.2	se	4	27.4	29.86	29	25	1	60.0
19-Sep	8.00	2.0	0	pc-mc, PM ts-rain	6.8	se-sw	2	28.4	29.86	29	29	2	147.0
20-Sep	8.00	1.9	1	clr-pc, AM haze	2.6	s-sw	3	28.5	29.94	29	29	3	323.0
21-Sep	9.00	3.3	1	pc-ovc, AM haze, PM ts	7.1	w-nw, s	3	29.0	29.95	28	27	1	1796.0
22-Sep	9.00	2.0	1	mc-ovc, ts-rain	4.2	n-nne	3	24.7	29.96	30	26	1	11234.0
23-Sep	5.50	2.2	1	mc-ovc, ts-rain	0.9	n-nne	4	21.8	29.93	22	22	-	12.0
24-Sep	11.00	2.4	1	mc-ovc, scat fog	12.8	n-nne	4	21.8	29.95	24	22	2	4479.0
25-Sep	10.00	3.6	1	clr	7.7	ne	2	18.4	30.08	30	30	2	50445.0
26-Sep	9.00	2.0	0	clr	3.1	ne	3	18.8	30.07	30	30	1	359.0
27-Sep	10.00	2.0	1	clr/haze	3.2	nw-ne	3	19.3	30.02	30	30	2	730.0
28-Sep	9.00	2.0	0	clr/haze	3.1	ne, se	2	20.0	29.97	27	27	1	226.0
29-Sep	9.00	2.0	1	clr	8.4	nne	4	19.6	29.99	30	30	1	736.0
30-Sep	10.75	2.1	1	clr-mc	6.9	n-ne	3	18.9	30.10	26	26	2	2731.0
1-Oct	8.50	1.7	0	clr-pc	4.8	n	3	18.8	30.23	28	27	2	798.0
2-Oct	9.00	2.0	0	pc/haze	1.9	ne-s	3	20.9	30.09	26	27	2	182.0
3-Oct	7.50	2.0	2	pc-mc	4.0	calm, se	2	24.1	30.04	29	29	2	4076.0
4-Oct	8.50	2.0	0	mc-ovc	1.5	calm, e-s	4	23.1	29.99	29	21	1	39.0
5-Oct	9.00	2.1	1	ovc, AM fog, PM ts	2.8	se	4	25.4	29.89	30	18	1	68.0
6-Oct	10.00	3.2	1	ovc	16.2	n	4	15.8	30.05	27	27	1	2903.0

