The Raptor Population Index

Taking the Pulse of Raptor Migration

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Who is monitoring raptor populations?

The answer seems to be "nobody" and "everybody" at the same time. Many of us collaborate in one way or another by linking our observations to large systems that keep track of bird populations of different taxa, and there are multiple monitoring systems in place (focused on small landbirds, waterfowl, shorebirds, and many others with a regional or state focus on all birds). Yet raptors seem to be an underserved group. So the question remains, who, and how, are raptors monitored? The answer is a complex process under construction.

This challenging task was undertaken by the Raptor Population Index (RPI) project. A description of this system has its roots inside the history of hawkwatching, so that is where I will start.

Modern hawkwatching formally started in the Americas in the fall of 1934, when Maurice Broun performed his first counts of migrating hawks atop the Kittatinny Ridge, in the Appalachian Mountains of eastern North America. There, conservationist Rosalie Edge had recently purchased several hundred acres of land to protect a raptor migration site near Kempton, Pennsylvania, from the hawk shooters who awaited the stream of migrants. She hired Broun and his wife Irma to be caretakers of the newly founded Hawk Mountain Sanctuary.

Broun's self-imposed mission was to investigate raptor migration while young and brave Irma kept hawk gunners from entering the property. Broun continued to count migrants each successive fall, excluding some years during World War II, and he quickly developed a systematic method of tracking them annually. He kept careful records and made detailed observations, thereby founding the first raptor migration monitoring site. In the process, he did not restrain himself from other, more emotional expressions of awe. While reading Broun's journal entries, one cannot but wonder: What is this? A genuine scientific study? Or an excuse to indulge his eyes with the beauty and mastery of the flight of eagles, falcons, and hawks?

Juvenile **Northern Goshawk.** *Goshute Mountains, Nevada; October 1998. © Jerry Liguori.*

Merlin. *Wasatch Mountains, Utah; September 2003. © Jerry Liguori.*

The **Merlin** (left) and **Northern Goshawk** (above) are widespread in North America and elsewhere, and their populations have been extensively monitored in recent decades. But what is the Big Picture? What major trends are evident when the results of scores of individual surveys are integrated? This article describes the Raptor Population Index (RPI) project, an exciting new collaborative effort that aims to uncover major patterns in raptor population trends in the Americas.

Years later, Broun's initiative was emulated in other locations, first in the Northeast and then elsewhere in the United States. Over the years, he and other hawkwatchers slowly, but successfully, transformed the hobby of shooting hawks into the hobby of watching hawks.

The magnitude of Broun's legacy was evident many years later when, in 1974, a group of northeastern hawkwatchers founded the Hawk Migration Association of North America (HMANA), an organization dedicated to conserving raptor populations through the scientific study, enjoyment, and appreciation of raptor migration. HMANA set formal

standards for data collection and actively promoted the establishment of raptor migration monitoring sites across North America by citizen-science groups.

Through the 1970s and 1980s, these first isolated dots on a large map were replaced by clusters of monitoring sites in the Northeast. Cape May and Montclair in New Jersey, Whitefish Point in Michigan, Lighthouse Point in Connecticut, Derby Hill and Braddock Bay in New York, and many more—indeed too many to name individually—followed. Hundreds of hawkwatchers flocked to migration monitoring sites and sat in exposed lookouts waiting for the next migrant to provide them with captivating views and an opportunity to practice their identification skills. Field guides solely dedicated to raptor identification were developed and one of the first ones, entitled *Feathers in the Wind*, was published in 1973 by Hawk Mountain's Jim Brett and Alex Nagy.

The **Swainson's Hawk** (juvenile here) is numerous across much of western North America, and populations are believed to be steadily increasing. Pesticide use on the South American wintering grounds was a major source of mortality in the mid-1990s, but a recent ban on the use of pesticides on the wintering grounds in Argentina has reversed the decline. *Wasatch Mountains, Utah; August 2005. © Jerry Liguori.*

HMANA got busier, too. Individual sites started recording daily standardized counts and submitting their data to HMANA, thus generating the largest archive of raptor migration data in the world. Through the years, more than 1,800 localities have submitted more than one million hours of observations on more than 100,000 data sheets!

