The Yellowstone Raptor Initiative

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NPS/B. ERTEL

A golden eagle with an unidentified waterfowl as its prey.

It was the first backpacking trip of the season, our first time hiking this trail in its entirety, and the first season of a new program designed to document raptor populations in Yellowstone National Park. As we (Lisa Baril and David Haines) tightened our boots and cinched the straps of our backpacks loaded with tripods, spotting scopes, and enough food to last three days, we headed down the trail just after dawn on a blue-bird day in June. Our task was to survey this 18-mile stretch of trail for raptor activity and breeding territories. We were especially interested in golden eagles and red-tailed hawks, but documented all raptor species observed along the way. We gave cliff faces particular attention since this is the preferred nesting habitat for golden eagles, peregrine falcons, prairie falcons, and occasionally red-tailed hawks. Using spotting scopes we scanned the cliffs for the tell-tale signs of raptor activity—whitewash (the highly acidic avian waste material) and the stick nests created by golden eagles and red-tailed hawks. Whitewash often shows up as long, vertical streaks for falcons and shorter, wider streaks for other raptors.

A golden eagle came into view and began an undulating flight display—a graceful plunging dive with wings tucked in from hundreds of meters above the ground, then pulling up and climbing back into the sky for a repeat performance—a signal to other golden eagles (and us) that this territory was occupied. A second golden eagle, the female, flew in front of the cliff face and landed in a large stick nest. Squinting into our spotting scopes from half a mile away, we could make out a small chick, about 5 or 6 weeks old, still covered in downy white feathers, wobbily negotiating its home on the rocks. Elated with this find within the first few hours of the trip, we took careful notes and photographs to document the exact location for future reference and headed on our way. It was an auspicious start for the Yellowstone Raptor Initiative—a trip that would reveal the locations of two prairie falcon territories, four golden eagle territories, a bald eagle nest, and countless red-tailed hawk and American kestrel observations.

Five-Year Initiative

Established in 2011 and funded in annual increments by the Yellowstone Park Foundation, the Yellowstone Raptor Initiative (YRI) is a five-year project to collect baseline information on certain raptor species in the park. It was designed to complement Yellowstone's existing bird monitoring program, which includes trumpeter swans (*Cygnus buccinator)*, common loons (*Gavia immer*), colonial nesting species, songbirds, and three raptor species: bald eagles (*Haliaeetus leucocephalus*), ospreys (*Pandion haliaetus*), and peregrine falcons (*Falco peregrinus*). Although Yellowstone's existing raptor monitoring program has provided more


NPS/J. PEACO

An immature great horned owl.


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A Swainson's hawk, among raptor species prioritized by YRI.

than 20 years of information regarding raptor population changes—including the recovery of the bald eagle and peregrine falcon following the 1972 restrictions on DDT use—an additional 19 species of hawk, eagle, falcon and owl species breed in Yellowstone, and another 14 currently use or have moved through the park seasonally. We have had very limited or no information on most of these species, several of which are of growing conservation concern throughout the western U.S. as residential development and other human activity increases across the region. With such a large preserved habitat, Yellowstone provides an ideal location to increase our understanding of raptors and their ecology throughout the Northern Rocky Mountain ecosystem.

However, given the large number of raptor species in the park and the limited staff and funding, the YRI's priorities are species of conservation concern, species with high visibility, and the development of techniques that can be used to survey multiple species. The YRI is focused on gathering baseline information on golden eagles (*Aquila chrysaetos*), red-tailed hawks (*Buteo jamaicensis*) and Swainson's hawks (*B. swainsoni*) with less intensive surveys for American kestrels (*F. sparverius*), prairie falcons (*F. mexicanus*), and owls.

Although important to understanding the role of raptors in the park, sharp-shinned hawks (*Accipiter striatus*), Cooper's hawks (*A. cooperii*), and northern goshawks (*A. gentilis*) will not be surveyed during the initial five-year period because of the intensity of the surveys needed to obtain adequate sample sizes. Yellowstone has habitat suitable for a large and healthy population of these forest-dwelling hawks and if the YRI continues beyond this initial five-year period, accipiters will be added to the program.

The YRI will distribute the results of this research in internal reports, peer-reviewed publications, and popular literature, and provide public outreach and education opportunities to highlight the ecological importance of aerial predators throughout the Yellowstone landscape. The YRI has also solicited raptor observations from park employees and visitors to augment field work done by YRI staff. In this article we highlight some of the accomplishments made during the first two years of the YRI.

