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SUMMARY OF RAPTOR ENCOUNTER RECORDS AT THE BIRD BANDING LAB

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Abstract.—Since the inception of the North American Bird Banding program through 2008, the United States Geological Survey (USGS) Bird Banding Laboratory (BBL) has received approximately 54 000 encounter reports of banded raptors of 52 species, excluding local recaptures and band-only reports. Between 1960 and 2008, banded raptors were encountered at an overall rate of approximately 2.9%. Since 1996, with the inception of the 1–800 toll-free number, the BBL has regularly processed 1500–2000 encounter reports of raptors annually. Raptors with the highest encounter-report rates were Bald Eagle (*Haliaeetus leucocephalus*; 14.0% of the banding records), Golden Eagle (*Aquila chrysaetos*; 8.3%), Great Horned Owl (*Bubo virginianus*; 8.0%), Snowy Owl (*Nyctea scandiaca*; 7.6%), and Peregrine Falcon (*Falco peregrinus*; 7.1%). Over time, raptor encounter reports indicating the bird was shot have greatly decreased, whereas there has been an increase in vehicle collisions. Longevity records of raptors are among some of the oldest in the BBL database, and the age at encounter of raptors caught and released as part of normal banding operations was comparable to that of rehabilitated and released raptors. Mapping of raptor encounter reports in North America indicated that encounter records clustered around dense human populations and along coasts. With advances in marking technology, encounters of living marked raptors may begin to exceed recoveries of dead or injured birds (currently the most common method of encounter).

Key Words: *Bird Banding Lab*; *encounter*; *longevity*; *mortality*; *raptor*; *recovery*.

RESUMEN DE LOS REGISTROS DE ENCUENTRO DE RAPACES EN EL LABORATORIO DE ANILLAMIENTO DE AVES

Resumen.—Desde el inicio del programa de Anillamiento de Aves de América del Norte hasta el año 2008, el Laboratorio de Anillamiento de Aves (LAA) del USGS ha recibido aproximadamente 54 000 informes de encuentro de aves rapaces anilladas pertenecientes a 52 especies, excluyendo las recapturas locales y los informes sobre solamente anillas. Entre 1960 y 2008, las rapaces anilladas fueron encontraron a una tasa global de aproximadamente 2.9%. Desde 1996, con la creación de la línea telefónica 1–800 gratuita, el LAA ha procesado regularmente informes de 1500–2000 encuentros de rapaces al año. Las aves rapaces con las tasas más altas de encuentro son *Haliaeetus leucocephalus* (14.0% de los registros de anillamiento), *Aquila chrysaetos* (8.3%), *Bubo virginianus* (8.0%), *Nyctea scandiaca* (7.6%) y *Falco peregrinus* (7.1%). Con el tiempo, los informes de encuentros indicando que el ave fue muerta por un disparo han disminuido considerablemente, mientras que ha habido un aumento de informes de muertes por colisión con vehículos. Los registros de longevidad de aves rapaces son algunos de los más antiguos de la base de datos del LAA, y la edad de encuentro de las rapaces capturadas y liberadas como parte de las operaciones normales de anillado es comparable a la de las aves rapaces rehabilitadas y puestas en libertad. El mapeo de los informes de encuentro de rapaces en América del Norte indicó que los registros de encuentran agrupados en torno a poblaciones humanas densas y en las costas. Con los avances en la tecnología de marcado, los encuentros de individuos marcados vivos pueden comenzar a superar las recuperaciones de aves muertas o heridas (en la actualidad el método más común de encuentro).

[Traducción del equipo editorial]

The United States Geological Survey Bird Banding Laboratory (BBL) and the Canadian Wildlife Service Bird Banding Office cooperatively manage the North American Bird Banding Program (NABBP) and maintain the database for all migratory birds banded in North America. This database contains more than 65 million banding records and more than 4 million encounter records. Encounter records, or encounter

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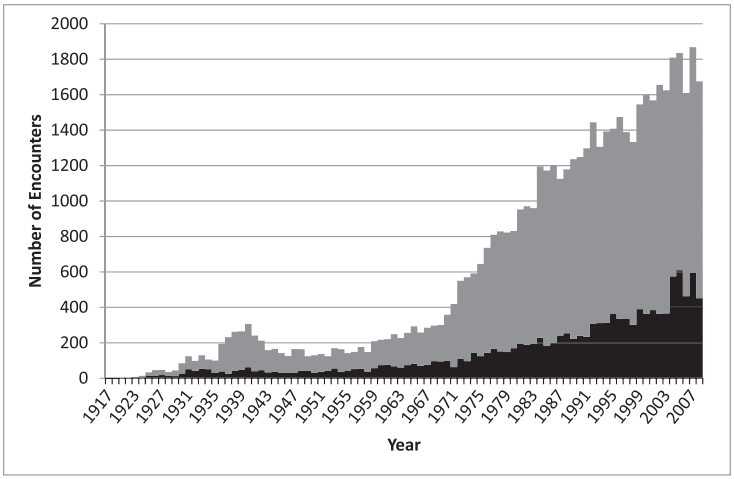