The coverage increased elsewhere over time. In the late 1970s, Steve Hoffman, an energetic and contagiously enthusiastic biologist from Pennsylvania, who had become infected with a passion for hawkwatching at Hawk Mountain, started exploring the migration of birds diverted by the Great Salt Lake and adjoining desert in the West. Migrant hawks reluctant to cross over its salty flats, devoid of appropriate habitat, were found migrating along mountain ridges adjacent to both the east and west sides of the lake. But the localities to monitor these migrations were remote, with some, like the Goshute Mountains of Nevada, requiring both a good drive from the nearest city and a rigorous hike up a steep mountain range. Not exactly the sorts of places that would attract volunteers to spend the day and then drive home for dinner, these sites required professional hawkwatchers willing to endure seasonal field work under often harsh conditions.

The face of today's network of raptor migration monitoring sites, affectionately called hawkwatches, has changed. It is now run by a mix of professional biologists and volunteer citizen-scientists who collect systematic, standardized, observational data. Each hawkwatch is a data-generating location, many contributing to the creation of a large-scale picture of migration. Similar networks run with the help of volunteer citizen-scientists, such as Cornell Lab of Ornithology's Project FeederWatch, the U.S. Geological Survey's Breeding Bird Survey, and others, are changing the way we conceive of the science of bird population ecology.

These different citizen-science projects involve several common elements: a large research question or monitoring goal, a network of data-generating locations, a standard mechanism to record and report data, a centralized data repository to collect information, and ad hoc analytical tools to extract the information needed to close the cycle and address the central research or monitoring objective. Properly managed, citizen-science projects can be a very efficient and cost-effective tool for gathering robust datasets to address large-scale research and monitoring questions.

Current contributions by birders and hawkwatchers, now more skilled than ever and armed with powerful, high-quality optics, excellent identification guides, and detailed data collection protocols, are unprecedented. Citizen-science projects are rapidly gaining respect among the scientific community. It is no longer uncommon to find many of these initiatives supported by highly competitive funding sources such as the National Science Foundation and to see the results of such research published in peer-reviewed periodicals of international acclaim such as *Science* and *Nature*.

Traditionally, hawkwatches were concentrated in the eastern U.S., especially along the Atlantic Coast and in the Appalachian Mountains. Today, many of the most thrilling hawkwatches in North America are located far inland. Examples include hawkwatches in the Goshute Mountains of northeastern Nevada, the Sandia Mountains of central New Mexico, and Whitefish Point in northern Michigan.

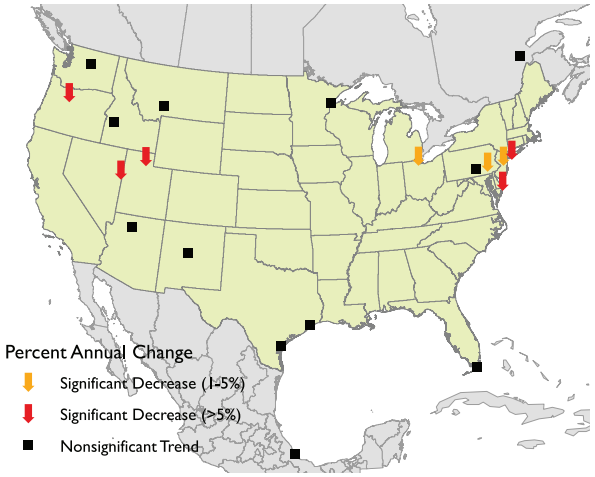
Goshute Mountains, Nevada. *September 1998. © Jerry Liguori.*

Sandia Mountains, New Mexico. *April 1998. © Jerry Liguori.*

Whitefish Point, Michigan. *April 2000. © Jerry Liguori.*

American Kestrels are declining. Results from 22 sites under RPI analysis show declines at many sites. Habitat loss in the Northeast, exposure to West Nile Virus, predation by Cooper's Hawks, long-term drought, and possibly contamination have been advanced as plausible hypotheses to explain these trends, but there are no definite answers yet. *Data supplied by Christopher J. Farmer, Hawk Mountain Sanctuary; map by Kei Sochi.*

American Kestrel Hawkwatch Data



A primary objective of the RPI project is the creation of a mechanism to collect data from many monitoring sites and to archive them permanently in a centralized database. However, archived data do not serve any purpose if they are not used. The RPI project includes among its goals the task of analyzing the migration count data to estimate regional and continental population trends for all relevant species of migratory raptors *and* the task of making this information widely available to the general public, the scientific community, and agencies charged with management and conservation of our natural resources.