Appendix C. continued

Date	Obs. Hours	Number Obsrvrs[1]	Visitor Disturb[2]	Sky Condition[3]	Wind Speed (kph)[1]	Wind Direction	Thermal Lift[4]	Temp. (°C)[1]	Baro. Press. (in Hg)[1]	Visib. East (km)[1]	Visib. West (km)[1]	Flight Dist.[5]	Raptors / Hour
7-Oct	9.00	2.6	1	clr-pc	7.7	ne-e	3	16.4	30.17	30	30	2	536.0
8-Oct	8.50	1.9	1	clr-ovc	9.2	ene-e	2	20.3	30.10	30	30	1	188.0
9-Oct	9.00	1.8	0	ovc	10.7	ene-se	3	24.7	30.02	21	18	1	128.0
10-Oct	8.50	1.0	0	mc-ovc, AM fog	5.8	sse-s	4	25.6	29.96	26	21	1	87.0
11-Oct	3.75	2.0	1	mc-ovc, fog/ts	5.3	sse-s	4	22.7	29.89	5	5	1	7.0
12-Oct	8.00	2.3	0	mc-ovc, AM fog/rain	7.3	e-se	3	23.6	29.76	15	15	2	108.0
13-Oct	3.50	2.0	0	pc-ovc	3.0	var	3	17.5	29.59	28	28	2	53.0
14-Oct	8.50	2.0	1	clr, scat haze	3.4	w-wnw	3	19.1	29.96	30	30	2	744.0
15-Oct	9.50	1.5	0	pc	3.8	se-s	2	23.0	30.03	30	30	3	619.0
16-Oct	10.00	1.8	0	clr	20.9	ne	3	14.2	30.31	30	30	2	7162.0
17-Oct	8.50	2.0	0	clr	8.7	ne	3	13.7	30.30	30	30	2	1109.0
18-Oct	9.00	2.0	0	clr-pc	3.0	ne, se	2	17.2	30.11	30	30	2	1273.0
19-Oct	10.00	2.2	0	clr	2.4	calm, ene-se	2	20.6	29.97	30	30	3	1361.0
20-Oct	9.00	2.0	1	pc-mc	5.3	ne-e	2	20.5	30.01	30	30	3	1183.0
21-Oct	8.50	2.0	1	pc-ovc, fog/haze, scat rain	5.4	ne	3	20.6	30.00	21	19	1	418.0
22-Oct	8.50	2.0	0	pc, fog/haze	4.3	ne-se	4	23.9	29.92	15	15	3	156.0
23-Oct	8.50	1.7	0	pc, fog/haze	6.1	sse-s	3	23.4	29.75	18	18	2	215.0
24-Oct	8.00	2.0	0	mc-ovc	19.5	s-ssw	4	24.0	29.72	29	27	1	11.0
25-Oct	8.00	2.0	0	clr	8.8	n-nne	3	20.1	30.09	30	30	2	584.0
26-Oct	8.75	1.8	0	clr	6.6	nne-e	3	18.1	30.32	30	30	2	323.0
27-Oct	8.50	2.0	0	clr	3.8	ne, se	3	16.5	30.37	30	30	2	115.0
28-Oct	8.50	2.0	0	clr	8.2	ne-se	3	12.7	30.40	30	30	2	268.0
29-Oct	8.50	2.0	0	clr	5.6	ne-se	3	15.1	30.39	30	30	2	264.0
30-Oct	8.00	1.9	0	clr, AM haze	6.4	ne-se	3	15.9	30.31	20	20	2	360.0
31-Oct	8.00	2.0	1	pc-mc	5.4	ne-se	3	19.3	30.12	26	26	2	55.0
1-Nov	7.50	2.0	0	clr-mc, scat fog/haze	2.7	se	3	20.9	30.01	24	24	3	76.0
2-Nov	7.50	2.0	0	pc-ovc, fog	5.2	e-se	3	21.6	30.05	10	8	2	114.0
3-Nov	8.00	2.0	0	clr-ovc, AM fog	3.1	ne-se	2	21.6	30.14	24	20	2	137.0
4-Nov	8.00	2.0	1	clr-pc	6.4	nnw-ne	2	20.3	30.17	27	26	1	186.0
5-Nov	7.50	2.0	0	clr	9.4	ne	3	18.8	30.13	30	30	2	80.0
6-Nov	8.00	2.0	0	clr	3.0	ne-se	3	18.1	30.18	27	27	2	60.0
7-Nov	8.00	2.0	0	clr	3.2	ne-se	3	18.4	30.21	24	24	3	55.0
8-Nov	8.00	2.0	0	pc, AM fog	0.0	calm	3	21.0	30.20	12	9	3	100.0
9-Nov	8.50	1.4	0	clr-mc, AM fog	1.3	n-ne, var	3	20.7	30.30	10	7	2	178.0
10-Nov	8.00	2.0	0	pc/fog	1.3	n-ne	3	19.2	30.23	9	7	1	64.0
11-Nov	7.50	2.0	0	pc-ovc, AM fog	0.6	calm, sw-nw	3	20.3	30.18	9	7	1	43.0
12-Nov	7.50	2.0	0	pc-ovc, fog	4.6	e-se	3	19.4	30.20	4	3	2	41.0
13-Nov	7.50	2.1	0	pc, AM fog	3.1	e-se	3	20.6	30.16	11	11	2	11.0
14-Nov	7.50	2.0	0	pc, AM fog	8.6	e-se/var	3	20.0	30.05	14	17	3	8.0
15-Nov	7.50	2.0	0	mc-ovc, PM rain	10.3	e-se	3	20.8	30.03	17	12	1	15.0

[1] Average of hourly records.

