American Kestrel Northeast Region
4th Annual Nest Box Program Report – 2021

Northeast region includes New England & Mid-Atlantic states: DE, CT, MA, ME, MD, NH, NJ, NY, PA, VA, VT

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NYC photos by Francois Portmann https://www.fotoportmann.com/series/nggallery/series/American-Kestrels-NYC-

Details about the banded New York City female in the above photo are on page 4

Never doubt that a small group of thoughtful, committed, citizens can change the world.
Indeed, it is the only thing that ever has.

Margaret Mead

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Top 10 American kestrel nest box program states in northeast region

Data is from kestrel nest box program managers in 10 northeast states from Virginia to Maine. The total 2021 banding-age nestling count of **4,083** includes two new contributors not included in the 2020 count. **Counts limited to those received from contributors in both 2020 and 2021 are:**

2020 banding-age nestling count: **3,252** 2021 banding-age nestling count: **4,065** one-year % increase: **25%**

1. **Pennsylvania: 1,764** (up 25% from 1,336 in 2020)
   41 by Emily H. Thomas and Don Watts in northwest PA (down 18 from 2020)
   377 by PA Game Commission, Southeast Region, led by Lauren Ferreri & Dan Mummert (up 151 from 2020)
   186 by Paul Karner and Jere Schade in Northampton County (down 10 from 2020)
   485 by Central PA Conservancy, led by Steve Eisenhauer (up 168 from 2020)
   53 by Shaver's Creek Environmental Center near State College, led by Jon Kauffman (up 24 from 2020)
   35 by Jim Moffett in Chester & Berks Counties (up 9 from 2020)
   108 by Hawk Mt. Sanctuary in Berks County, led by JF Therrien (up 20 from 2020)
   70 by Hershey Area Raptor Partnership, led by McKelvie, Holzman & Becker (down 1 from 2020)
   256 by Devich Farbotnik in Bucks County (up 3 from 2020)
   58 by Jere Schade and Steve Benningfield in Bucks County (up 21 from 2020)
   95 by PA Game Commission, Northcentral Region, led by Mario Giazzon (up 61 from incomplete 2020 count, missed 7 boxes in 2021 that were likely successful)
2. **Virginia: 840** (up 21% from 2020)
   283 by Lance & Jill Morrow in Shenandoah Valley (equal to the 283 in 2020)
   395 by Alan Williams (up 176 from 2020)
   162 by Highland County Kestrel Project, led by Patti Reum (a conservative count estimate)
3. **New Jersey: 360** (up 2% from 2020)
   46 by Friends of Hopewell Valley Open Space (up 11 from 2020)
   8 by Raritan Headwaters and Morris County Parks (equal to 8 in 2020)
   94 by Natural Lands in southern NJ, led by Steve Eisenhauer (down 14 from 2020)
   168 by NJDEP/ENSP and Duke Farms in central and northern NJ, led by Bill Pitts (up 22 from 2020)
   44 by John Smallwood in Sussex and Warren Counties (down 11 from 2020)
4. **Connecticut: 336** (up 2% from 2020)
   164 Northeast CT Kestrel Project, led by Tom Sayers (up 4 from 2020)
   167 Northwest and Northcentral CT Project, by Art Gingert and Mike Dudek (up 7 from 2020)
   5 by Larry Fischer (down 4 from 2020)
5. **New York: 288** (down 13% from 2020)
   248 by Mark Manske in northern NY (down 45 from 2020)
   22 in western NY (up 4 from 2020)
   18 NY National Wildlife Refuges submitted by Carl Zenger (new entry for 2021)
6. **New Hampshire: 200** (up 102% from 2020)
   9 by Mark Manske (up 7 from 2020)
   191 by Steve Wheeler (up 94 from 2020)
7. **Vermont: 103** (down 30% from 2020)
   103 by Brian Lowe (down 45 from 2020)
8. **Massachusetts: 75** (down 9% from 2020)
   27 by Joey Mason (up 6 from 2020)
   6 by Mike Maurer (down 3 from 2020)
   42 by Kestrel Land Trust (down 10 from 2020)
   No number from Andrew Vitz in central MA this year
9. **Maine: 46** (down 39% from 2020)
   37 by St. Albans Kestrel Nest Box Project by Marek Plater (down 27 from 2020)
   9 by Logan Parker (down 3 from 2020, but count is incomplete)
10. **Delaware: 24** (up 85% from 2020)
    24 by Jacque Williamson and Jordon Brown with Brandywine Zoo (up 11 from 2020)

New York City kestrel update for 2021: data primarily from Chris Soucy and Rita McMahon
The Raptor Trust (Bird Rehabilitation Center): located in northern NJ but receives kestrels mostly from NYC. Received **40** HY (nestling/juvenile) kestrels from NYC were released and **7** more died (5 adults received). Count includes Jersey City and Hoboken City, NJ kestrels since both cities are just across the river from NYC.

Introduction

The audience for this annual report includes:

- Kestrel landlords: all landowners and land managers where nest boxes are located
- Researchers and enthusiasts trying to understand, and hopefully reverse, the population decline kestrels have been experiencing in the northeast region – and elsewhere – over the past 50+ years
- Nest box program managers, volunteers and anyone else interested in learning more about this charismatic species

With this broad audience in mind the report is a mix of charts, photos, text, tips, technical information and hopefully enlightening and inspiring stories. Over 100 references are at the report's end: nearly all have weblinks accessible by simultaneously pressing Ctrl+Click if the report is being read on a digital device. Similar weblinks are included in the report text.

Feedback from readers is always appreciated. Pulling together this annual report is a fascinating educational experience. The northeast region kestrel recovery effort is a shared mission, even if most of us have never met in person. Especially appreciated are those farm and other landowners who have embraced the program. Kestrel nest box managers are essentially helpless without suitable land on which to locate nest boxes.

Readers of prior annual reports will notice some repetition in this year's report. This limited repetition is by design: information is updated or simply supports new information for people who haven't read or remembered everything in past reports.

Notes from the field

Input worth sharing comes in from kestrel nest box program managers, professionals and enthusiasts. The following notes reflect some of this input.

D55: Cover photo story

The female kestrel – about to be engaged by a male in spring, 2020 – with a federal silver aluminum band on its right leg and a blue band on its left leg has an interesting history, as described by Jeff Kolodzinski, Senior Wildlife Biologist at the Port Authority of NY & NJ:

This bird was captured at Teterboro Airport in New Jersey just west of New York City on 9/9/19 and relocated to High Bridge Hills Golf Club in High Bridge, NJ. This was done in an effort to reduce bird strikes with aircraft at the airport. Unfortunately, kestrels are one of the most frequently struck birds at most of the area airports. We are trying to understand how they move throughout the region and respond to being captured and relocated so that we can minimize bird strikes without negatively impacting the birds as much as possible. We have a partnership with United Airlines and Audubon International to relocate some of our raptors to local golf courses that are part of a Cooperative Sanctuary Program which aim to enhance and provide habitat for birds and other species of wildlife (more on this at: https://auduboninternational.org/raptor-relocation-network/).

This particular bird returned to the airport on 10/28/19 and was recaptured and relocated to Clinton Wildlife Management Area in Clinton, NJ. At the time, we also fitted this bird with a nanotag that allows us to track her movements through the Motus Network (more on this at: https://motus.org/). Unfortunately, we've yet to receive any data back on this bird (data from our other birds is publicly available here if you create a free login: https://motus.org/data/tracksSelect?e=2013-01-01&l=2020-12-31&s=3570). There are several possible reasons for this: The bird may not have flown near any receiving antennas, the data from the antennas has not been uploaded yet, or the nanotag has fallen off the bird. Since we are the first researchers to deploy nanotags on kestrels, we're wondering how effective our attachment method is. The nanotags are attached to one of the bird's central tail feathers with a resin and will fall off when the bird molts (which may start in early April). Below is a picture of the bird after we fitted her with a nanotag. Notice the pea-sized transmitter at the base of the tail and antenna extending beyond the tail feathers.