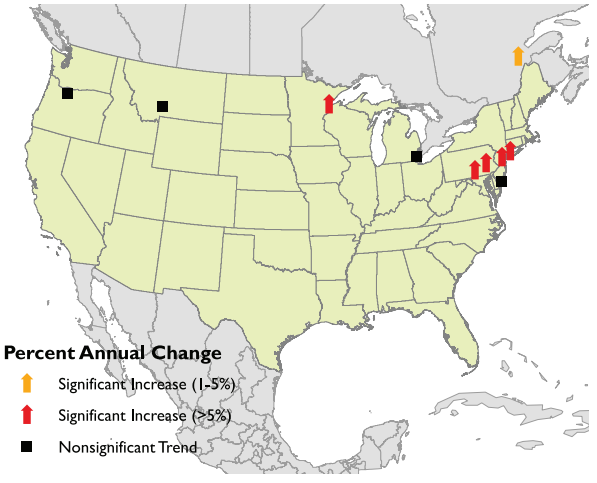
The task is of enormous proportions. The tedious transfer of data from thousands of archived paper data forms to electronic format is currently underway, thanks to the efforts of Laurie J. Goodrich and dedicated volunteers at Hawk Mountain Sanctuary (HMS), HMANA, and HawkWatch International. Once a complete, site-specific dataset is compiled in electronic format, it is transferred to the RPI project's analysis team for trend analysis. Dr. David J. T. Hussell, a scientist of the Ontario Ministry of Natural Resources and current member of the RPI project Science Advisory Committee, has developed a statistical model capable of detecting and quantifying population trends from migration count data generated during long time periods.

The RPI project's partner HMS hired Dr. Christopher J. Farmer as North American Monitoring Coordinator to lead the project analysis unit. He has since collaborated with Hussell to further enhance the early regression model to fit the project datasets. Initial analyses have focused on the most robust datasets available from across the continent, generally encompassing ongoing studies from which at least a decade of consistent annual monitoring has occurred.

Juvenile male **American Kestrel.** *Wasatch Mountains, Utah; September 2005. © Jerry Liguori.*

Juvenile **Bald Eagle.** *Wasatch Mountains, Utah; November 2006. © Jerry Liguori.*

Bald Eagle Hawkwatch Data



Recently "delisted" as an endangered species, the Bald Eagle has increased noticeably at hawkwatches in the northeastern United States and at several sites in the West. Additional long-term monitoring of the species is warranted. *Data supplied by Christopher J. Farmer, Hawk Mountain Sanctuary; map by Kei Sochi.*

The potential for citizen-science projects to make significant contributions has increased recently, thanks to the internet and developments in database and other software applications. Jason Sodergren, a systems engineer from Detroit who is also an avid birder and a HMANA board member, developed HawkCount.org, an online information system to collect data from RPI project sites. HawkCount.org functions not only as the new archive for HMANA's datasets but also as an interface with the

The key goal of hawkwatches is population monitoring, but public education is a valuable secondary component. Most hawkwatches welcome visitors of all levels of birding skill.

network of hawkwatches. Sodergren's aim is for HawkCount.org to become the central bank where these data are stored as well as a data exploration tool available for use by contributors.

Directions to sites, maps, summary statistics of count data, site photos, and other information are expected to be part of HawkCount.org reporting capabilities. Accordingly, the contribution of hawkwatchers to raptor monitoring continues to grow as new sites join the RPI project.

Why is this important? Because other North American bird monitoring schemes such as the Breeding Bird Survey (BBS) and the Christmas Bird Count (CBC) do not have the ability to monitor raptor populations adequately. Raptors are elusive, they live in low densities, and they are difficult to detect from BBS routes; or they winter outside the CBC coverage area. Perhaps Red-tailed Hawks and American Kestrels can be properly sampled along BBS routes, since they occupy disturbed habitats and do not avoid roads or human settlements the way Broad-winged Hawks and Mississippi Kites do, but most raptor species are poorly detected in these surveys.