[2] Median hourly visitor-disturbance rating (subjective assessment by observers): 0 = none, 1 = low, 2 = moderate, 3 = high.

[3] Predominant sky condition during day: clr = clear (0-15% cloud cover); pc = partly cloudy (16-50% cover); mc = mostly cloudy (51-75% cover); ovc = overcast (76-100% cover); ts = thunder storms.

[4] Median hourly rating concerning prevalence of lift-generating thermals, based on subjective assessments of solar intensity, wind speeds, and migrant behavior: 1 = excellent, 2 = good, 3 = fair, 4 = poor.

[5] Median hourly rating concerning line-of-sight distance of flight from observation site: 1 = close, detection and identification possible with naked eye; 2 = moderate, detection possible with naked eye, but binoculars needed for identification; 3 = far, binoculars needed for both detection and identification; 4 = distant, birds detected and identified only with excellent binoculars or spotting scope and by experienced observers.

Appendix D. Daily count records: 2001.

Date	Obs. Hours	Species Codes[1]																										Total	Birds / Hour
		BV	TV	OS	NH	SK	WK	MK	SS	CH	UA	HH	RS	BW	SW	WT	RT	FH	RL	UB	CC	GE	BE	AK	ML	PG	UF	UU		
15-Aug	8.00	0	0	0	0	0	2	6	0	0	0	0	2	4	0	0	0	0	0	0	0	0	1	0	0	0	0	0	15	1.9
16-Aug	7.00	0	0	0	0	17	0	0	0	0	0	0	1	4	0	0	1	0	0	0	0	0	0	0	0	0	0	0	23	3.3
17-Aug	7.50	0	0	0	0	0	1	1	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0.7
18-Aug	8.00	0	0	0	0	0	0	0	1	1	0	0	0	2	0	0	0	0	0	1	0	0	0	2	0	0	0	0	7	0.9
19-Aug	7.00	0	0	0	0	0	0	0	0	2	0	0	0	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	7	1.0
20-Aug	8.00	0	0	0	2	0	1	5	0	2	0	0	2	16	1	0	0	0	0	1	0	0	0	0	0	0	0	0	30	3.8
21-Aug	8.00	0	0	0	0	0	0	0	0	1	0	0	0	15	3	0	0	0	0	0	0	0	0	0	0	0	0	0	19	2.4
22-Aug	7.75	0	0	0	0	0	1	1	1	7	1	0	1	14	0	0	0	0	0	0	0	0	0	1	0	0	0	0	27	3.5
23-Aug	7.50	0	0	0	0	1	0	1	0	1	1	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	10	1.3
24-Aug	8.50	0	0	0	0	3	2	359	0	1	0	0	6	56	5	0	1	0	0	0	0	0	0	0	0	0	0	0	433	50.9
25-Aug	8.25	0	0	0	0	0	0	16	0	5	0	0	0	57	0	0	5	0	0	0	0	0	0	0	0	0	0	0	83	10.1
26-Aug	8.33	0	0	0	0	0	0	2	0	4	0	0	1	65	2	0	0	0	0	0	0	0	0	2	0	0	0	0	76	9.1
27-Aug	8.00	0	0	0	0	0	1	2	0	9	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	3.3
28-Aug	1.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
29-Aug	5.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
30-Aug	6.00	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0.3
31-Aug	6.50	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.2
1-Sep	4.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
2-Sep	4.00	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	2.0
3-Sep	7.50	0	0	1	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0.7
4-Sep	7.50	0	0	0	1	2	0	2	0	2	0	0	0	2	8	0	0	0	0	0	0	0	0	0	0	0	0	0	17	2.3
5-Sep	8.00	0	0	3	0	8	1	17	0	8	0	0	0	1	3	0	2	0	0	0	0	0	0	0	0	0	0	0	43	5.4
6-Sep	8.00	0	0	1	0	7	0	2	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	1.8
7-Sep	8.00	0	0	0	0	5	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	1.0
8-Sep	8.00	0	0	0	0	3	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	7	0.9
9-Sep	5.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
10-Sep	8.00	5	1	0	3	0	0	69	4	22	0	0	3	224	1	0	1	0	0	0	0	0	0	1	2	1	0	0	337	42.1
11-Sep	9.50	0	0	1	4	2	0	476	4	19	0	0	2	488	1	0	2	0	0	0	0	0	0	11	0	0	1	0	1,011	106.4
12-Sep	10.00	0	0	2	14	8	0	1,198	4	30	0	0	3	3,478	6	0	2	0	0	0	0	0	0	14	0	0	0	0	4,759	475.9
13-Sep	8.75	0	1	2	1	3	2	237	15	12	0	0	2	1,535	1	0	0	0	0	0	0	0	0	9	1	0	0	0	1,821	208.1
14-Sep	8.00	0	0	1	9	1	0	51	7	1	0	0	0	604	1	0	2	0	0	0	0	0	0	11	0	2	0	0	690	86.3
15-Sep	8.00	5	0	1	2	1	0	55	22	5	0	0	1	3,579	6	0	1	0	0	0	0	0	0	6	1	2	0	0	3,687	460.9
16-Sep	8.50	0	0	1	1	0	1	22	13	4	1	0	1	3,843	3	0	2	0	0	0	0	0	0	6	1	2	0	0	3,901	458.9
17-Sep	8.50	0	0	2	1	1	0	45	9	0	0	1	0	552	1	0	1	0	0	0	0	0	0	1	1	1	0	0	616	72.5
18-Sep	9.00	0	0	0	1	0	0	17	6	2	0	0	0	31	1	0	0	0	0	0	0	0	0	1	1	0	0	0	60	6.7