Golden Eagle

The golden eagle, considered one of the quintessential eagles of the world, is found throughout most of the northern hemisphere with ecological equivalents throughout the southern hemisphere. Driven by prey availability, golden eagles primarily occupy open habitat that allows for hunting small mammals such as rabbits, hares, and ground squirrels. Cliffs serve as their primary nesting substrate, but tree nesting is common in locations that provide high prey density and limited cliffs. Golden eagles have long been observed and recorded in the park, especially during the winter feeding at carcasses. Although some are park residents, many of the golden eagles observed during winter are likely migrants from Alaska and Canada. Studies of several radio-tagged birds show that golden eagles from as far north as the Brooks Range in Alaska migrate to areas in and around Yellowstone for the winter, while others pass through on their way to wintering grounds in Colorado, New Mexico, and as far east as Arkansas (R. Domenich, raptorview.org, pers. comm.; Carol McIntyre, Denali NP, pers. comm.).

Prior to the YRI, there were no documented records of breeding golden eagles in Yellowstone despite ample nesting habitat and a suspected large population size. Throughout the western U.S., concerns about wind energy development, agriculture, and increased urbanization have stimulated research on how these changes are affecting golden eagle populations (Kochert et al. 2002). The portion of the park's population that is migratory may be exposed to some or all of these threats when leaving the park. Increasing what is known about golden eagles in Yellowstone, where the species' ecology is largely unaltered by human activities, can help inform management decisions, such as the location of wind farms, throughout the Northern Rockies.

For the golden eagle, the objectives of the YRI are to locate and document all breeding territories in the park, determine the breeding population density across the park, evaluate annual measures of reproductive success, and determine nesting chronology. The YRI also collects prey remains and eggshell fragments from nests in order to identify breeding season prey selection and the presence of chemical contaminants that affect eggshell thickness and therefore reproductive success. We will also collect golden eagle biological specimens shed in the nest area for a DNA study examining territory turnover rates and genotypic variation across a broad region. The YRI is working with researchers in Wyoming and Montana to better understand the impacts of land-use types on golden eagle occupancy and reproduction, and how its breeding season diet varies across the landscape.

Methods. Although most searches for territorial golden eagles and observations of active nests were made from the ground during the 2011 and 2012 breeding seasons (April to July), several flights were conducted to assess the effectiveness of using fixed-wing airplanes in locating active territories. We also followed up on reported sightings and areas where birds were opportunistically observed during general bird surveys in Yellowstone's core bird program. Exploratory searches were conducted in areas park-wide where the habitat was considered suitable for golden eagle occupancy (i.e. cliffs near open habitat for foraging). Although golden eagles may build nests in trees, we concentrated our efforts on cliff-nesting birds since they are more easily found. More focused efforts to locate tree-nesting eagles will be made after most of the suitable cliffs have been surveyed.

We determined occupancy by the presence of a mated pair of adult birds, a single bird showing territorial behavior, nest structures that contained new material and fresh greenery, or by other reproduction-related activities. We observed suspected territories during a minimum of two four-hour visits from April through July. If there was no evidence of occupancy during these visits, we considered the territory unoccupied. If a territory was occupied, we determined if the pair was actively nesting as indicated by evidence of egg-laying, the presence of nestlings, or an adult in incubation posture in the nest. Golden eagles commonly forgo breeding in years when food has been limited during the prior months, and as a result not all pairs occupying a territory lay eggs. The proportion of pairs that lay eggs in a given year can therefore be an important measure of a population's response to changing food supplies (Steenhof and Newton 2007), but this information is often difficult to obtain because nests may fail before they have been observed.

If a nest was active, we monitored the nest until it failed or the nestlings fledged. Locating young after they fledge is difficult, so nests were considered successful if at least one nestling reached 52 days old (~80% of fledging age) since nestlings at this stage have a high probability of fledging. To assess the reproductive health of the population, we calculated productivity as the number of fledged young per occupied territory. Careful notes and photographs were taken of the location of occupied territories and all nests within a territory. In August of 2011, after the eagle chicks had fledged, we entered three of the five nests to collect eggshell fragments and prey remains.

Results. Although aerial surveys can be an economical way to survey a large number of territories, they yielded little return on finding new territories in Yellowstone. Golden eagle nests in Yellowstone tend to blend in well with the rock, making it difficult to survey from a plane. With their ability to remain stationary, helicopters would be a more effective aerial survey method, but are cost prohibitive. Future surveys will therefore be done on foot.