Below are a summary of observations and a map:

USGS Band	Date Encountered	Comments
1893-14555	*9/9/2019*	*Relocated to High Bridge Hills Golf Course in New Jersey, about 35 miles west of New York City*
1893-14555	*10/28/2019*	*Recaptured. Nanotag added and relocated to Clinton Wildlife Management Area (WMA), about 50 miles west of New York City*
1893-14555	*3/11/2020*	*Female Kestrel seen mating. May nest in Manhattan Borough in New York City. Has blue band that reads D55 and a silver band on the right leg. So far we can only make out 1893- on the silver band.*
1893-14555	*3/15/2020*	*The bird has been seen regularly in the Manhattan area for at least one week prior to reading the band number. The bird is currently mating with a male who has been in the area for at least six months. The pair has been observed entering a nearby nest cavity.*
1893-14555	*3/18/2020*	*Kestrel female with a USGS metal band #1893- on right leg and a blue band with white characters # D55 on left leg. Observed in New York City, NY on 3/18/2020. The bird is alive and free and was seen mating.*
	Spring, 2021	D55 was observed mating and successfully raising two broods of young in same Manhattan area where it nested in 2020.

The nanotag attached in October, 2019 apparently fell off not long after it was affixed since photographs in Manhattan in early 2020 show no evidence of it. However, D55 has been identified on numerous occasions in the 2020 and 2021 breeding seasons in Manhattan, raising young each year. Jean Shum and Loyan Beausoleil have been able to monitor D55 – primarily using rooftop viewpoints – during the nesting seasons, and report to Kolodzinski when D55 hasn't been seen in a while. In 2021, D55 fledged five young in a first clutch, and then three more in a second clutch, with one additional young recovered after falling from the nest and delivered to a bird rehabilitator. In the nonbreeding season multiple reports have come in to Kolodzinski noting D55 is at the Teterboro Airport (where it was originally captured) about six miles west of Manhattan.

48-year New Hampshire kestrel nest box program

In 1974 Steve Wheeler became interested in kestrels (then known as Sparrow Hawks) while in grad school, and started putting up boxes statewide, with banding beginning in 1976. By then he was employed as a Biologist with the New Hampshire Fish and Game Department, eventually becoming the Migratory Bird Biologist in the 1980s. He implemented and managed the state's Falconry Program, becoming a Master Falconer in the 1990s, while continuing to work with kestrels in his spare time and, since retirement, expanding his statewide efforts.

In the early days, like nearly everyone else, he attached boxes to utility poles – with permission – and any isolated field edge trees he could find, maintaining 40 to 50 boxes annually. This seemed to work well through the 1990s, when occupancy began to decrease, partly due – in his opinion – to actual population decline experienced throughout the Northeast and partly to an artifact experienced by many long-term projects. Initially there was a discernable upward trend of widespread box use in the late 1970s and 1980s, when almost any box placed in fair grassland habitat was accepted. Today, looking back at those areas, he wouldn't consider a box installation at many of those locations. Although into the early 2000s box occupancy was poor, productivity of successful nests remained reasonably good, generally around 3.5 young per successful box.

An important turning point for Wheeler was meeting Tom Sayers – an established Connecticut kestrel nest box manager – about five years ago at a Massachusetts Hawk Watch meeting. Wheeler had looked at various box post systems (either a dug hole or "flag pole" type) but decided that was not practical on a large scale (too many holes to dig and too many rocks in the "Granite State of New Hampshire). Sayers' telescopic pole system offered a good alternative.

Sayers also learned from Wheeler, who always shingled his roofs so boxes would remain dry inside and last for many years, even decades (Wheeler disagrees with the need for holes in box bottoms, asking: "Why not keep water out in the first place?"). So Sayers improved his roof system and Wheeler borrowed from Sayers' post system.

Wheeler used Sayer's sliding post concept but simplified it, using a 10', 4" x 4" post secured with three 5/16" by 4" construction lag screws affixed to a 6' steel post (stop-sign type) driven 2-3' in the ground. Post drivers for this purpose are available for about $40 (see: Amazon.com : MIXXIDEA 24 Inch Post Driver Fence Post Driver with Handle Steel Head Fence Post Driver Rammer Brown Hand Post Pounder : Tools & Home Improvement). Another Wheeler modification is using just one box u-bolt and one pole clip.

Wheeler uses a lightweight box with a swing-out front door and about a 12-degree slanting roof (exact angle not important). Boxes are constructed of premium ¾" x 10" wide white pine, which provides about 80 square inches of floor space, about the minimum he'd want to use since he's had boxes fledge as many as six kestrels. The roof board is screwed on top of the angle-edged back board and sides, with caulk seal for the joint. The back board does not extend beyond the roof, so no nailer is needed for the top edge.

For roofing Wheeler buys a 3' by 65' roll of roofing underlayment: Grip Rite Eave and Valley Protector. A 14"-wide strip is cut off, doubled over, and with 3/4" roofing nails, attached to the top and folded down over the back board edge, extending 3" down and nailed. This double thickness and extended flap over the back edge ensures no leakage.

Recently, Wheeler put up 11 boxes in a week. Several were on University of New Hampshire farm properties. It took about ten minutes for each installation. If relocation is needed, the three lag screws are removed; the box comes down and with a jeep off-road type jack and a short chain bolted to the post, it is quickly pulled out.

For new locations Wheeler has used contacts at the New Hampshire Audubon Society and, more importantly, Cornell's eBird sighting records for kestrels, paying particular attention to all reports from early April to mid-June. These sightings are overlaid on satellite imagery, invariably showing usage of grassland habitat or other suitable open areas. Basically, he's letting the birds select a potential site and then he considers other factors. The excellent eBird image detail often allows determination of a possible box site installation (not in actual cropland) prior to visiting the area and contacting the landowner.

For landowner contacts Wheeler uses the onX-Hunt app, which provides names, addresses, property lines and acreages. This information complements the eBird kestrel sighting reports. The eBird app also allows map layers to be saved to smartphones, a useful feature in remote areas with poor reception when talking with a landowner. As an interesting side note, Wheeler sometimes noted a tight cluster of eBird kestrel reports, over several years, at one location. On the ground follow-up, in several cases, revealed an existing breeding territory usually located in an old barn or some other structure. In 2021, he found a pair that apparently fledged two young from a floodplain silver maple tree cavity.

Once on-site Wheeler looks for a fence row, un-mowed back field edge, drainage ditch, or some location similarly away from normal field operations and also acceptable to the landowner. A second prerequisite is that the box location is within 200-300' of a nearby tree line. On their initial flight, fledglings must make it to the safety of the tree line.

Wheeler notes that in the extreme northeast region, both Brian Lowe in Vermont and Marek Plater in Maine have higher occupancy rates than he does. Their project areas seem more concentrated, whereas he tries to build territories on a statewide, landscape-scale basis in the best habitat he can find. He's divided the state into six regions, which allows more efficiently focused labor and travel from May through July.

As of November, 2021, Wheeler had 137 kestrel boxes up: mostly in New Hampshire but several in bordering Maine and Vermont. Another 15 were scheduled for installation in fall, 2021, before the ground freezes. He's anxious to see how his recent adjustments work out, and is beginning to see new box installations quickly occupied: 43% of the new boxes installed in 2020 had nest attempts in 2021. His count of nestlings banded rose from 97 in 2020 to 191 in 2021.