Figure 1. The volume of encounter reports per year for diurnal raptors (■) and owls (■), excluding local recaptures and ''band only'' reports.

reports, are the result of someone encountering a bird after it has been banded or auxiliary-marked, or both, and then reporting the federal band number and/or an auxiliary marker along with the details of the encounter, such as species, how, when, and where, to the BBL. Here we summarize the band-encounter database for North American raptors, specifically the raptor encounter rates by species, longevity records, the temporal patterns of how raptors were encountered, and the spatial distribution of raptor encounters over time.

Banding data for North American migratory birds were received as early as 1903 and encounter reports were first documented in 1914. The first encounter report of a banded raptor was an American Kestrel (*Falco sparverius*) banded in 1916 and encountered in 1917. The number of raptor encounter reports was relatively small with fewer than 400 encounters per year until 1972, when the number of reports began increasing steadily (Fig. 1). As of 2008, the BBL had processed 54 024 encounter reports of banded raptors for 52 species, excluding local recaptures and reports in which the reporter stated that he had only the band. Since 1999, the BBL has processed 1500 or more raptor encounter reports per year (Fig. 1), or 1.46–1.72% of the 82 000–97 000 reports received annually for all species. On average, from 1958–2008, 76.2% of raptor encounter reports were diurnal raptors, whereas 23.8% were owls.

Prior to 1996, all encounter reports were submitted via postal mail (paper reports), either by the band finders or by biologists and officials who were given details of encounters. After the installment of the toll-free band reporting phone line in 1996 and distribution of federal bird bands with the toll-free number inscribed on them, the proportion of reports submitted via phone rose sharply (Fig. 2). In 1999 the BBL began receiving and processing encounter reports via its website and in 2007 the BBL converted the encounter reporting form to the www.reportband.gov url. Whereas the number of reports submitted via the web has steadily increased, the toll-free line continues to receive the highest proportion of encounter reports (Fig. 2).

QUALITY CONTROL

The BBL receives encounter reports from a variety of sources, not limited to, but including bird banders, hunters, the general public, state, federal or provincial biologists, and avid birdwatchers. Although the variables collected for each encounter report are standardized, the BBL cannot control for each reporter's interpretation of what he found or saw, or where or when a band encounter occurred. Therefore, the BBL has developed a series of 50 quality control measures to check each individual record to ensure that only high quality, vetted data are issued to the bander and stored in the BBL database. These measures filter out encounter reports with unusual dates, complex descriptions of the encounter location, and unusually long movements from the banding location, among other characteristics. When an encounter report is flagged

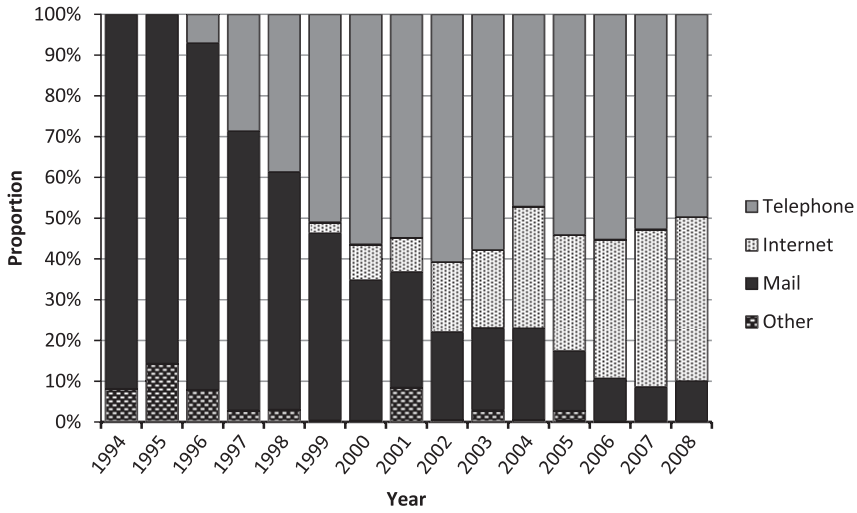

Figure 2. The proportion of reports received via different reporting methods.

due to one or more of these filters, we review the data in detail and attempt to verify the questionable aspects of the report.