From previous observations by core bird program staff we knew of three golden eagle territories that had not been documented. There had also been reports of multiple sightings by staff and visitors at three other locations that were later identified as breeding areas. YRI staff discovered an additional 12 not previously reported territories.


J. KEEL

A golden eagle observed from the ground by survey participants.

Table 1. Golden eagle territories surveyed in Yellowstone National Park, 2011 and 2012.

Year	Occupied Territories	Active Territories	Successful	Fledglings	Productivity†
2011	15	5	4	5	0.56
2012	16	5	0	0	0

† Estimate is based on 9 occupied territories for 2011 and 13 for 2012 because these are the territories for which enough information was collected to calculate productivity estimates.

We documented a total of 18 territories and 44 golden eagle nests during the 2011 and 2012 breeding seasons. A possible 19th territory was located, but could not be confirmed. Like many raptors, golden eagles build and maintain several nests within a territory. Maintaining multiple nests within a territory is thought to "hedge" against destruction of one of the nests so that the pair may quickly re-nest if it is early enough in the breeding season to allow for completion of the nesting cycle. Multiple nests may also provide an alternative if the parasite load in a favored nest becomes high and serve as a territorial warning to other golden eagles.

In 2011, we confirmed nesting in five of the nine territories for which sufficient observations were made. Observations were made at an additional seven territories, but because of the time of year they were visited and/or remoteness we were unable to make definitive assessments of nesting behavior and occupancy at these sites. Four of the five nests fledged a total of five young for a productivity of 0.56 young produced per occupied territory (Table 1). In 2012, we monitored 14 of the 18 known sites for nesting activity and confirmed occupancy at an additional two sites, but only five pairs nested and none were successful. The nesting status of the remaining four territories could not be determined.

When visiting a nest that had young, we determined the approximate age of nestlings using a descriptive guide to nestling development (Driscoll 2010). Using the approximate age of the nestlings, we back-calculated to the estimated date of egg-laying and hatching based on published estimates of the average incubation period. We also forward-calculated fledge dates by using published estimates of the average time it takes young to fledge. We estimate that the golden eagles on average laid eggs from March 28 to April 1, and that the chicks fledged from July 18 to 22. Analysis of eggshell thickness revealed that eggshells were within the normal historical range, indicating little, if any, contaminant loads. Prey remains collected from the three nests revealed a high proportion of birds were fed to nestlings, including common ravens, black-billed magpies, several species of duck, and even a Swainson's hawk. Mammal remains included the skull of a deer, ground squirrels, and a yellow-bellied marmot. Fewer mammal remains were found than bird remains, but this may be because shed feathers are more likely to remain in the nest than mammal bones after the female removes the carcass.

C.R. PRESTON

A golden eagle chick peers from its nest.

Conclusions. Although we have only two years of data, it appears that while Yellowstone supports a sizeable breeding population of golden eagles, few are able to produce young. As mentioned above, golden eagles may forgo breeding in years when prey is limiting, particularly during late winter and early spring. Food-stressed females are unable to increase their body mass enough to allow for egg-laying. In Idaho, the percent of females that lay eggs is related to jackrabbit abundance and inversely related to winter severity (Kochert et al. 2002), and nesting success in Alaska has shown direct correlations with the cyclic nature of snowshoe hares (McIntyre and Schmidt 2011). Yellowstone's winter–spring prey base may be limited with a patchily distributed acyclic snowshoe hare population (Hodges et al. 2009), a restricted white-tailed jackrabbit population (Gunther et al. 2009), and high variability in the distribution of wolf- and winter-killed carcasses on the landscape depending on winter severity (Wilmers et al. 2003). Only long-term monitoring of both golden eagles and their prey will reveal patterns of reproduction as related to prey density and variation in weather.

Although our sample size was small, the nesting dates for golden eagles in Yellowstone are later on average than has been reported for eastern Wyoming (Kochert et al. 2002) and central Montana (V. Slabe-Catena Consulting, personal comm.), presumably because of the difference in elevation.

Red-tailed hawk.

Red-tailed hawk nest. with adult and one chick.

As more territories become known and monitored, more precise information on nesting chronology will be gathered. Knowledge of how the timing of nesting relates to environmental factors will augment reproductive data and help us to better understand the effects of climate change on golden eagle ecology in Yellowstone.