See the following site for a 2021 short newspaper article about Steve Wheeler's work: Steve Wheeler kestrels New Hampshire - Bing

Desperate Connecticut female

Larry Fischer reports an unusual occurrence at one of his nest boxes:

At a box that has historically been one of his most successful, a female was hanging around but a male never showed up. It was getting late in the season when another female showed up and started courting female number one. Female number two engaged in flight with wings held slightly below the horizontal, fluttering the tips. She did that quite a bit. Then she went to the ground, caught what appeared to be a deer mouse and tried presenting it to female number one who didn't want to have anything to do with the whole thing. Female number two with the mouse in her bill would fly up to female number one who would then fly to a new branch. Female number two would fly to the new perch and try to present the food again. The branch hopping and pursuit persisted for a while but female number one never accepted the mouse. Fischer checked the box a few weeks later and there were no eggs and no kestrels around.

NYC male kestrel: judging from the white head-top fluff this appears to be a just-fledged urban nestling learning to fly.

Nest box and mounting pole/post construction

Documentation of nest box installations (box design, mounting systems, predator control) is scanty in much published research about raptor and owl nest box programs, which complicates evaluation of data collected (Lambrechts et al 2010). Providing more detail – including photographs and/or diagrams – would be helpful in evaluating variables that could affect results.

The Art Gingert box design downloadable from a number of websites, e.g. [AMERICAN KESTREL NEST BOX PLAN & CONSTRUCTION NOTES - 2015 Master Copy.pdf (peregrinefund.org)], is side-opening, with a 93 square inch floor, and 3"W x 4"H entrance hole (allowing wood ducks to occasionally use it by turning their bodies sideways when entering and exiting). Mark Manske in New York and the Morrows in Virginia prefer top-opening boxes. Different designs have advantages and disadvantages, just like the mounting pole/post and predator control systems.

For perspective, a kestrel box construction story is told by Mark Manske in New York, who learned about kestrel nest box programs from the legendary and flamboyant Frances Hamerstrom, whose boxes were sometimes reported as not being in good condition (one was on old peach crate). Once, when Hamerstrom was away for a few weeks Manske replaced her old boxes with new ones, only to find – upon her return – her response to be that the old boxes had to be re-installed in their former locations (Manske 2021 personal communication). Personal preference is often a primary determiner of nest box and mounting system construction. The kestrel's preference is for a nest site that is dry, safe and close to food. A building roof eave, rusted-out metal building cornice, protected ledge, tree cavity and many varieties of built boxes – preferably containing some loose debris on which they can place their eggs – all can work. The question is which nest sites and boxes most consistently fledge healthy kestrels: not a simple question to answer.

Like many people, I enjoy building my own nest boxes, with designs that are continually evolving. One of my early nest box mentors was Bruce Colvin, who has managed a barn owl box program in southern NJ for over 40 years. All his boxes have aluminum-on-wood roofs with drip edges which, if the rest of the box is well-made, last for decades. Nearly all my kestrel boxes have similar roofs, although a few are white PVC or have "Peel and Seal" roll roof painted white (see: Peel & Seal Instant waterproof repairs 3-ft W x 33.5-ft L 100.5-sq ft Aluminum Roll Roofing in the Roll Roofing department at Lowes.com). Usually, roofs are the first part of boxes to fail, so extra effort on roof design can result in many more years of service. My latest kestrel boxes are octagonal in shape, flat or slightly-back-sloping drip-edged roofs, 80 square inch floors, 3" holes starting 1.5" below roof and 11" above a concave floor bottom, painted exterior, with all wood scavenged from construction dumpsters, waste pallets or old-deck boards (11/16" to 1" thickness). I won't claim this design is better than all others but do think the opening door closure on octagonal boxes is tighter and more reliable than with my 4-sided boxes. I like the look, find it functional and haven't yet had a wet box interior in the nesting season. Construction requires special tools and extra time but it's rewarding work and, for me, 8-sided walls and concave floors look more like a natural tree cavity.

Like nest boxes, mounting systems reflect personal choices and skill, along with local concerns (e.g., predators vary by site and region), funding and the desire to involve others, such as scout or school groups. When hanging a box on an existing building or utility pole, a suggestion is to first hammer a 4" galvanized nail in so at least 2" remains pointed upwards 45°. Instead of a backing board on the box use a 1" thick 1.5" wide spacer board cut at a 45° angle at the top and sticking 6" below the bottom of the box. If your box is front opening, for a utility-pole mount affix the spacer board to the right side of the box if you're right-handed, and on the left if you're left-handed (to make maintenance easier). Reverse this if the box is back opening. If your box is side opening a back-mounted spacer board usually works best . About an inch below the top of the backing board, drill a 5/8" hole at a 45° angle upwards through the board and box wall. Boxes can then be quickly and safely hung on the nail before using three 3.5" torx-head deck screws in the bottom of the spacer board to secure it to the building or wood pole. If boxes must be removed later, unscrewing the three torx-head screws at the bottom is all that's required before unhanging the box from the top nail. Torx-head screws are less likely to strip during installation/removal than Phillips head screws.

Spacer board on front-opening octagonal box left side.

This mounting system allows you to stay a couple feet below – and off the side of – the box during installation, removal and monitoring. Although top-opening boxes are easier to build and help avoid premature fledging when banding older nestlings, they require climbing up an additional two feet for monitoring/maintenance tasks. Side/back/front opening boxes – although safer and easier for monitoring/maintenance tasks – are more susceptible to water intrusion unless built carefully, and are more of a concern when removing and returning older nestlings for banding. To minimize this premature fledging concern, return older nestlings (after banding) by facing them inward on the entrance/exit hole of a closed box, allowing them to jump back into the box on their own. Blocking the hole with a sponge/rag/glove immediately after each bird is returned, and for a few minutes after the last bird is returned, is another safety measure. Art Gingert recommends attaching a long string to a sponge, so the hole can be unblocked once the ladder is removed and the nestlings have calmed down.

Eliminating back boards eliminates the crease between the roof and back that – even when well-sealed – can degrade with time and allow water to enter the box. With no back board, the roof can extend beyond all four sides of the boxes, reducing the chance of water intrusion. Use of spacer boards also allows roofs to be sloped in any direction away (to the sides or back) from the entrance hole, reducing the likelihood rain will be blown through the front hole, assuming the roof overhang is adequate. Back opening boxes then become an option, which some banders prefer when capturing adults with a net over the front hole. Back-sloping boxes should be gradual (e.g. 1" drop front to back) so wind is not funneled towards the entrance hole. Front overhang of 3-4" is enough to keep rainfall from holes starting 1.5" below the roof. A short drip edge is recommended just under the front overhang.

Many nest box programs rely entirely, or almost entirely, on utility pole mounts, with aluminum wraps for predator control used as needed. Utility poles are stable, with negligible rocking back and forth in windy conditions, and utility lines readily available for kestrel perching along road right-of-ways or fields. They're also no-cost, already existing, easily accessible when on roadways (although many are in fields or on private lanes) and may be more productive than most other post mounts (see page 11 chart). But the question whether to mount on utility poles is controversial, and often avoided in the research literature due to the complexities involved. Concerns include:

- It's rarely possible to secure formal approval from utility companies to install boxes on their poles.
- Safety and liability issues, particularly with leaning ladders against round poles that support electric lines
- Adjacent vehicle traffic causing kestrel fatalities, most often with fledglings (for poles along public roads)
- Strasser and Heath (2013) found almost ten times the number of failures in boxes around high traffic and development locations compared to boxes in low traffic and low development areas.

Most utility companies ignore the issue, but some will request removal or will remove boxes themselves. Paul Karner in eastern PA has addressed the approval problem by installing identification plates on all his boxes, with his name and phone number, so utility company staff will know who to call if a concern arises. Karner has been able to establish an informal understanding – not a formal approval – regarding his utility pole boxes.