Further, in 2006 the BBL data management system was modernized allowing the BBL to store more details of encounter reports and implement improved quality control measures. Due to the limitations of the older database, many historical records that were considered to be acceptable would now be flagged and need additional inquiry. The BBL is currently completing digitization of its historical paper and microfilm encounter reports. These electronic records will be stored in a more readily accessible archive, allowing better verification of historical records and improving the quality of information available for use by the research community.

ENCOUNTER RATES

Banding data prior to 1960 were stored electronically only if there was an encounter for the record, so it is unknown how the volume of encounter reports related to the number of banding records for these years. After 1960, banded raptors were encountered and reported at an overall rate of 2.9%, but several species were encountered at much higher rates. The Bald Eagle (*Haliaeetus leucocephalus*) had the highest encounter reporting rate of 14.0%. This value represented the proportion of total encounter reports per total bandings. Because some banded birds are encountered alive, the same band may be encountered and reported multiple times. If we include only a single encounter report per band (i.e., the number of unique band-encounter reports), the encounter reporting rate is 12.2% for Bald Eagle. The four other raptors with the highest overall encounter reporting rates, with the unique band-encounter reporting rates in parentheses are Golden Eagle (*Aquila chrysaetos*), 8.3% (8.0%); Great Horned Owl (*Bubo virginianus*), 8.0% (7.9%); Snowy Owl (*Nyctea scandiaca*), 7.6% (7.3%); and Peregrine Falcon (*Falco peregrinus*), 7.1% (6.2%). For comparison, the five species with the highest number of encounter reports were Red-tailed Hawk (*Buteo jamaicensis*), with 9234 encounter reports and a 4.93% encounter rate (total encounter reports per total bandings), Sharp-shinned Hawk (*Accipiter striatus*; 4805 and 1.08%), Bald Eagle (4432 and 14.0%), American Kestrel (3906 and 2.2%), and Great Horned Owl (3338 and 8.0%). Other species with greater than 1000 encounter reports are Northern Saw-whet Owl (*Aegolius acadicus*; 3309), Cooper's Hawk (*Accipiter cooperii*; 3154), Osprey (*Pandion haliaetus*; 2441), and Barn Owl (*Tyto alba*; 2082).

HOW RAPTORS WERE ENCOUNTERED

Band-encounter reports also provide information on the causes of mortality of banded birds. Henny and Wight (1972) used these reports to document the importance of shooting pressure for regulating the populations of Cooper's Hawks and Red-tailed

Table 1. Changes in the reports of how banded raptors were obtained over nine decades, demonstrating the decline in raptor shooting. This table represents 55 BBL ''how obtained'' encounter categories for raptors.

''How Obtained'' Categories	Number of Encounters (%)									Category Total
	1920s	1930s	1940s	1950s	1960s	1970s	1980s	1990s	2000s	
Found dead	56(24)	445(27)	697(36)	575(37)	1228(48)	2722(48)	4793(57)	6419(62)	9140(67)	26 075
Shot	137(58)	842(50)	867(45)	621(40)	690(27)	850(15)	539(6)	296(3)	99(1)	4941
Injury	9(4)	52(3)	76(4)	93(6)	119(5)	305(5)	597(7)	1115(11)	1756(13)	4122
Snares/traps	19(8)	204(12)	138(7)	61(4)	129(5)	260(5)	176(2)	57(1)	76(1)	1120
Motor vehicle/ highway	2(8)	24(1)	25(1)	50(3)	152(6)	671(12)	1201(14)	1301(13)	1367(10)	4793
Other [a]	14(6)	114(7)	130(7)	168(11)	225(9)	816(15)	1060(13)	1184(11)	1120(8)	4831
Decade total	**237**	**1681**	**1933**	**1568**	**2543**	**5624**	**8366**	**10 372**	**13 558**	**45 882**

[a] Represents 44 how obtained codes that equaled <5% of the total encounters in any decade, with most <1%.

Hawks during 1929–65. During the 1930s, the recovery rates of Cooper's Hawks from shooting were actually higher than those for most waterfowl species, although these rates declined significantly after 1940. Mortality rates from shooting for Red-tailed Hawks were much lower than those for Cooper's Hawks but remained fairly constant through the 1950s (Henny and Wight 1972).