Appendix D. continued

Date	Obs. Hours	Species Codes[1]																											Total	Birds / Hour
		BV	TV	OS	NH	SK	WK	MK	SS	CH	UA	HH	RS	BW	SW	WT	RT	FH	RL	UB	CC	GE	BE	AK	ML	PG	UF	UU		
19-Sep	8.00	14	0	0	3	0	0	0	8	0	0	0	0	114	1	0	1	0	0	0	0	0	0	3	3	0	0	0	147	18.4
20-Sep	8.00	13	1	1	4	0	0	0	18	8	0	0	1	270	1	0	1	0	0	0	0	0	0	1	2	2	0	0	323	40.4
21-Sep	9.00	8	0	2	4	0	0	49	207	30	0	0	0	1,453	3	0	1	0	0	0	0	0	0	24	8	7	0	0	1,796	199.6
22-Sep	9.00	47	0	1	9	0	0	101	167	42	1	0	3	10,841	0	0	5	0	0	0	0	0	1	8	4	4	0	0	11,234	1248.2
23-Sep	5.50	0	0	0	0	0	0	0	1	4	0	0	0	6	0	0	0	0	0	0	0	0	0	1	0	0	0	0	12	2.2
24-Sep	11.00	0	0	4	2	0	1	189	386	7	0	0	0	3,805	1	0	0	0	0	0	0	0	0	67	8	9	0	0	4,479	407.2
25-Sep	10.00	0	0	4	9	0	0	74	228	88	0	0	0	49,992	3	0	0	0	0	0	0	0	2	40	4	1	0	0	50,445	5044.5
26-Sep	9.00	0	0	0	4	0	0	131	51	26	0	0	0	130	0	0	2	0	0	0	0	0	0	12	2	1	0	0	359	39.9
27-Sep	10.00	0	0	1	14	0	0	10	109	37	2	0	1	514	0	0	0	1	0	0	0	0	0	40	0	1	0	0	730	73.0
28-Sep	9.00	0	0	3	9	0	0	10	93	26	0	0	1	70	0	0	2	0	0	0	0	0	0	12	0	0	0	0	226	25.1
29-Sep	9.00	0	0	4	3	0	0	14	225	63	0	0	0	360	3	0	2	0	0	0	0	0	0	58	2	2	0	0	736	81.8
30-Sep	10.75	15	0	1	4	0	0	15	239	61	0	0	1	2,299	0	1	0	0	0	0	0	0	0	91	2	2	0	0	2,731	254.0
1-Oct	8.50	6	0	2	5	0	0	38	195	101	0	0	2	391	0	0	1	0	0	0	0	0	0	47	0	0	0	0	788	92.7
2-Oct	9.00	18	2	1	5	0	0	0	64	14	0	0	0	42	0	0	0	0	0	0	0	0	0	35	1	0	0	0	182	20.2
3-Oct	7.50	6	0	3	8	0	0	12	121	3	0	0	0	3,906	1	0	0	0	0	0	0	0	0	15	1	0	0	0	4,076	543.5
4-Oct	8.50	0	0	1	2	0	0	2	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	39	4.6