Identification plate on exterior of all Paul Karner's utility pole nest boxes

Assuming my own steel-pipe mounted boxes – nearly all along interior fence lines – are more productive than utility-pole mounts, I compared the last four years of production data for my NJ and PA programs. So far, the initial assumption is wrong, with a significantly higher production coming from the utility-pole mounts. However, as always, the devil is in the details: of my 60 utility-pole mounted active boxes in 2021, 10 were located along low-traffic rural public roadways (within 20') and 50 were in privately-owned fields or along private access roads. Boxes along higher traffic roads will likely have higher failure rates (Strasser and Heath 2013).

2018-21 data – **8% more young/box produced from all occupied utility pole boxes than from steel pipe-mounted boxes**

		Utility pole			Steel pipe		
Year	state	#boxes	#young	#per box	#boxes	#young	# per box
2018	PA	1	5	5	11	43	3.9
	NJ	1	4	4	22	80	3.6
2019	PA	13	59	4.5	19	70	3.7
	NJ	3	5	1.7	18	65	3.6
2020	PA	36	153	4.2	44	159	3.7
	NJ	3	14	4.7	26	94	3.6
2021	PA	58	228	3.9	65	256	3.9
	NJ	2	10	3.3	27	84	3.1
Totals		116	469	4.0	232	851	3.7

As much as I've tried to avoid utility pole mounts, about 30% of my occupied nest boxes are on utility poles. I try to cycle out successful utility pole boxes in a subsequent season by installing a nearby steel-pole-mount (removing the utility pole box after the new box is up). 70% of my mounts are on 1-1/4" steel base pipes with 1" pipe inserts that end in floor flanges screwed to 2" thick, concave-interior box bottoms. If all components are purchased new, this system isn't cheap, but I was able to salvage or purchase used pipe for most of my steel mounts, and secure grant or donation funding for many more.

I have not installed predator guards on steel-pipe mounts but do install 24"-high aluminum sheet wrap on 4"x6"x10' wood post mounts used in field settings and on a number of utility pole mounts in PA where fox squirrels – not present in southern NJ – occupy boxes, even those 200' from woodland. Nearly all my steel-pipe mounts are along fence lines, clamped to a fence post if a stable one is available, but always with concrete poured at the steel-pipe base two feet below ground level. A 40-lb. concrete pour is enough to stabilize the box even when stable wood posts are unavailable.

Ladder safety

Whether a ladder is being leaned on a building, tree or pole, it must be level. Since many ground surfaces are uneven a shovel, hatchet or trowel may be needed to level both feet. For some this may be inconvenient, particularly with frozen or rocky ground. Both my ladders have levelers on their feet. The Werner style is self-leveling while the other style requires manual adjustment. I prefer the manual style, available from Xtenda-Leg, which is similar to the model in the below photo. The manual style is significantly lighter than the self-leveling Werner style.

When leaning a ladder against anything vertical, use the 4:1 OSHA safety guideline for where to place the feet. For example, a 12' high ladder would have its feet 3' from the building or pole base. If leaning against a tree or pole, use a safety strap as shown in the below photo. Use a cam-lock system that allows you to tighten it securely. High-quality straps like those from NRS (Northwest River Supply) are recommended. An additional safety measure is to foam wrap the top rung with a gap in the middle. Duct tape the foam to the rung (no one stands on this top rung anyway). This helps lock the ladder in place while climbing to install the strap. Ladders will twist on poles and trees, even if the feet are well planted. Trust me on this: I survived a tumble (unharmed) long ago but feel very lucky.

Mounting height

High-mounted boxes (15' or more) are likely to more consistently attract kestrels and to be more predator-resistant (Brauning 1983, Preston and Norris 1947), but the ease and safety of lower mounts is important to the long-term viability of a program (past my own working lifetime). Some people don't climb ladders and most prefer short ladders or want a second person available to help stabilize the ladder when in use. Due to these concerns, and since success with boxes mounted at 10 feet is well documented (Morrow & Morrow 2021), all my PA utility pole boxes will be lowered for the 2022 season to 10 feet. Some of my PA steel-pipe-mounted boxes that currently telescope up to 14 to 16 feet will be bolted at the 10-foot height, which is accessible with a 6- to 8-foot fiberglass stepladder (pick the ladder height best suited for your own height). Fiberglass ladders are safer when working along electrified livestock fence lines, and stepladders can be used in the folded-out position or folded-in against a stable pole, tree or building. Productivity will be monitored for the lowered boxes to see if this 10-foot (to the box bottom) height can work for all my PA and NJ boxes. Another advantage of lower heights is that shorter ladders (such as 6- to 7-foot stepladders) can be hauled around inside rather than on top of many passenger vehicles.

Sandy soils = few meadow voles = few breeding kestrels (except for the southeastern subspecies)

In 2013 Natural Lands – a regional conservation organization – started a kestrel nest box program in New Jersey's five southern counties. Post-mounted boxes were installed on private farmland grasslands: usually on or adjacent to grazing land. Box numbers grew to over 100 by 2018, with regular relocations, additions and removals – depending on kestrel use – but were reduced to 75 by 2021. From two known existing kestrel nests in this region in 2013 (one in a roadside tree-mounted nest box and another in a utility pole cavity) the program grew to 30 active (≥1 egg laid) nest boxes and 108 young produced in 2020, and 94 young produced in 2021. 23 of the 29 boxes active in 2021 were in the state's most agricultural western county, Salem, with four active boxes in adjacent Cumberland County and two active boxes at a closed landfill in north-adjacent Gloucester County. None of the 20 boxes installed between 2013 and 2018 in the outer coastal plain Cape May and Atlantic Counties were occupied by kestrels, and all were removed by 2021. An effort to attract nesting kestrels to the extensive complex of blueberry fields in Atlantic County, with 12 installed boxes at one time, proved fruitless.

The lack of breeding kestrel activity in this outer coastal area mirrors the historic and current Breeding Bird Survey (BBS) lack of activity documented by the Peregrine Fund in southeastern coastal plain areas (Peregrine Fund 2020a)._In Virginia, Sipe (2002) notes: "It is unclear what population trends have occurred within the Virginia Coastal Plain over recent years, but it is evident that a much greater number of birds are present in this area in the winter, with only 6.5% of total birds being observed during the breeding season". One suggested explanation for this relative lack of kestrel breeding activity on sandy soils in coastal plain areas is that these soils do not support meadow vole populations at levels beneficial to kestrel breeding. In North Carolina meadow voles are documented as locally common in the piedmont and mountain regions, uncommon to rare in the northern coastal plain and Outer Banks, and absent from the southern coastal plain (Lee et al. 1982, Webster et al. 1985). Vole-consuming kestrels in the breeding season are similarly almost absent in North Carolina's coastal plain region: *"*Transient and winter resident, declining; scarce and sporadic breeder" (Carolina Bird Club 2020).

New Jersey has mountain, piedmont and coastal plain regions similar to both North Carolina and Virginia, with the outer coastal plain's sandy soils in southern counties currently supporting no known kestrel nests while the more organic loamier soils in its inner coastal plain around Salem County and western Cumberland County support a healthy kestrel breeding population. The relative lack of livestock grazing land in New Jersey's outer coastal plain also likely suppresses kestrel breeding activity, although kestrels are common in migration, with some overwintering in this region.

In comparison, the smaller southeastern kestrel subspecies – *Falco s. paulus* – breeds well in sandy open pineland savannah habitat and coastal plain regions (Bohall-Wood and Collopy 1987), perhaps primarily because its diet focuses on lizards and invertebrates *(*Lane and Fischer 1997), which are common year-round in more southern regions. There is evidence that kestrels – like the majority of bird species – are able to see into the ultraviolet light spectrum, so the urine and feces trails of small rodents and other prey are visible to them (Viitala et al 1995, Rajchard 2009, Koivula et al 2016). However, more recent research indicates their UV vision may be much less than other species (Mitkus 2018). Regardless of the actual strength of their UV vision, there is no question that kestrel eyes have evolved to see prey cues undetectable to our human range of vision.