Since 1965, use of mortality information obtained from the band-encounter reports was complicated by changes in the codes used to characterize this information. The total number of ''how obtained'' codes increased from 52 to 78, and a number of the original codes were also redefined, reducing their comparability among different time intervals and potentially complicating analyses of these data. Additionally, changes in band-encounter reporting procedures during recent decades may have encouraged use of a few general codes that do not indicate specific causes of mortality, which could also bias reporting patterns for the codes representing specific mortality factors. For example, the number of reports of birds ''found dead'' and ''found injured'' has generally increased since 1920 and made up approximately 80% of all band-encounter reports since 2000 (Table 1). Forty-four ''how obtained'' codes represent such small percentages of the total encounters that no trends can be detected (Table 1). For the band encounters reported with specific mortality codes, the number of raptors that were shot and captured by snares and traps has steadily declined, representing only a small percentage of reports in recent decades. A number of factors likely have contributed to this trend, including a better appreciation for raptors by the public and improved laws protecting raptors from illegal shooting. In contrast, the percentage of birds striking motor vehicles increased steadily as a source of raptor mortality through the 1980s, but has reached a plateau in recent decades (Table 1), suggesting that collisions with motor vehicles has become a significant mortality factor for a number of raptors.

As shown by Henny and Wight (1972), band-encounter reports have the potential to provide important information on anthropogenic sources of raptor mortality. However, these reports are unlikely to provide unbiased insights into natural sources of mortality, as birds dying of natural causes in remote locations are less likely to be encountered than those colliding with vehicles or buildings (McIntyre 2012). In addition, changes to the BBL codes system have reduced the inferences possible from the mortality data. In order to improve the comparability of these data and their relevance for the management and conservation of raptor populations, we recommend that the BBL promote data-reporting processes that encourage identification of probable causes of mortality rather than the use of broad undefined codes. Additionally, the BBL should adopt a system of ''how obtained'' codes that are consistently defined, relevant to avian conservation, yet allow for new sources of mortality to be added without affecting the existing code definitions.

Longevity of Raptors and Rehabilitation

Whereas most studies using banding are not designed to investigate the longevity of a species, banding and encounter data allow the BBL to document longevity records for most North American migratory bird species including 42 raptor species (Lutmerding and Love 2010). The initial criteria for

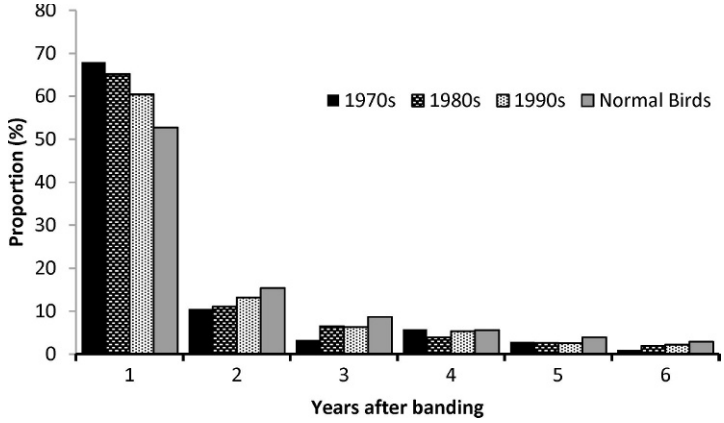

Figure 3. Proportion of encounter reports by number of years after banding for raptors caught and released as part of normal banding operations (average = 2.35 yr ± 4.12, n = 40 762), rehabilitated birds banded in the 1970s (average = 1.66 yr ± 3.05, n = 209), rehabilitated birds banded in the 1980s (average = 1.80 yr ± 3.15, n = 615), and rehabilitated birds banded in the 1990s (average = 1.91 yr ± 2.93, n = 819).

establishing a longevity record is that a bird must exceed 4 yr of age based on the age at banding. The BBL strongly encourages banders to submit any longevity records existing in their individual files through the www.reportband.gov website. The most current version of longevity records is available on the BBL website.

The oldest banded raptor on record is a Bald Eagle that was at least 32 yr and 10 mo at the time of encounter, and this bird is among the oldest documented birds reported to the BBL. There are several raptors with slightly shorter longevity records including Red-tailed Hawk (29 yr and 9 mo), Golden Eagle (28 yr and 3 mo), and Great Horned Owl (28 yr). In contrast, the majority of raptors are encountered within one year of banding. The proportion of birds encountered more than a year after banding sharply decreased over time (Fig. 3). The average time between banding and encounter is 2.35 yr (±4.12, n = 40 762).