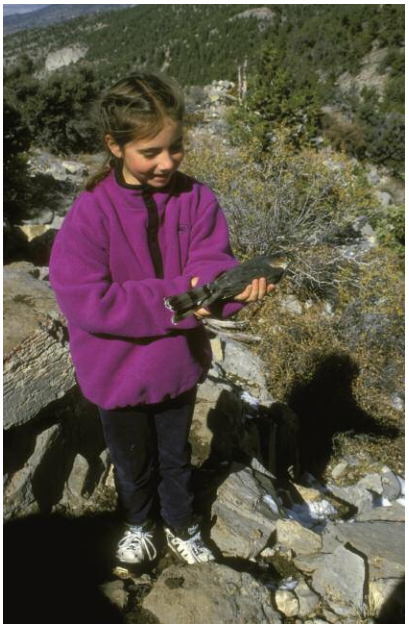
Low densities of raptors are another challenge. Even if detected regularly, the sample sizes collected do not allow for well-supported statements about their demographics. Migration seems an ideal opportunity to attempt the feat. These migrants are diurnal, conspicuous, and relatively easy to track as they aggregate along landscape features such as mountain ridges and shorelines. Thus, hawkwatching affords a magical opportunity, combining the enjoyment of the aesthetic beauty of raptors with the possibility of contributing to the knowledge of raptor migration ecology and the status of raptor habitats continent-wide.

There are still some challenges to reaching the RPI project vision. Most hawkwatches remain clustered in the Northeast. The high density of hawkwatches in Pennsylvania, New Jersey, Massachusetts, and New York is a result of the high density of hawkwatchers and the relative ease of access to these sites. The density of data points contrasts abruptly with the relative paucity of sites in the Midwestern states of Missouri, Illinois, and Iowa, to name a few.

At several hawkwatches, large numbers of visitors get to look at wild hawks close up and listen to lectures by famous raptor experts. *Cape May, New Jersey; September 1994.* © *Jerry Liguori.*

HawkWatch International (HWI), a non-profit organization based in Salt Lake City and a partner in the RPI project, runs the only network of professionally staffed sites across several western states and around the Gulf coast. HWI's network covers portions of three major flyways in the West, as well as the Florida Keys and Texas Gulf Coast Region. The coverage, though, is thin compared to the East.

A view of the geography of raptor migration in



A volunteer admires an adult **Sharp-shinned Hawk.** *Goshute Mountains, Nevada; September 1999. © Jerry Liguori.*

North America resembles the veins of a circulatory system peppered with nodes along its route where hawkwatchers take its pulse. The farther north you go (especially in Canada), the thinner these veins become.

The veins also thicken in southern locations. What happens at those places outside southern Canada and the U.S. where multiple routes converge and small creeks turn into a torrent of migrants? The RPI project currently has only a few sites contributing data from outside Canada and the U.S., with just three sites in Mexico. These are regions where hawkwatching is in its infancy. The most abundant migrants recorded in these localities—Turkey Vultures, Broad-winged Hawks, Swainson's Hawks, and Mississippi Kites—migrate through in impressive quantities, with as many as several million recorded in one area over one field season.

Large proportions of the global population of these particular species fly through these sites, suggesting that perhaps monitoring only these major southern convergence points would be sufficient. Does the existence of such sites make the operation of other hawkwatches unnecessary? No. All sites, even those that contribute data on only a few species, that track a small volume of migrants, or that have an overlap in the populations covered in relation to other sites, contribute valuable information which supplements the large-scale picture.

In 1990, Hawk Mountain scientists published an article in the *Auk* that included an analysis of count data collected in the period 1934–1986. For each species, they plotted the number of birds recorded per 10 hours of observation against the year and obtained a series of points showing the ups and downs of populations over time. As might be expected, different species showed different trends. A species like the Osprey showed a series of points with an upward trend, a tendency that when fitted to a regression line demonstrates that the long-term population increases are statistically significant and not simply a random oscillation of count results through time.

In contrast, Peregrine Falcons showed steep declines in the years following World War II through the mid-1970s, after which their populations followed an upward trend that continues to this date. These trends can be understood within the context of stories familiar to all of us. Rachel Carson brought the problem of the excessive use of DDT (and other organochlorine pesticides and their secondary metabolites) to the attention of the public with her book *Silent Spring*, published in 1962. Migration counts had pointed to these negative trends already, but, augmented by the work of other researchers, these observations were consistent with the hypothesis that DDT had a role in thinning the eggshells of Peregrine Falcons and other raptors. This information led to the ban of DDT use in the U.S. in 1972. Since then, raptor species negatively affected during the DDT era have experienced a demographic rebound visible in more recent trend

Hawkwatchers take various measurements on this juvenile **Golden Eagle** and then release it. *Cape May, New Jersey; October 1995. © Jerry Liguori.*

Populations of many raptor species are thinly but very widely distributed. To understand what is happening with "our" **Broad-winged Hawks,** it is essential to extend monitoring to critical migratory corridors and wintering sites throughout Latin America.
Veracruz, Mexico; September 2002.
© Kevin T. Karlson.

analyses based on migration counts.