Female finds a NYC rodent (note the blue band indicates this is D55 who spends time at Teterboro Airport in New Jersey)

One way to set up a kestrel nest box program

There are many ways to build a kestrel nest box program, much like building an individual nest box. Creativity reigns supreme, along with tenacity and, of course, a desire to help a declining species. One system has been used for the 2013 Natural Lands southern NJ and 2018 Central PA Conservancy programs. The primary establishment tools continue to be Google Earth and onX Hunt map (onxmaps.com) programs, followed by US Postal Service mailings. Careful evaluation of habitats and subsequent discussions with landowners about historical and current land use can minimize selection of sink habitats that could attract breeding kestrels but don't provide adequate prey and acceptably-low disturbance levels throughout the nesting period: a concern noted by Touihri et al. (2019). Beyond identification of prospective locations for boxes, Google Earth serves as a data management system since boxes added or removed correspond with identifying pins placed on a map.

Prime kestrel habitat is grassland, but not all grassland is equal. Pastureland typically ranks highest, especially when not heavily grazed. Wet pasture areas and weedy ditches raise the habitat rank even higher. Hay fields are often associated with pasture as a source of winter-season food for livestock. Most hay fields, provided they are not cycled out on a regular schedule with row crops, rank just below pasture since the resultant habitat for prey (small rodents, grasshoppers, frogs, lizards, smaller birds) is also good habitat for kestrels, even though prey availability can be greatly reduced when hay crops are late in their growth cycle.

In less remote areas Google Earth street views provide closeup images valuable in choosing box locations, particularly since kestrels utilize roadside utility lines for perch hunting. Road right-of-way weedy margins and ditches are often prime hunting areas.

Typical Google Earth street view that allows a virtual drive around properties to explore habitat potential

Harper (2014) expresses a preference for Google Maps rather than Google Earth while planning kestrel nest box trails. He notes that the reason "Google Maps was chosen over Google Earth was that the satellite option and Google Street View on Google Maps was sufficient to fill our needs for imaging without having to download Earth. Also, we do not have the ability to share from Google Earth and have the map appear in Google Search results the way Google Maps does." Harper notes "the fact that Google Maps is free to the public weighed into the decision heavily. With software like ArcGIS ranging from $1,500 to over $10,000, these programs would not fit into our budget (as for most communities trying to start a nest box trail)." In the academic and business/nonprofit worlds ArcGIS is often the primary map tool, but it can be cumbersome to learn and use, and costly to purchase and maintain.

The historical map reference tab available with both Google Earth and Maps helps locate kestrel habitat. Referencing back five or ten years usually reveals how long land has been pastured, or if a hayfield is in a row crop rotation. Meadow voles, and other kestrel prey such as grasshoppers, can take years to become well established. Row crop rotation typically reduces small rodent and large insect populations.

The onX Hunt maps program helps hunters avoid restricted private property and provides landowner information that can lead to permission to hunt. The high quality of the aerial maps and available topographic overlay qualifies this program as a replacement or supplement to Google Earth or Maps. Nest box locations can be easily marked with symbols. Property ownership identification – not available with Google Earth or Maps – includes lot lines, acreage and addresses. The addresses are most important, since even in today's internet age US Postal Service letters can work well with farmers, and especially with Amish and Mennonite farmers, where some of the best kestrel habitat is in PA and other states. The response rate to mailed letters is improved by including on the outside of every mailed envelope a reference to the contents (e.g., re: free falcon nest box program to help control rodents). Whereas Google Earth and Maps are free, onX Hunt has an annual fee: about $100 for one state.

In southern NJ, maps created of connected farmland patches (Smallwood et al 2009) were a secondary guide in deciding where to locate nest boxes. The two southern NJ priority patch size areas identified in the Smallwood research are Salem County, where grazing land and hay fields are interspersed with row crop acreage, and the extensive blueberry farm acreage around Hammonton in Atlantic County. After seven years of installing, adding and relocating boxes, the Salem County area appears to still have potential for additional nest box installations whereas in sandier soils around Hammonton no kestrel nesting resulted.

Large southern NJ landfills show promise – and danger – for kestrels using nest boxes. In 2020 boxes installed at two landfills (one abandoned and another decades-old and little-used) were successful at both sites, with one landfill supporting two successful boxes in 2021. Many public solid waste landfills are eventually managed as grassland, with mowing done only frequently enough to prevent woody plant growth that might pierce protective clay cap layers. Small rodents and large insects are often abundant. The danger comes from flared methane burner pipes that kestrels may fly over or perch on and be singed or burned beyond recovery (Keeping Company with Kestrels 2013). Both of these landfill locations are being monitored for flare concerns, with corrective actions, such as box removals, to be taken if necessary. The landfill with two successful kestrel boxes is in the process of relocating their single flare to a lower elevation and enclosing it to prevent bird injuries. A third kestrel nest box will be added for the 2022 nesting season.

Internet searches are also helpful. Searching under horse, beef cattle, dairy or similar livestock and hay farm categories resulted in additional contacts. The positive response rate from email inquiries – between 20 and 30% -- has been similar to postal service mailings that may sit on a kitchen table for week or so (one Amish family noted a letter sat on their table for a year before they responded with a phone call; two successful kestrel boxes are now on their farm).

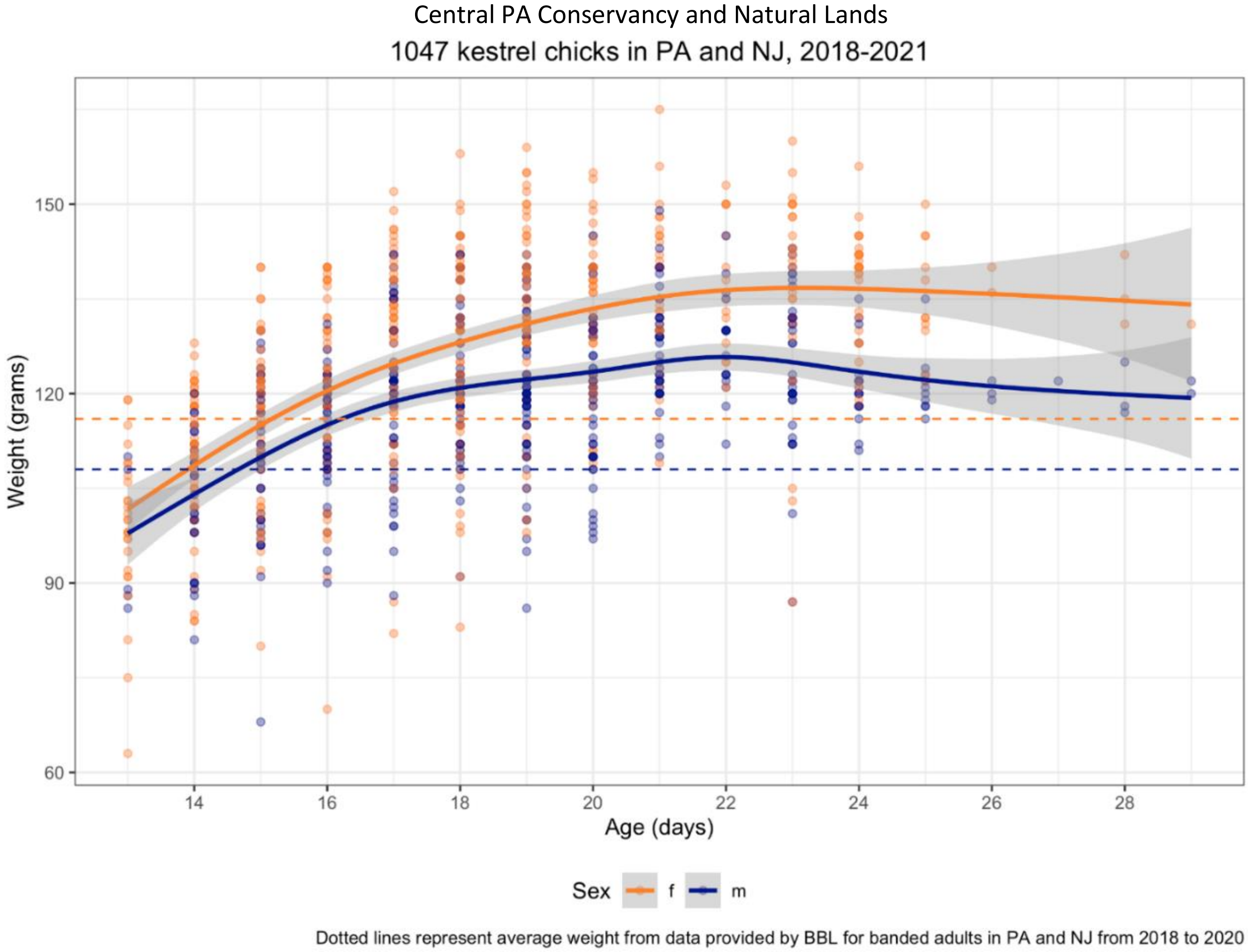
Door-to-door visits have been productive in setting up kestrel nest box programs but were avoided in setting up the southern NJ and central PA programs, although some nest boxes were installed when nearby landowners inquired about the program after seeing boxes installed or monitoring being done. "Word-of-mouth" references also resulted in new contacts. Once boxes are installed, some participants ask for a text message or email before each visit, but most allow unannounced visits, provided they know who the visitor is and/or can identify the vehicle on their property.