5-Oct	9.00	0	0	1	1	0	0	1	47	2	0	0	0	2	0	0	0	0	0	0	0	0	0	8	1	5	0	0	68	7.6
6-Oct	10.00	8	19	1	11	0	0	16	145	35	0	0	0	2,591	7	0	3	0	0	0	0	0	0	55	5	7	0	0	2,903	290.3
7-Oct	9.00	0	0	3	17	0	0	0	41	15	0	0	1	445	0	0	3	0	0	1	0	0	0	10	0	0	0	0	536	59.6
8-Oct	8.50	0	2	0	3	0	1	2	99	32	0	0	0	16	0	0	1	0	0	0	0	0	0	31	1	0	0	0	188	22.1
9-Oct	9.00	0	0	2	5	0	0	0	42	2	0	0	0	26	0	0	0	0	0	0	0	0	0	42	3	6	0	0	128	14.2
10-Oct	8.50	0	0	2	2	0	0	0	58	0	0	0	0	11	0	0	0	0	0	0	0	0	0	11	1	2	0	0	87	10.2
11-Oct	3.75	0	0	0	1	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	1.9
12-Oct	8.00	0	0	0	2	0	0	0	22	2	0	0	0	74	0	0	0	0	0	0	0	0	0	6	0	2	0	0	108	13.5
13-Oct	3.50	0	0	0	1	0	0	0	3	1	0	0	0	47	0	0	0	0	0	0	0	0	0	1	0	0	0	0	53	15.1
14-Oct	8.50	0	0	0	17	0	1	0	93	31	1	0	0	528	42	0	4	0	0	0	0	1	3	20	0	3	0	0	744	87.5
15-Oct	9.50	0	152	1	9	0	0	1	43	3	0	0	0	353	7	0	0	0	0	0	0	0	1	47	0	2	0	0	619	65.2
16-Oct	10.00	9	304	0	17	0	1	2	140	164	0	0	1	6,359	109	0	8	0	2	0	0	0	0	41	3	2	0	0	7,162	716.2
17-Oct	8.50	9	73	1	3	0	0	0	29	19	0	0	0	948	5	0	16	0	0	0	0	0	1	4	1	0	0	0	1,109	130.5
18-Oct	9.00	9	140	0	21	0	1	0	97	45	1	0	3	855	14	3	6	0	0	0	0	0	1	75	1	1	0	0	1,273	141.4
19-Oct	10.00	16	137	2	26	0	2	0	89	41	1	0	1	970	6	0	9	0	0	0	0	0	0	59	1	1	0	0	1,361	136.1
20-Oct	9.00	41	124	0	9	0	1	0	156	54	0	0	0	727	14	1	4	0	0	0	0	0	0	51	1	0	0	0	1,183	131.4
21-Oct	8.50	3	51	0	13	0	2	0	87	20	0	0	0	213	0	0	4	0	0	0	0	0	0	20	3	2	0	0	418	49.2
22-Oct	8.50	4	27	0	4	0	0	0	21	2	0	0	0	79	4	0	1	1	0	0	0	0	0	13	0	0	0	0	156	18.4
23-Oct	8.50	25	141	0	8	0	0	0	7	1	0	0	0	30	0	0	2	0	0	0	0	0	0	1	0	0	0	0	215	25.3