In recent decades, a large number of rehabilitated raptors have been banded prior to their release. The length of time between banding and encounter for these birds was compared to that of raptors that were caught and released as a part of normal banding operations. This comparison may demonstrate that rehabilitation efforts have improved over time, using raptors caught as part of normal banding operations as a measure of success. The average amount of time between banding and encounter has gradually increased from 1.66 yr (±3.05, n = 209) for birds rehabilitated and released in the 1970s to 1.80 yr (±3.15, n = 615) for the 1980s and 1.91 yr (±2.93, n = 819) for the 1990s. Compared to raptors banded and released in normal banding operations, the proportion of encounters for rehabilitated raptors within the first year of banding for all decades is higher. However, the difference in time between banding and encounter for rehabilitated raptors compared to normally caught raptors is becoming progressively smaller (Fig. 3).

Temporal and Spatial Patterns

The BBL uses seven levels of encounter-location precision to account for the variability with which encounter locations are reported. They include: the exact geographic coordinates, 1-min block, 10-min block, county, state, country, and no (unknown) coordinate precision and are assigned based on the encounter location information provided by the finder. The 1-minute block coordinate precision represents an area covering 0°01′ of latitude by 0°01′ of longitude and the 10-minute block coordinate precision represents an area covering 0°10′ of latitude by 0°10′ of longitude. Most often the information provided in the reports results in a 10-min block designation indicating that the encounter occurred within that block. When only the county, state, or country are provided in the encounter report and the finder does not reply to queries from the BBL for more detailed information, coordinate precision levels are then assigned based on the most precise information that was provided.

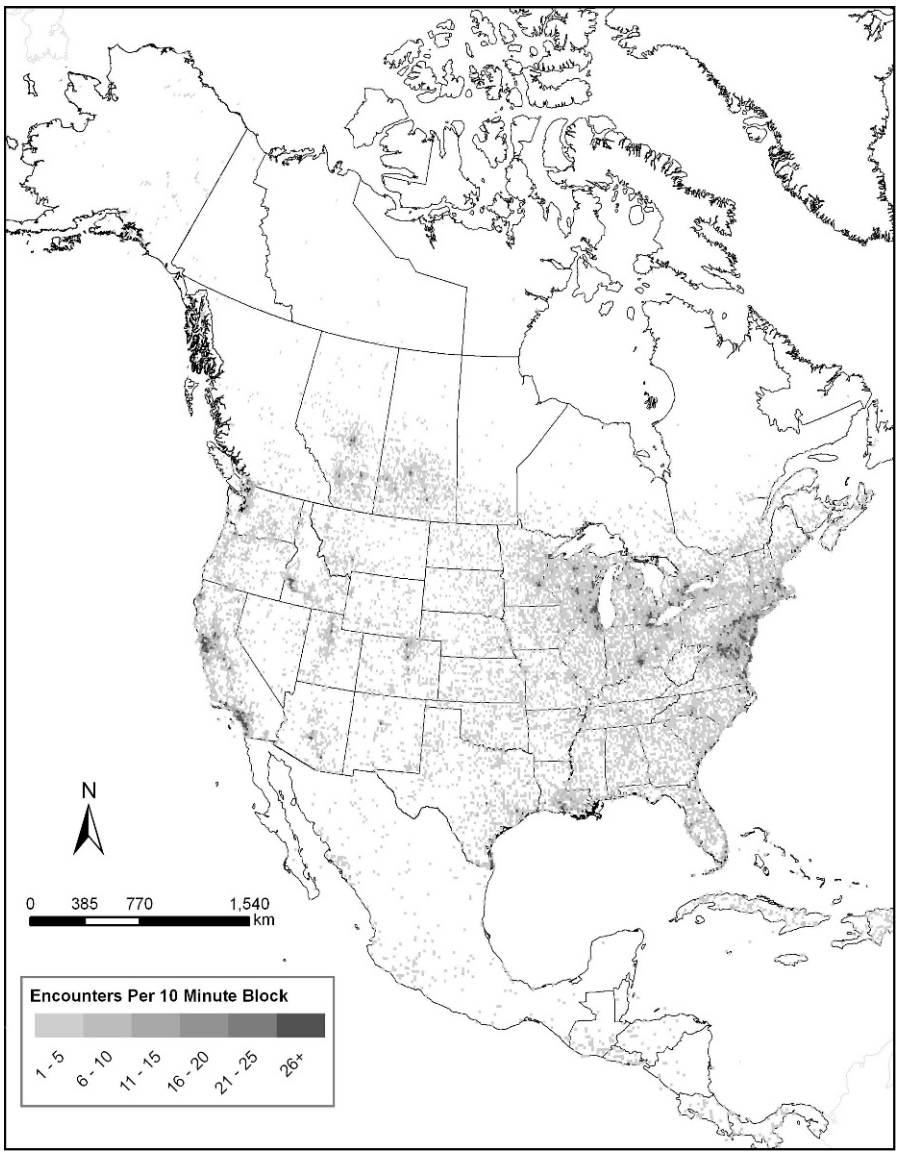

Figure 4. Raptor encounter density in North America, 1950 to 2008. 51 226 encounters are displayed at a 10-min block coordinate precision level. The remaining 1996 encounters all have a coordinate precision greater than 10-min block, unknown, or erroneous location data (USGS-BBL 2010, USGS 2005, ESRI 2008).