The key establishment tool with both programs has been use of letterhead paper and envelopes in mailings. Affiliation with regional organizations like Natural Lands, Penn State University's Shaver's Creek Environmental Center and the Central PA Conservancy undoubtedly improves the response rate.

How to measure success

Measuring success of a kestrel box, on an individual box and program basis, inevitably involves sink/source determinations: is the number of healthy young produced by each pair enough to maintain a population? Is a box or program an ecological trap – a sink – or a source that is expanding the population?

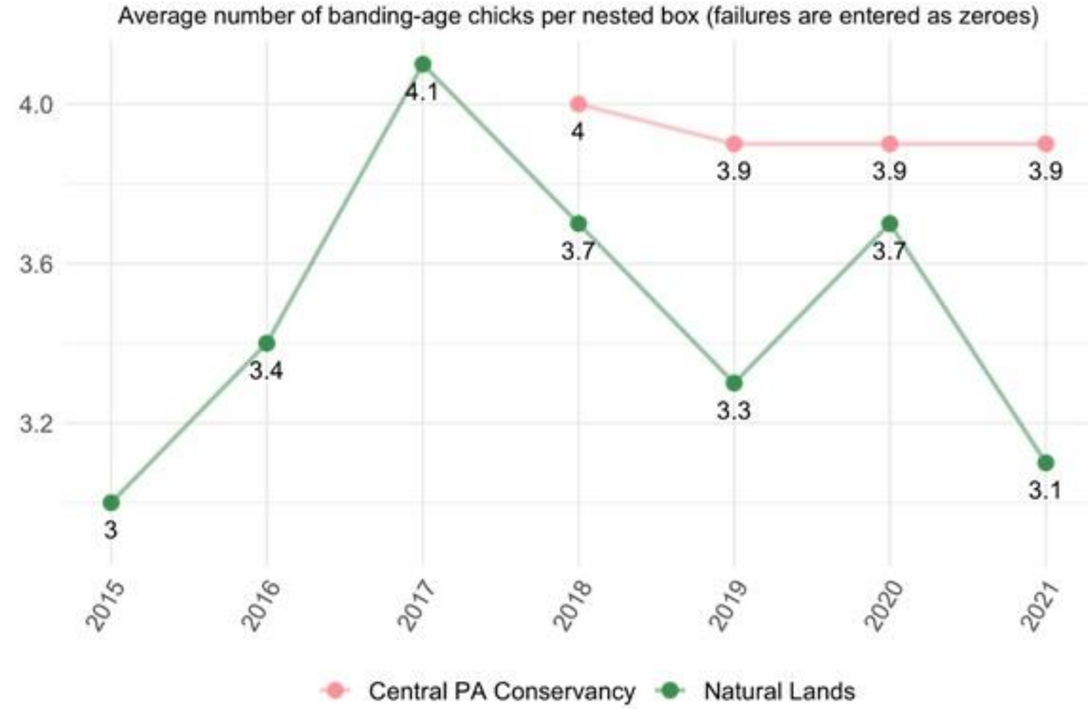
a. Nestling health



One component of the sink/source assessment is nestling health based on weight relative to age in days, and especially to sex (Maness and Anderson 2013). The reference used for calculating age within a day or two after 12 days of age is *A Photographic Timeline of Hawk Mountain Sanctuary's American Kestrel Nestlings* (Klucsarits & Rusbuldt 2007). Most nestlings in the two above-noted study areas reached adult weight at 15 days, and nearly all were above it at 22 days. Weights appear to plateau or even drop a bit in the last week before fledging at around 30 days, suggesting food is reduced by parents, caloric needs are higher for larger nestlings and/or other factors. Ricklefs (1968) notes barn swallows, swifts and several families of oceanic birds experience a similar nestling weight recession after exceeding adult weight, and attributes this weight loss to: "the high water content of embryonic tissues, especially feathers, and the loss of water due to the maturation of these tissues".

Recorded nestling weights can be combined with other productivity measures – particularly the young per occupied box measure noted below – in making decisions about box removals, relocations on the same property or – in the case of consistently high nestling weights and counts in a box – adding an additional nearby box. Boxes annually producing underweight young and low fledge numbers may be sinks pulling the population in a negative direction. Banders find underweight young – sometimes just the "runt" but sometimes more than one or the entire brood – which brings up the question: am I wasting bands or should I assume this bird or birds will gain enough weight to fledge and survive? The answer is rarely clear, but an understanding of average weights by age is helpful. Supplemental feeding, as time allows, may be considered for extreme circumstances.

b. Banding-age young per occupied box



Young per occupied box is particularly valuable in sink-source assessments. The definition of banding-age young has long been imprecise, with fledgling, nestling and chick the terms most often used in the literature. The distinction between nestling and fledgling can be misrepresented. In most nest box reports, fledgling rarely meets the dictionary definition of a nestling that flies from the nest, since it is essentially impossible to spend the time necessary to watch boxes long enough to capture this moment for all nestlings. Additionally, the minimum age of banding-age young ranges widely in the research literature. Katzner and Robertson (2005) note the recommended banding age as 10 to 23 days.

In most cases, this imprecise definition of a banding-age kestrel may not create a significant data error. Morrow & Morrow (2021) note that 98% of their 1,900 banded nestlings (12 to 25 days old) fledged over a 13-year period, with adjustments made for dead chicks found in boxes after all have fledged. Tuttle (2019) noted that of 67 eggs hatched, 98.5% fledged, and in 2017 of 75 hatched eggs 97.3% fledged. However, in some years and programs the fledge rate of banding-age young may be significantly below these high percentages. Mullican (2018) found that of 342 nestlings, 244 (71%) reached 80% of the fledgling age (24 days or older).