Red-tailed Hawk Monitoring

Look up into the sky in Yellowstone and you are likely to see a red-tailed hawk, by far Yellowstone's most observable raptor species. Named for the rusty-red tail feathers of the adults, red-tails are raptors of open country, preferring to forage for ground squirrels and other small mammals in grasslands and sagebrush, while primarily nesting in trees on the periphery of their hunting grounds. Like most raptors, red-tails build and maintain multiple nests in a single territory, but only choose one per season for egg-laying. Despite the ubiquitous nature of red-tails in Yellowstone, little is known about their population size, habitat use, diet, or reproduction. To start filling this information gap we initiated a monitoring program for which the goals are to locate and document their nesting territories, determine their reproductive success and annual variations in nesting chronology, and estimate their population size on the northern range.

Methods. Survey methods for red-tails largely followed those used for golden eagles. We conducted one flight during May 2011 to determine whether aerial surveys were an effective way to locate and monitor red-tailed hawk nests. Most nest searching and monitoring, however, was done from the ground by looking for red-tails exhibiting territorial or nesting behavior (e.g., undulating flight, carrying nesting material or food, copulation). Once a territory was identified we monitored the hawks' behavior to locate a nest. In many cases we found nests by searching for them in trees within the territory. As with the golden eagles, active nests were monitored until the nestlings fledged or the nest failed. Nests were considered successful if at least one nestling reached 34 to 37 days old (~80% of fledging age) since nestlings at this stage have a high probability of fledging and locating young after they fledge is difficult. To assess the reproductive health of the northern range population, we calculated productivity as the number of fledged young per occupied territory. Careful notes and photographs were taken of the location of territories and all nests within a territory.

Results. The aerial surveys were not effective in searching for or monitoring red-tailed hawk nests due to the large amount of nesting habitat available on the northern range and the difficulty of observing nests in conifers. During 2011, we documented 33 locations where we had observed red-tail pairs. Within those territories we located 18 nests, 14 of which were active. Twelve of the nests were successful, with a minimum of 19 fledglings. We wondered if this high rate of nesting success (86%) may have been inflated by the small sample size and our locating some nests relatively late in the season. The nestlings are older then and more likely to fledge, and we were unlikely to find nests that had already failed.

By the end of the 2012 breeding season, however, we had documented 48 nests in 34 territories on the park's northern range. We monitored 26 active nests, most of which were found at the start of the nesting season in May, and 24 of

Table 2. Red-tailed hawk nesting chronology, 2011 and 2012.

Nesting Chronology	2011 Average (n=10)	2012 Average (n=24)
Mean Incubation	May 8-10	May 6-8
Mean Hatching	June 8-10	June 2
Mean Fledging	July 22-24	July 13-17

them fledged a total of 47 young, resulting in a nesting success rate of 88% and a productivity estimate of 1.7 young produced per occupied territory. The breeding chronology for red-tailed hawks on the northern range varied slightly from 2011 to 2012 (Table 2). The average lay, hatch, and fledge dates were approximately one week earlier in 2012 than in 2011, which could be attributed to the milder winter conditions. Ground squirrels, a primary prey resource, come out of hibernation earlier when conditions are milder. Continued monitoring over the next three years may indicate if these slight shifts are a function of spring conditions.

Conclusions. The high density of ground squirrels coupled with ample nesting habitat appears to have allowed for a high density of nesting red-tails on the northern range with some active nests spaced as little as 0.66 km apart. The high nesting success rates we observed are unusual and indicate a healthy population that may be a source for less productive populations in and around Yellowstone. Since great horned owls (*Bubo virginianus*) and great gray owls (*Strix nebulosa*) will use old red-tail nests or compete with red-tails for nesting space, the high density of red-tails may aid owl populations. Our goal is to monitor at least 30 nests a year distributed across the northern range to obtain annual estimates of nesting success and productivity for this region. Although we restricted our surveys to the northern range for this five-year project, a future goal may be to compare reproductive rates and nesting densities to those of other areas such as Yellowstone Lake or the Thorofare region where the red-tail population is suspected to be lower.

Raptor Roadside Survey

The purpose of the roadside survey for red-tailed hawks, Swainson's hawks, and American kestrels on the northern range is to provide an annual index of population abundance for these species and long-term data for detecting population changes. These surveys are designed to be accurate, rapid, cost-effective for limited staffing, and repeatable, with a protocol that complements nesting surveys for these species. The roadside surveys will continue beyond the initial five-year period as staffing allows.