In a paper published by Steve Hoffman and Jeff Smith in *Condor* in 2003, a much more complex mosaic was presented, derived from six different locations operated by HawkWatch International along two different flyways in the Intermountain West and Rocky Mountain regions. The story is similar: different species showing different trends. But these stories are subjected to different interpretations. For example, Hoffman and Smith hypothesize that the positive trends found in Ospreys are a result of an increase in water reservoirs, that increases in Turkey Vultures have to do with the fact that this species is expanding its range northward, and that fluctuations found in Northern Goshawks are a consequence of their boreal irruptions.

In both scientific publications, data transformed into information helped to take the pulse of raptor migration, and in some cases, such as the Peregrine Falcon's, prompted action.

The RPI project has begun producing biennial assessments of population trends, the first one published in the spring of 2008. From that point forward, HawkCount.org, the online system of the RPI project, has been establishing itself as the main source of information for all of its target audiences: the general public, the scientific community, and wildlife management and conservation authorities.

Hawkwatching is an opportunity to learn about and enjoy raptor migration. But perhaps more importantly, it may be an opportunity through which a network of citizen-scientists can actively contribute to the generation of information critically needed to conserve our majestic and powerful raptors. After all, who said the joys of hawkwatching cannot be combined with the science of conservation?

The ABCs of the RPI Project

The Raptor Population Index (RPI) project is a collaboration of three leading raptor conservation organizations: Hawk Migration Association of North America <hmana.org>, Hawk Mountain Sanctuary <hawkmountain.org>, and HawkWatch International <hawkwatch.org>.

The goals of the project are (1) to produce statistically defensible indices of abundance of migratory raptors from as many sites as possible, (2) to provide frequently updated assessments of the status of each species, and (3) to make those results widely available to participating monitoring sites, the scientific community, conservation agencies, and the public.

Independent raptor monitoring sites submit data to a centralized information system (HawkCount.org). Data stored in these databases are being analyzed, using a recently developed statistical model, to make population trend estimates for as many species as possible.

What is the Status of Data Collection and Analysis?
Data collection is a huge task. It involves engaging independent sites to enter their hourly count data into HawkCount.org. At present, more than 180 sites contribute data through HawkCount.org. But this mechanism is fairly new, as data were submitted to HMANA on paper forms in the past. We have close to one million hours of observations from hundreds of sites in paper forms, so the transfer will take some time and a significant effort to complete.

Data have been transferred into electronic form for some of the sites (those with the longest time series) and have also been analyzed. This first comprehensive assessment of population trend analyses of 14 species from 22 sites across the continent is titled *The State of North America's Birds of Prey*.

What has been Learned from Data Analysis So Far?
Perhaps the most interesting findings are not the individual trends themselves but the complexity of a multi-site perspective. An analysis of data from the two famous localities for raptor migration monitoring—Hawk Mountain and Cape May—demonstrates that during the period 1976–2003 there were increases for Bald Eagle and Cooper's Hawk, decreases for Sharp-shinned Hawk and American Kestrel, and non-significant trends for Red-shouldered Hawk and Northern Harrier. When one zooms out to a larger picture that includes localities across the continent, American Kestrel declines appear widespread at hawkwatches, although more precipitous near the Atlantic coast, at western sites, and during the most recent decade. For species with more complex patterns of trends, multiple sites are key to understanding regional population dynamics over time. These trend estimates will be assembled and updated regularly, providing a larger picture of migrant raptor population trends across significant portions of the range for some species.

Like any other citizen-science project, the RPI project can deliver a wealth of information with direct applications to management and conservation. Two factors are essential to the continued success of the project: the participation of raptor monitoring sites, most of them operated by volunteer citizen-scientists, and (of course!) money. The project is currently funded through matching grants from the National Fish & Wildlife Foundation and the U.S. Fish & Wildlife Service's Neotropical Migratory Bird Conservation Act. For 2008, we must raise an additional $65,000 to cover the personnel to run the project, for the management of our information system, to cover data analysis, and to strengthen collaboration among and recruitment of more monitoring sites.

More information on the RPI project is available online <rpi-project.org>. Another good resource is *The State of North America's Birds of Prey*, edited by K. L. Bildstein, J. P. Smith, and E. Ruelas I., which was published in the spring of 2008 as volume 3 of the *Series in Ornithology* books, produced by the American Ornithologists' Union and the Nuttall Ornithological Club.