An overall North American raptor encounter density map was created for encounters with 10-min block coordinate precision or finer (Fig. 4). The number of encounters within each 10-min block in North America was totaled and displayed using six intervals to reflect the relative density of raptor encounters. Encounters with a coordinate precision broader than 10-min block (county or state level for example), unknown, or erroneous location information were not used in this summary. Of the approximately 54 000 raptor encounter reports, 51 226 occurred in North America (including Central America and the Caribbean Islands) and have a 10-min block coordinate precision or finer. The greatest number of encounters in one block was 376 at the southern tip of the Delmarva Peninsula. Visual interpretation of

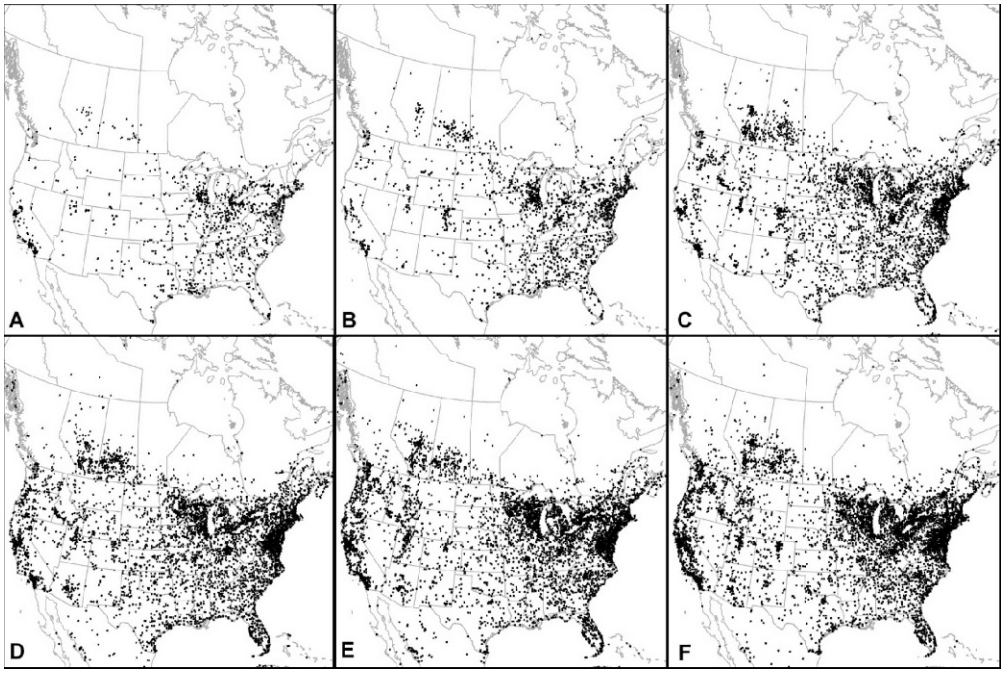

Figure 5. Temporal change in the location of raptor encounters from 1950 to 2008. Ten minute blocks are displayed in black when at least one encounter occurred within a block. (A) 1950–59 (1470 encounters); (B) 1960–69 (2503 encounters); (C) 1970–79 (5909 encounters); (D) 1980–89 (10 316 encounters); (E) 1990–99 (12 900 encounters); F. 2000–08 (14 736 encounters).

Fig. 4 indicates greater clustering between the east coast of the United States and the Mississippi River, around large water bodies such as the Great Lakes, and near populated areas. In contrast, the central and western parts of the country show a lower overall density with less clustering. These results are consistent with the interpretation that raptor migration follows the topography of the landscape and that individuals sometimes concentrate along the coast of a large water body before attempting to cross (Mueller and Berger 1967, Bednarz et al. 1990). However, compounding this analysis is the clustering of encounter reports around urban areas and major banding stations, indicating that raptors are more likely to be encountered where human density or trapping effort is greater.

To show changes in encounter locations over time, the overall encounter-density map of North America was split into six decadal density maps beginning with the 1950s (Fig. 5). The overall number of encounters with a valid 10-min block coordinate precision or finer increased over time. From the 1960s to the 1970s, the number of encounters increased by 136%, the greatest increase between decades. There was a 75% increase from the 1970s to the 1980s, a 25% increase from the 1980s to the 1990s, and a 14% increase from the 1990s to the 2000s with an average increase in raptor encounters between decades of 64%. These maps also indicated that there was not a significant shift in encounter location among decades, other than a greater number and density of encounters from the same general areas. This is most heavily influenced by an increase in the number of raptors banded each year (Bystrak et al. 2012).