Methods. We developed a point count survey method based on other survey protocols with similar goals and the advice of several experts in the field. We treated the 2011 season as a pilot year to evaluate the method for accomplishing our goals in an accurate and timely manner. We used the road corridor from Swan Lake Flats to the northeast entrance as a transect and placed 100 stop points approximately 0.8 km apart. The transect was split into two routes and one observer completed each route. During 2011, each point was surveyed for 10 minutes during which the observer recorded all raptors heard and observed onto a topographic map along with information on species, sex if possible, behavior, color morph where applicable, and abundance. Surveys began by 0900 and were completed by 1800.

Table 3. The percentage and abundance of raptors observed during the northern range roadside survey, 2011 and 2012.

	% (Abundance)	
Species	**2011**	**2012**
Red-tailed Hawk	64% (67)	72.5%(153)
American Kestrel	11% (11)	8.1%(17)
Swainson's Hawk	1% (1)	7.1%(15)
Golden Eagle	6% (6)	3.8%(8)
Bald Eagle	1% (1)	2.8%(6)
Osprey	4% (4)	2.8%(6)
Sharp-shinned Hawk	2% (2)	0.9%(2)
Turkey Vulture	3% (3)	0.5%(1)
Cooper's Hawk	1% (1)	0.5%(1)
Northern Goshawk	—	0.5%(1)
Prairie Falcon	4% (4)	0.5%(1)
Unknown Buteo	NA (7)	—
Unknown Raptor	NA (11)	—
Total Birds Observed	**122**	**215**

Based on data gathered during the pilot season and expert opinion, in 2012 we increased the distance between points to 1.6 km and doubled the survey time at each point. Increasing the distance between points reduced the likelihood of double-counting raptors and reduced the number of stops from 100 to 38. Lengthening the time at each point increased the likelihood of detection. Whereas each point was surveyed only once during the breeding season in 2011, during 2012 each point was surveyed once in May and once in June, to account for only the breeding population, avoiding young of the year and migrants. After the survey, all data collected at each point are entered into the geographic information system (GIS) to spatially analyze detections.

Results. During 2011, we recorded 122 detections of 11 species. Of the detections identified by species, red-tailed hawks accounted for 64% followed by American kestrels (11%) and golden eagles (6%) (Table 3). In 2012, when we visited each point twice, we recorded 215 detections. As in 2011, we recorded 11 species, and red-tailed hawks were once again the most numerous (73%), followed by American kestrels (8%), next were Swainson's hawks (7%).

Conclusions. Due to modifications of the protocol and only two years of data, it is too soon to estimate population sizes or breeding densities for the three target species on the northern range. By the end of 2015, however, the YRI plans to have an estimate of the adult red-tailed hawk, Swainson's hawk, and American kestrel populations for this region, including an estimate of the number of breeding pairs. This five-year dataset will serve as baseline information to which

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A ranger-led program on raptor migration, September 2011.

Most hawk watch sites in North America are located in the eastern U.S. where tens of thousands of hawks, eagles, and falcons migrate along the Appalachian mountains and eastern coastline each autumn. The western U.S. presents more of a challenge in determining the paths of migrating raptors because of the abundant mountain ranges and competing ridgelines that can spread the migrants out over a large area and reduce concentrations in any one particular spot.

The site closest to Yellowstone is located north of the park in the Bridger Mountains near Bozeman, Montana. More than 2,000 raptors, many of them golden eagles, pass through the Bridgers on their way to wintering areas in the southern U.S. and Central, and South America. With Yellowstone located along the same flight path, we wondered if there was a similar corridor in the park. During the fall of 2010 we scouted several potential areas and found a promising site in Hayden Valley. Although Hayden Valley is not a traditional migration site, it does provide a location for thermal uplift as raptors move across a large and mostly forested plateau. Despite the differences between the landscape features of Hayden Valley and traditional monitoring sites, we observed significant numbers of migrating raptors there. During our one-week pilot monitoring effort at the Hayden Valley site in 2010, we counted 737 migrating raptors of 10 species in just 20 hours of observation. Most (81%) of the birds identified to species were Swainson's hawks, which have one of the longest migrations of any raptor—8,000 to 10,000 km from breeding areas across western North America to wintering grounds in central Argentina. The results from 2010 were exciting and prompted us to increase our monitoring effort the following year.

future studies may be compared and, if continued beyond the initial five-year period, this survey may reveal population changes and trends over time.