The young per occupied box measure (acknowledging the occasional imprecision of this term) is emphasized for my two programs in this report as a primary sink/source measure, along with total young per year. Assuming box failures are factored in as zeros, this is arguably the most accurate single productivity measure on an individual box basis and in a particular geographic area. Increased accuracy could be gained by checking boxes, and banding young, in the last week of the 30-day nestling period, but the costs probably outweigh any accuracy gains since premature fledging increases the likelihood of early death.

Where is the sink/source line drawn with any individual kestrel box? One suggested line is: a kestrel nest box averaging three chicks or more per year is a source, whereas one below two is a sink. The boundary line between two and three likely varies with geography and local conditions, such as the percentage of the population that is migratory and how far migrants travel. Jacobs (1995) suggests this line in Wisconsin may be closer to three per box:

> *To estimate the recruitment standard for kestrels, Henny (1972) calculated an annual mortality rate of 69% for yearlings and 47% for adults from band returns. He assumed that 82% of the yearlings and all the adults attempted to breed. Based on these assumptions, Henny believed with 73% of the nests successful, each*

breeding female must produce 3.92 young per successful nest for the population size to remain constant. Seventy-seven percent of the band recovery data used to determine the recruitment standard came from the northeastern United States, including Wisconsin. My average of 4.1 young per successful nest with 70% of the nests successful is similar to Henny's recruitment rate of 3.92. My results do not account for renesting attempts and are probably a conservative estimate of actual productivity for each breeding female. These long-term data suggest the kestrel population was stable on my study area.

The noted 70% nest box success rate and 4.1 young produced per successful box calculates to 2.8 young per occupied box.

c. Banding-age young per successful box

The young per successful box measure can help reveal whether problems are occurring in the egg or nestling stages, or if problems are with individual boxes or are more program-wide. A low "per successful box" rate might indicate late spring and summer season food shortages. A high "per successful box" rate and a low "per occupied box" rate suggests a need to remove or relocate failure-prone and low productivity boxes, or to identify and address concerns – such as predation – with those boxes. Concerns might be temporary or permanent, correctable or unavoidable:

- inexperienced first-year parents
- too much disturbance during nesting
- extreme weather conditions, such as excessive high or low temperatures, or too much rain
- loss of one or both parents
- food shortages (early or late in the nesting season)
- inadequate or starling-removed bedding substrate creating bare floor
- excessive water entering a box, often due to poor construction or design issues
- predation (snakes, raccoons, possums, crows, Cooper's hawks, starlings, etc.)
- nearby pesticide use, such as rodenticides or insecticides
- box sway or twisting in the wind causing egg addling or cracking

d. Percent occupancy

Percent occupancy of boxes is a useful population trend measure (Smallwood et al 2009a, Morrow & Morrow 2021, Shave & Lindell 2017), particularly when complementing productivity-per-box measures. However, the percent occupancy measure potentially creates an ecological trap (Demeyrier et al 2016, Gehlbach 1994, Ma¨nd et al. 2005) if boxes are kept in place even when there's low productivity per box due to predators, disappearing late-season prey base, habitat changes or other factors (Delibes et al. 2001, Battin 2004). Research with the Little Owl in Germany (Gotschalk et al 2011) found: "Our results suggested that the efficiency of this nest box program could be substantially increased if unoccupied nest boxes were relocated to sites where occupancy is more likely, and if unproductive nest boxes were relocated to locations that would enhance breeding success." The productivity sink/source line for the Little Owl in this research was calculated at 2.35 young per occupied box.

With percent occupancy as the primary research measure, highly productive individual boxes may not be properly evaluated as indicators of a location that could support additional boxes in the same apparently good habitat. In addition to lost opportunities for more kestrel nests, competition among kestrels for nest boxes in high quality habitat can potentially have negative results. On four occasions in our 4-year study period, clutches of 7 to 9 eggs were found, suggesting eggs were laid by different females. On one occasion, a headless female lying next to 5 eggs was in a box that soon had a live male and female alternatively incubating next to the carcass: 3 young fledged from this box. There may be other reasons for unusually large clutches but adding another box nearby – with 400 yards an appropriate minimum distance in good habitat – might help answer this question.

9 eggs in a box that likely came from two different females. 3 young fledged.

Male incubating eggs next to headless female. Another box, about 10 miles away, had a headless male in it four months before the nesting season: the body was removed and the box had a successful kestrel nest in the spring.

Female in box keeping young warm next to headless female which was removed after this visit.
Three young fledged.

Another concern with percent occupancy as a primary measure is how it not only discourages placement of additional boxes on highly-productive properties, but also on new properties within the study area. One barrier to box placement is securing landowner access, which can sometimes take years. Another barrier is the inability to initially identify all promising habitats in a study area. Flexibility in adding new nest boxes can result in higher productivity. A nest box program manager focused more on research than overall production may be reluctant to add new boxes – or remove boxes when habitat is degraded by land use changes – since additions and removals may skew research findings.

A state program that highlights benefits and concerns with percent-occupancy as a measure is active in Georgia, where the southeastern subspecies – *Falco s. paulus* – may be the more common breeder. Parrish et al (2019) notes:
Kestrels will regularly nest and roost in nest boxes and buildings as well as in hollow crossmember pipes on power poles where they often displace European starlings (Sturnus vulgaris). The kestrels are insulated from excessive heat by the nest material the starlings brought into the pipes, allowing them to incubate eggs and rear young in these metal structures. About 85% of Georgia's southeastern kestrel population depends on these powerline structures at present for nest sites. . . . Based on extensive work conducted by Georgia DNR it is believed two powerlines host about 450 breeding pairs.

As these power poles with hollow crossmembers are being replaced, experimental nest boxes are being installed in their place, but with varying degrees of success. It appears that numerous box options (heights, sizes, predator-proof designs) may have to be explored, with percent occupancy being less an indicator of population trend than of appropriate nest box design and mounting.

Breen and Parrish (1997) portrayed a different view of Georgia's coastal plain breeding kestrel population, with 402 nest boxes erected during 1994 and 1995: "Nest box occupancy averaged 3%, although occupancy was 15% at Fort Gordon military base." In comparison, Beasley (2007) detailed the hollow crossmember pipe nest occupancy as: "Of the 373 usable transmission towers, 284 (76%) were used by breeding kestrel pairs in 2005 and 2006." Percent occupancy is obviously a valuable indicator, but is it indicating population trend, nest box/cavity preference, a combination of the two or something else? Both of these described populations are located in Georgia's coastal plain that covers the state's southern half, but the wide disparities of percent occupancy suggest this measure might not accurately reflect the overall population health.

Percent occupancy and nest box spacing can be closely connected. The transmission towers on Georgia's powerline right-of-ways are often about 200 yards apart, yet much kestrel nest box literature suggests half-mile spacing between boxes. Nesting kestrels are territorial, but territories vary with habitat quality (based primarily on food supply) and line-of-sight visibility. Nagy (1963) erected 9 nest boxes on his 320-acre Pennsylvania farm and, in a favorable prey year, had 6 pairs of kestrels nesting as close as 37 yards apart. Manske (2011) reports similar close nest spacing: "Two pairs of kestrels were found to have nested in the same barn at the same time during the 2009 season. One pair used a cavity on the north side of the barn and hunted lands north of the barn and the other used a cavity on the south side of the barn and hunted lands south of the barn."