The BBL also maintains band-encounter data for birds that are banded in North America and subsequently encountered elsewhere. The majority of these raptor encounter reports were from South America, with a few unusual reports in Europe and eastern Asia (Appendix). There were 595 raptor encounters in South America with a 10-min block coordinate precision or better (Fig. 6). Encounters were clustered near the northern countries and central Argentina, where a number of raptor species overwinter. The greatest number of encounters in one

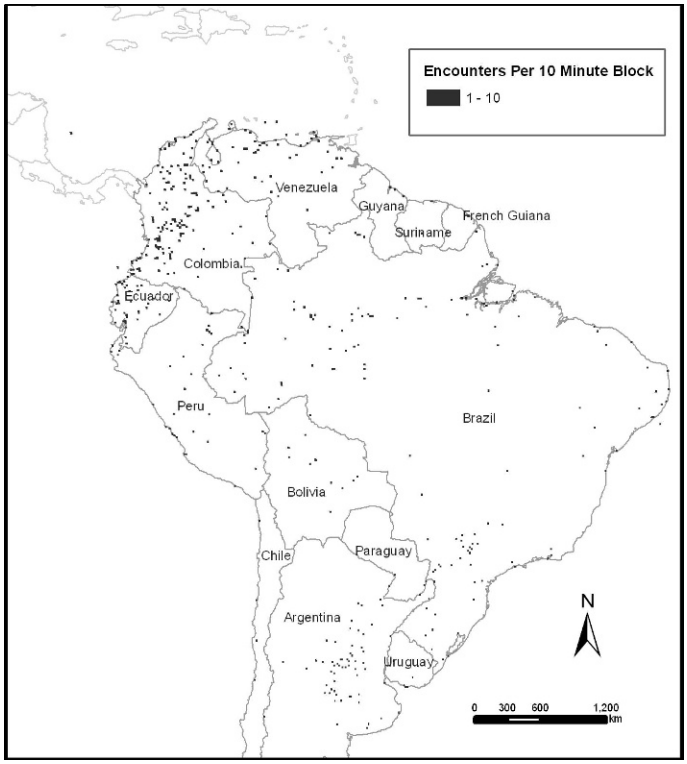

Figure 6. South American raptor encounters from 1950 to 2008. The 10-min blocks are shown in black when at least one encounter occurred within a block (USGS-BBL 2010, ESRI 2008).

block was 10 Swainson's Hawks (*Buteo swainsoni*) near Alta Italia, Argentina. The three most commonly encountered species in South America were Osprey (378 reports), Peregrine Falcon (160 reports), and Swainson's Hawk (100 reports).

Anthropogenic Factors

A number of factors can influence where a bird is encountered, including, but not limited to, a species' distribution, the location of banding stations, and the concentration of people to find and report banded birds. We investigated the relationship between raptor encounter locations and human population centers, by generating concentric circular buffer zones of 15 km, 30 km, 45 km, 60 km, and 75 km around population centers with a population greater than 100 000 people (Fig. 7). If a 10-min block straddled two buffer zones, it was assigned to the zone where its center occurred. We calculated the cumulative number and percentage of encounters within each buffer zone in the lower 48 states (Table 2) and found that >50% of raptor encounters in the lower 48 states occurred within 75 km of populated areas and nearly 30% occurred within 30 km. Given the widespread distribution and specific migration patterns of many raptor species, their proximity to cities and dense human populations appeared to be a significant factor in where birds were encountered. According to Hager (2009), 42 raptor species use urban centers, with many populations thriving in these urban environments. The risks and hazards of entering urban areas may further contribute to a greater number of raptor encounters in cities. To better understand anthropogenic influences on raptor encounters, additional research is needed to investigate the relationship between causes of raptor mortality and proximity of encounter locations to urban environments.