Autumn Migration in Hayden Valley

Allowing a brief glimpse into the wild world around us, the spectacle of raptor migration has fascinated humans for centuries. Ordinarily difficult to study because of their secretive and wide-ranging nature, most raptors become highly visible during migration. Because migration is energetically costly raptors reduce the need for flapping flight by using either thermal or slope soaring techniques to aid southward (autumn) and northward (spring) movements (Duerr et al. 2012). Thermal soaring takes advantage of warm rising air masses. On days with good thermal lift, raptors can quickly gain elevation then glide to the next thermal pocket to make forward progress. Slope soaring occurs when raptors take advantage of air masses in lower elevation areas coming into contact with mountains. This causes the air mass to rise and raptors can gain lift in this way. Slope soaring is common in the Rocky Mountains because of the numerous mountain ranges present. Specific points along these mountain corridors provide areas from which to observe large numbers of raptors during the migration period. Surveying raptors from migration sites is a cost-effective and efficient way to gather data on multiple species over a short period. Data gathered during raptor migration over the long term has led to important discoveries, including the effects of DDT on raptor populations (McCarty and Bildstein 2005). In addition to indicating population trends, information gathered from migration sites has increased our understanding of the phenomenon of migration itself, encompassing routes, phenology, flight dynamics, and other aspects of raptor behavior (Bildstein et al. 2007).

Methods. During the 2011 and 2012 observation periods, a total of 16 people participated in the counts with an average of 2 or 3 observers at the site each day. We observed for approximately six hours a day (less if limited by weather) on 35 days from September 13 to October 27 in 2011 and on 38 days from September 4 to October 26 in 2012. Observers scanned the entire northern portion of the sky and recorded all raptors seen moving past the site by species and, when possible, by age. Weather data, including sky condition, wind speed and direction, temperature, barometric pressure, and overall visibility were collected at hourly intervals for the duration of observations. We also record the thermal lift index, which is based on the amount of sunlight, wind, and raptor behavior (e.g., birds circling up in elevation indicates good thermal lift whereas birds having to flap frequently indicates poor thermal lift).

The area where we established our original count site in 2010 was located on a hilltop several miles south of Canyon Village that was closed during 2011 as a result of two fatal grizzly attacks in the area. We moved the count site to a lower elevation area at the northern end of the valley and then back to the original location in 2012. To determine if there were differences in the number of raptors detected between count sites, we conducted one day of simultaneous counts at both stations during 2012.

Results. In 2011, observers recorded 1,846 raptors of 16 species; in 2012, 953 raptors of 17 species; with a two-year total of 2,799 migrating raptors belonging to 17 species. Overall, red-tailed hawks, Swainson's hawks and golden eagles were the most abundant species; peregrine falcon, prairie falcon (*Falco mexicanus*) and turkey vultures (*Cathartes aura*) were the least abundant.

Despite the slightly greater effort in 2012 (194 hours) than during 2011 (177 hours), far fewer birds were recorded. We observed 526 Swainson's hawks in 2010, compared to 357 in 2011 and 46 in 2012, despite increasing effort over the three years. Variability in Swainson's hawk numbers is most likely a result of their notoriously unpredictable migration routes. Increases from 2011 to 2012 were seen in rough-legged hawks (*Buteo lagopus*) abundance, which nearly doubled, and turkey vultures, which did double. Observers at each count station during the simultaneous count recorded nearly the same number of each species indicating that although differences exist between the count stations in terms of visibility, observers are able to detect a similar number of birds. Although uncommon in the western US, we observed seven broad-winged hawks (*Buteo platypterus*) in 2012. A common migrant through the east, groups containing hundreds of broad-winged hawks, sometimes totaling tens of thousands in a single day, can be seen at migration sites in places like Duluth, Minnesota, and along the western shore of Lake Erie, Michigan.

Conclusions. The results of the 2012 season were drastically different from those of the previous year. For the observers, the major difference in 2012 was the reduced visibility on 16 of the 38 observation days due to smoke from fires burning in and outside the park. We strongly believe that this was the primary factor responsible for reducing the total count. Although the simultaneous count results indicated that a similar number of raptors could be observed at both locations, we acknowledge that this test was done for just a single day. A more robust assessment would have been to do simultaneous counts over multiple days, but due to the numerous days with low visibility and low daily counts comparisons between sites would have been difficult, if not impossible. Regardless of the lower counts in 2012, observations during the last few years have indicated that migrant raptors are moving across the Yellowstone plateau, and that Hayden Valley may be serving as a key geographic feature along their route. Only continued surveys will confirm this. The YRI will continue to explore locations throughout the park and determine if other features may produce comparable or higher concentrations. Over time, we hope to contribute to a large data set that will help track population trends along the Rocky Mountain Flyway.