Appendix D. continued

Date	Obs. Hours	Species Codes[1]																											Total	Birds / Hour
		BV	TV	OS	NH	SK	WK	MK	SS	CH	UA	HH	RS	BW	SW	WT	RT	FH	RL	UB	CC	GE	BE	AK	ML	PG	UF	UU		
24-Oct	8.00	0	0	0	4	0	0	0	2	0	0	0	0	1	0	0	1	0	0	0	0	0	0	3	0	0	0	0	11	1.4
25-Oct	8.00	8	300	0	3	0	0	0	28	17	0	0	1	210	2	1	9	0	0	0	0	0	0	4	0	1	0	0	584	73.0
26-Oct	8.75	7	121	0	10	0	1	0	60	9	0	0	1	66	22	0	20	0	0	0	0	1	0	5	0	0	0	0	323	36.9
27-Oct	8.50	0	22	0	4	0	0	0	20	4	0	0	0	33	13	0	16	0	0	0	0	0	0	2	1	0	0	0	115	13.5
28-Oct	8.50	3	143	0	10	0	0	0	31	9	0	0	0	44	3	1	17	0	0	0	0	0	0	5	1	1	0	0	268	31.5
29-Oct	8.50	9	108	0	15	0	0	0	37	9	1	0	1	25	0	1	23	0	0	1	0	0	2	32	0	0	0	0	264	31.1
30-Oct	8.00	0	197	0	11	0	0	0	68	6	0	0	1	42	0	0	17	0	0	0	0	0	0	18	0	0	0	0	360	45.0
31-Oct	8.00	0	0	0	14	0	0	0	15	6	0	0	0	5	1	1	5	0	0	0	0	0	2	5	0	1	0	0	55	6.9
1-Nov	7.50	0	38	2	11	0	0	0	6	1	0	0	1	8	2	1	2	0	0	0	0	0	0	4	0	0	0	0	76	10.1
2-Nov	7.50	3	61	1	8	0	0	0	10	2	2	0	0	7	0	0	8	0	0	0	0	0	0	12	0	0	0	0	114	15.2
3-Nov	8.00	5	74	0	4	0	0	0	18	9	0	0	0	16	1	0	5	0	0	0	0	0	0	5	0	0	0	0	137	17.1
4-Nov	8.00	31	57	2	9	0	0	0	41	19	0	0	3	8	1	0	7	0	0	0	0	0	1	6	1	0	0	0	186	23.3
5-Nov	7.50	6	18	0	9	0	1	0	17	7	2	0	2	10	0	1	6	0	0	0	0	0	0	1	0	0	0	0	80	10.7
6-Nov	8.00	12	9	0	6	0	0	0	12	6	0	0	0	6	0	0	8	0	0	0	0	0	0	1	0	0	0	0	60	7.5
7-Nov	8.00	8	5	1	8	0	0	0	12	3	0	1	0	5	2	1	5	0	0	0	0	0	0	4	0	0	0	0	55	6.9
8-Nov	8.00	4	58	0	11	0	0	0	7	4	0	0	0	7	0	0	5	0	1	0	0	0	0	3	0	0	0	0	100	12.5
9-Nov	8.50	3	91	0	15	0	0	0	10	9	0	0	2	25	1	0	14	0	0	0	0	0	0	6	0	2	0	0	178	20.9
10-Nov	8.00	0	0	0	10	0	1	0	7	22	0	0	2	9	3	0	4	0	0	0	0	0	0	6	0	0	0	0	64	8.0
11-Nov	7.50	2	9	0	2	0	0	0	6	4	1	0	0	12	3	0	2	0	0	0	0	0	0	1	0	1	0	0	43	5.7
12-Nov	7.50	15	2	0	7	0	0	0	9	4	0	0	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	41	5.5
13-Nov	7.50	2	0	0	3	0	0	0	1	2	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	11	1.5
14-Nov	7.50	0	0	0	3	0	0	0	2	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	8	1.1
15-Nov	7.50	0	0	0	1	0	0	0	4	5	0	0	0	4	0	0	0	0	0	0	0	0	0	1	0	0	0	0	15	2.0
Total	743.33	379	2,488	62	472	74	26	3,253	3,878	1,281	15	2	54	103,612	321	12	273	2	3	4	0	2	16	1,140	70	77	1	0	117,517	158.1

[1] See Appendix B for full names associated with species codes.