Future of Encounter Reporting

Marking technology, such as data loggers and transmitters, have advanced and improved the ability to track an individual bird's movements and fate with increasing accuracy and precision. Data from these

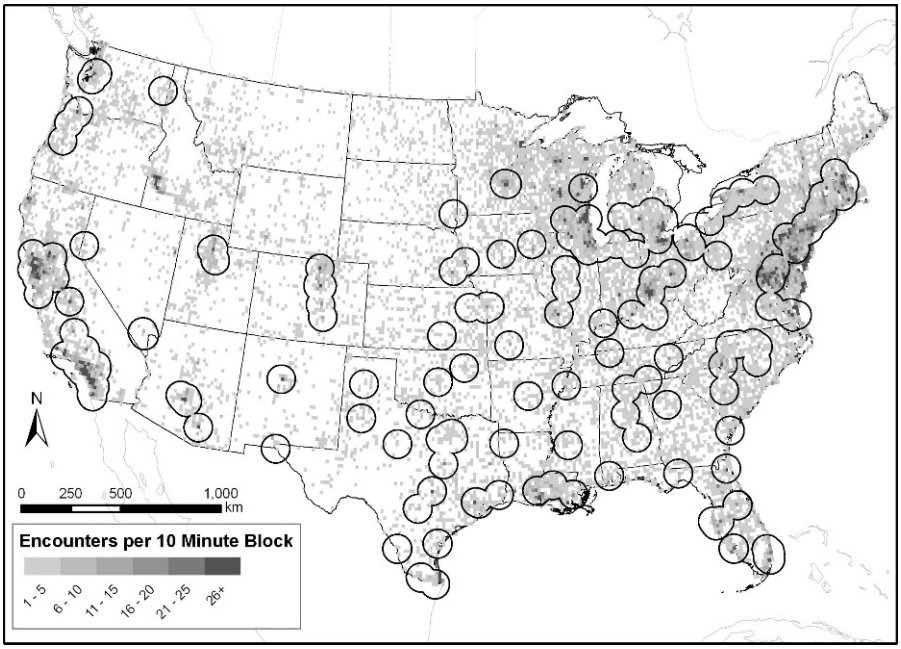

Figure 7. Raptor encounter density in the lower 48 states with one buffer zone in black that represents the area within 75 km of a populated area (≥100 000 people). (USGS-BBL 2010, USGS 2004, 2005, ESRI 2008).

technologies are not stored at the BBL, a fact that could compromise the thoroughness of the BBL encounter database and may reduce the accessibility of these data for the public and future research. Additionally, foreign recaptures and foreign resightings of auxiliary-marked birds are increasingly exchanged among bird banders via the internet, but are not consistently reported to the BBL. In order to maintain a comprehensive database for raptor movements in North America, the BBL encourages all bird banders to report such records to the BBL.

Table 2. Number of encounters and percentage of total encounters within each buffer zone. A populated area was defined as ≥100 000 people.

Distance from a Populated Area	Number of Encounters	Percentage
Within 15 km	6183	14.4
Within 30 km	12 097	28.1
Within 45 km	16 773	39.0
Within 60 km	20 329	47.3
Within 75 km	23 873	55.5
Greater than 75 km	19 150	44.5

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Appendix. Asian and European raptor encounters (USGS-BBL 2010).

SPECIES	ENCOUNTER DATE	ENCOUNTER LOCATION	BANDING DATE	BANDING LOCATION
Gyrfalcon (*Falco rusticolus*)	24 January 1973	Kamchatka Peninsula, Russia (54°05′N, 160°05′E)	3 July 1972	Near Nome, Alaska, U.S.A. (64°55′N, 165°05′W)
Snowy Owl *(Bubo scandiacus)*	18 February 1962	Sakhalin Island, Russia (47°35′N, 142°05′E)	18 July 1960	Near Cambridge Bay, Nunavut, CA (69°05′N, 105°05′W)
Peregrine Falcon[a] (*Falco peregrinus*)	7 February 1993	Near Shizuoka, Japan (35°05′N, 138°55′E)	1 June 1991	Marble Canyon, Arizona, U.S.A. (36°55′N, 111°35′W)
Peregrine Falcon[a] (*Falco peregrinus*)	17 January 1993	Near Shizuoka, Japan (34°55′N, 138°25′E)	1 June 1991	Marble Canyon, Arizona, U.S.A. (36°55′N, 111°35′W)
Peregrine Falcon (*Falco peregrinus*)	12 August 1985	At sea, near Iceland (52°05′N, 35°35′W)	8 July 1985	Algonquin Park, Ontario, CA (45°35′N, 78°35′W)
Peregrine Falcon (*Falco peregrinus*)	24 December 1986	Briton Sussex, England (50°55′N, 0°05′W)	18 July 1986	Near Hasting, New Brunswick, CA (45°35′N, 65°05′W)
Peregrine Falcon (*Falco peregrinus*)	27 April 2008	Cima Crocetta, Switzerland (45°57.5′N, 9°00.5′E)	29 September 1993	Michigan Island, Wisconsin, U.S.A. (46°55′N, 90°25′W)

[a] These two records represent the same bird, seen at separate locations and different dates.