Citizen Science and Education Programs

In 2010 the YRI initiated a program to involve the public and park staff in projects that not only raise awareness and appreciation of these top avian predators, but contribute to our understanding of raptor distribution in the park. Yellowstone's interpretive staff played an integral role by encouraging visitors to submit their sightings. To aid in the identification of raptors, we developed and made available at all visitor centers and ranger stations a handbook of raptor photos and identification tips for commonly observed species. All raptor sightings are entered into a GIS database.

Since the raptor sightings program began, we have received more than 1,000 sightings (fig. 1). They included 22 raptor species of which just three accounted for nearly half of all observations: 314 red-tailed hawks (23%), 174 bald eagles (13%), and 165 ospreys (12%). Observers ranged from park staff to visitors who were in the park for only a day. Report forms assisted in narrowing YRI staff efforts to locate breeding raptors and contributed to locating several of the red-tailed hawk nests that were monitored. In general, owls and

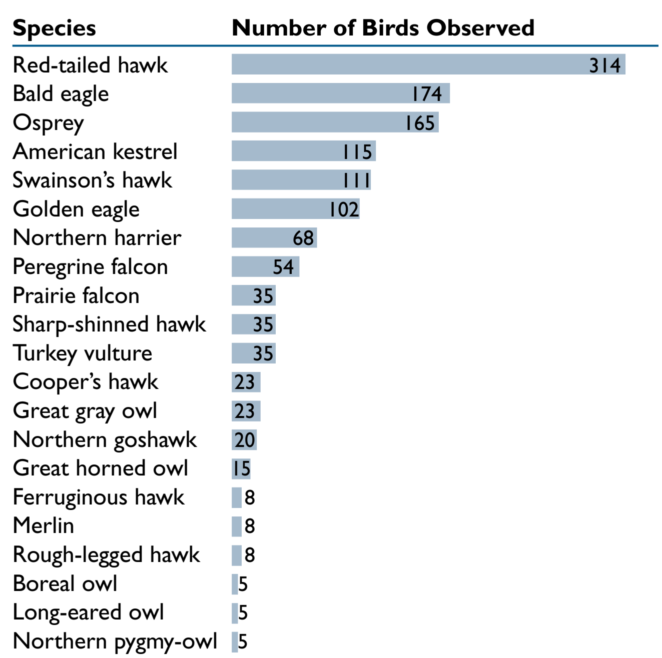

Figure 1. Raptor observations reported by staff and visitors, 2010–2012 (does not include unidentified raptor species).

accipiters (forest hawks) are infrequently documented largely because of their secretive nature and nocturnal behavior (most owls). Sightings of these species are especially important since little is known about their distribution and abundance in Yellowstone. For example, we received two reports of the rarely observed short-eared owl, a species known to breed here but with no known nesting territories. Reports like these are critical to increasing our awareness of how raptors are distributed across the Yellowstone landscape.

For the past three years, Education Ranger Katy Duffy has led migratory raptor ecology and identification field trips in which more than 180 people have participated. After meeting at the Fishing Bridge Museum to learn about raptor ecology and identification using mounts of raptors, participants go to Hayden Valley where Duffy points out migrating raptors and discusses identification tips and the ecology of migration. Duffy also teaches a raptor ecology and identification class for the Yellowstone Association each fall and was a guest speaker at the Winter Speaker Series in West Yellowstone in 2012, where she discussed the ecology of raptors in Yellowstone. On January 2012 and 2013 the YRI hosted a survey in which 25-30 volunteers annually helped us document winter use by bald and golden eagles throughout the park, Gardiner, and Paradise Valley. The YRI also presented a poster at the 11th biennial conference on the Greater Yellowstone Ecosystem on October 8-10, 2012.

Swainson's Hawk, American Kestrel, and Prairie Falcon

Although our primary nest searching and monitoring efforts are focused on golden eagles and red-tailed hawks, we are also interested in knowing more about the reproductive success of Swainson's hawks, American kestrels, and prairie falcons in the park. While the road-based survey described above will provide a northern range population estimate for Swainson's hawks and American kestrels, it will provide little information regarding reproduction. In the past, nest searching for these species has been largely opportunistic. All locations where territorial behavior was observed have been carefully marked and mapped so that more focused efforts in these areas can be made in the future. Since we have met our goal of monitoring 30 red-tailed hawk territories and identified 18 golden eagle territories, we will be able to devote more time to Swainson's hawks, American kestrels, and prairie falcons beginning with the 2013 breeding season.


USFWS/S.HILLEBRAND

Male American kestrel

Our American kestrel nest searching efforts will be primarily focused on the northern range because of the relatively high density observed there. For Swainson's hawks, however, we will focus on other areas where they are more abundant. More than 13 territories in the Yellowstone Lake area and Hayden Valley have been identified and volunteer Jack Kirkley, Ph.D. with the University of Montana-Western, has located two nests. An additional 20 territories were documented by YRI staff for future studies, but many of them are located in the Mirror Plateau and the Thorofare region where nest searching and monitoring is impractical due to the difficulty of accessing these areas on a regular basis to check nests.

YRI staff located six prairie falcon territories primarily while searching cliffs for peregrine falcons and golden eagles. Due to staffing limitations we monitored only two territories during 2012, but both produced fledglings, a total of at least four young. Our goal for 2013 is to monitor all six prairie falcon territories.

The Future of the YRI

Because of Yellowstone's long-term managed and preserved habitat, the park serves as a living laboratory for understanding ecology, ecosystem maintenance, predator/prey relationships, and raptor conservation. While the ecological contribution of predators such as grizzly bears, wolves, and coyotes has been well documented in Yellowstone, the landscape scale effects attributed to these keystone terrestrial predators do not encompass the aerial niche held by raptors. Awareness of raptors as an ecosystem driver has long been overlooked, and is only now perceived in other habitats as a primary or secondary contributor to top-down trophic cascades and the ecological functioning of Rocky Mountain systems. The YRI is designed to fill this gap in knowledge and to provide baseline information for several species of raptor not previously studied in Yellowstone.

The information gathered during the first two years of the YRI has stimulated questions for future research that we hope to be able to address with additional funding. For example, our observations of many raptors foraging in Hayden Valley just prior to fall migration indicates that it may be a stopover site for migrating raptors. We also are curious about the inter- and intra-seasonal movements of golden eagles and what proportion of the breeding population remains in the park during winter. Yellowstone's northern range may be a source for red-tailed hawks, but we have no information on juvenile dispersal. Are red-tailed juveniles coming back to the park to breed or are they colonizing areas outside the park? Only banding and radio-tagging birds will enable us to answer these questions.

The more we learn about how raptors are using the Yellowstone landscape, the better prepared we will be to address conservation issues such as climate change and increasing anthropogenic effects. For example, a solid estimate of the current red-tailed hawk population could be used as a benchmark for future monitoring. In the late winter/early spring of 2013 we began preliminary surveys to learn more about the distribution and habitat associations of select owl species in Yellowstone. We plan to continue, and perhaps increase, the role of citizen science in acquiring knowledge of Yellowstone's raptors. We will also continue educating the public concerning raptor ecology through interpretive programs, park publications, the park website and other social media.

We are excited to continue our efforts over the next three years and look forward to all we will learn about the raptors of Yellowstone National Park. The future of the Yellowstone Raptor Initiative beyond the five-year period is uncertain, but the data collected thus far has provided a glimpse into raptor ecology in Yellowstone. YS

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Lisa Baril began her career as an ornithologist in 2000 banding songbirds in Yosemite National Park. In 2009, Lisa recieved her Master's Degree in Ecology at Montana State University in Bozeman studying willow-songbird relationships and joined the Yellowstone Bird Program in 2008. In 2011, Lisa transitioned to the newly developed YRI.

David Haines has worked as a wildlife biologist for over ten years specializing ornithological studies. He has focused much time studying birds a prey throughout the western United States. Formerly of the Santa Cruz Predatory Bird Research Group David joined the YRI at its inception in 2011.

Katy Duffy has banded diurnal raptors, owls and songbirds in Wyoming, Montana and New Jersey since 1980 and has been a volunteer for Yellowstone's bird program since 2008. Katy has worked as an education ranger in Yellowstone since 1999; she is currently the park's interpretive planner.

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