During the most recent 4-year study period with the southern NJ (SNJP) and Central PA Conservancy (CPAP) programs, close box spacings were increasingly tried on farms with highly-productive boxes. Relocations on farms and removals from inactive areas also occurred. Findings include:

- For two boxes spaced 70 yards apart (one on a utility pole; one on steel pipe) at a Nittany, PA farm, both boxes were successfully occupied in 2020, but the timing (eggs were laid in the second box more than a week after the young fledged from the first box) suggests the same pair or one in the pair or another pair may have double-brooded in the second box. The next year a female was observed at one box with one egg and then, in a check two weeks later, this first box was abandoned (the egg was gone) and the adjacent box had six eggs. This suggests the disturbance caused by the box check process (a camera put in the box, causing the female to exit) may have prompted her relocation to the adjacent box (with only one egg in the first box her investment was minimal).
- At a Lewistown, PA farm in 2018 one steel pole box was successful. A second box was added on a utility pole 440 yards away, the steel pole box was relocated to a nearby utility pole and in 2019 and 2020 both were successful. A third box was added 330 yards away on a steel pole along a fence line. In 2021 all three boxes were successful, producing 13 chicks in healthy weight ranges at banding age.
- At a Belleville, PA farm, after one box was successful in 2019, a second box was installed 300 yards away (separated by a farmhouse and barn). Both boxes were successful in 2020 and 2021, with high chick counts and weights.
- At a Petersburg, PA farm in 2020, two boxes on utility poles 900 yards apart were successful. Two boxes were added, reducing spacing to 450 yards: all four boxes were successful in 2021 with 14 young produced.
- At a Spring Mills, PA farm, three of four boxes installed more than 700 yards apart in 2019 were successfully occupied. In 2020, all four were successful, but a fifth box located 250 yards away was unoccupied. In 2021, all five boxes were successful, producing 21 young. Two more boxes have been added for the 2022 season.

Not all farms with apparently good habitat, particularly in the SNJP, had similar positive kestrel breeding responses to box additions. One large Woodstown, NJ farm that had 7 successful boxes with 30 young in 2018, had 4 successful boxes with 19 young in 2019 after more boxes were added. 2020 results included 5 successful boxes with 20 young, and for 2021, 4 boxes were successful with 14 young. All successful boxes on this farm are over 1,000 yards apart. Complicating this farm's apparently-declining kestrel nest history is that it is the largest contiguous pastureland in the center of Salem County, which hosted 13 other successful boxes in 2021. It seems likely this farm is a source of kestrels dispersing to breed in boxes installed on surrounding farms. Reports of more Coopers hawks in the area in the breeding season may also be a factor in the more dispersed concentration of kestrel nest boxes.

The percent occupancy rate of the CPAP boxes steadily increased from 35% (12 of 34) in 2018 to 76% (123 of 162) in 2021. The SNJP boxes saw a 40% (30 of 75) rate in 2021, but in the years since the beginning of the program in 2013 the rate has varied widely, never exceeding 40%. With SNJP boxes regularly being relocated – on the same farms and elsewhere – and additions/reductions frequently occurring, the accuracy of this measure before 2021 is low. More attention is now being paid to recording data related to this measure in both the SNJP and CPAP, as its value is recognized as an important puzzle piece to help understand kestrel nesting trends.

e. Monitoring/measuring effects

Measuring success often involves disturbance associated with monitoring and data acquisition. Attention is drawn to an individual nest box manager's focus: towards research or more on productivity and minimum disturbance. Researchers can convincingly argue that capturing, identifying and banding adults (preferably both males and females) in nest boxes produces the most valuable data, since more adults will live for at least another breeding season and be available for recapture, whereas most young will die before breeding. Also, if adults aren't recaptured, then one doesn't learn about surviving banded young from previous years.

Smallwood's (2016) research suggests capturing adults during nesting does not negatively impact nest box productivity. However, Varland and Laughin (1993) admit: "We accidentally broke one egg in each of four clutches of five eggs while handling the adult kestrels". Similarly, Craft and Craft (1986) recommend that "pre-hatch visits should be limited to prevent nest failures" but during the post-hatch nesting period they found no significant increase in failure rates with intensive disturbance. Comments on this topic can generate strong opinions, depending on one's focus. Disturbances during nesting – depending on the timing, frequency and duration – have the potential to cause abandonment, egg or nestling damage, feeding interruption and premature fledging.

As previously noted, premature fledging is a concern with any monitoring disturbance, but particularly with young 23 days or older being banded and measured. Sometimes they fly from the box upon approach before the hole can be blocked (a recommended procedure whenever older nestlings are suspected). Usually they are retrievable after they land nearby, but on occasion they fly too far away before crash-landing on a property where access is not possible. Kestrels, like most animals, have individual personalities and temperaments. Surprising behavior can be expected, like the feisty 21 day old that decides he/she just wants out of the box once a human face appears.

A researcher over 50 years ago set one disturbance standard. Francis Hamerstrom (1970) – an early proponent of Bal-Chatri traps for capturing adults away from the nest box – noted: "We used a ladder to check each box to avoid leaving a scent trail for predators. Although we often inspected our boxes from the road, we climbed to them only three times a year. In spring, we checked to see that the boxes were fit for use. In mid-June or early July we visited each box again to check on activity and to band young. In August, after the kestrels had fledged, we returned to clean the boxes and ready them for another season." Adults in nest boxes weren't banded in either the SNJP or the CPAP, but no conclusion is asserted that this policy positively affects productivity. Initial nesting season box checks in the two programs are in the first week of May. One of Hamerstrom's students, Mark Manske, has managed a successful kestrel nest box program in northern New York for decades, and does his first box checks "on or near June 24" (Manske 2011).

Fledge date records have guided most monitoring and data collection for both programs, with a focus on minimizing unnecessary disturbance. Assuming 30 days for incubation and another 30 days in the box before fledging, the age determination at banding allows a quick calculation for the fledge dates. Full clutch dates would be 60 days prior.

Mean fledge dates (n= # of boxes)

Year	SNJP	CPAP
2018	7-3 (n=20)	6-29 (n=12)
2019	6-24 (n=18)	6-20 (n=30)
2020	6-23 (n=23)	6-18 (n=75)
2021	6-27 (n=24)	6-20 (n=123)

Manske's first check date of June 24 would not work for our more southern boxes since most young would have fledged by then. But geographic latitude is not the only determining factor. Nestling in our CPAP boxes fledge an average of five days before the SNJP boxes, even though the climate is significantly colder and snowfall is greater in central PA than in southern NJ. Suggested explanations are a higher overwintering kestrel population, better habitat and more old barns and other farm structures for shelter in central PA. Overwintering resident kestrels tend to nest earliest. Local and regional factors clearly affect fledging and full clutch dates. Craig and Trost (1979) recorded mean annual kestrel fledge dates between July 9 and 24 in Idaho. Varland and Loughin (1993) recorded a mean fledge date of June 20 over five years in Iowa.

Our programs' first week of May box checks serve three purposes: removal of starling eggs if present (nesting material kept in place), replenishing bedding material in boxes where it has been removed by starlings, and documenting kestrel eggs or chicks. The mean full clutch date for SNJP boxes (4-27) was a week later than CPAP boxes (4-20) in 2021. The SNJP boxes had lower kestrel occupancy (40% compared to 76% for CPAP) and higher starling use. Kestrels frequently force starlings out of their nest boxes, sometimes laying eggs on top of or among starling eggs, but sometimes starlings move kestrels out, particularly when starling numbers are high in the vicinity. The CPAP's high occupancy and earliest fledge date of May 18 (of 123 successful boxes in 2021) suggest that a second week of May first check might be preferable, since it minimizes disturbance in the early egg laying, incubation and nest box selection stage. This later date will be considered in PA for the 2022 season, although the additional week would probably result in having to deal with more starling chicks rather than eggs in some boxes.

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Concluding thoughts

Response to criticism

Constructive criticism received from past reports includes:

- a summary abstract should be included at the top of the report
- too many stories are included ("anecdotal" stuff)
- more conclusions and analysis of data and findings would be helpful

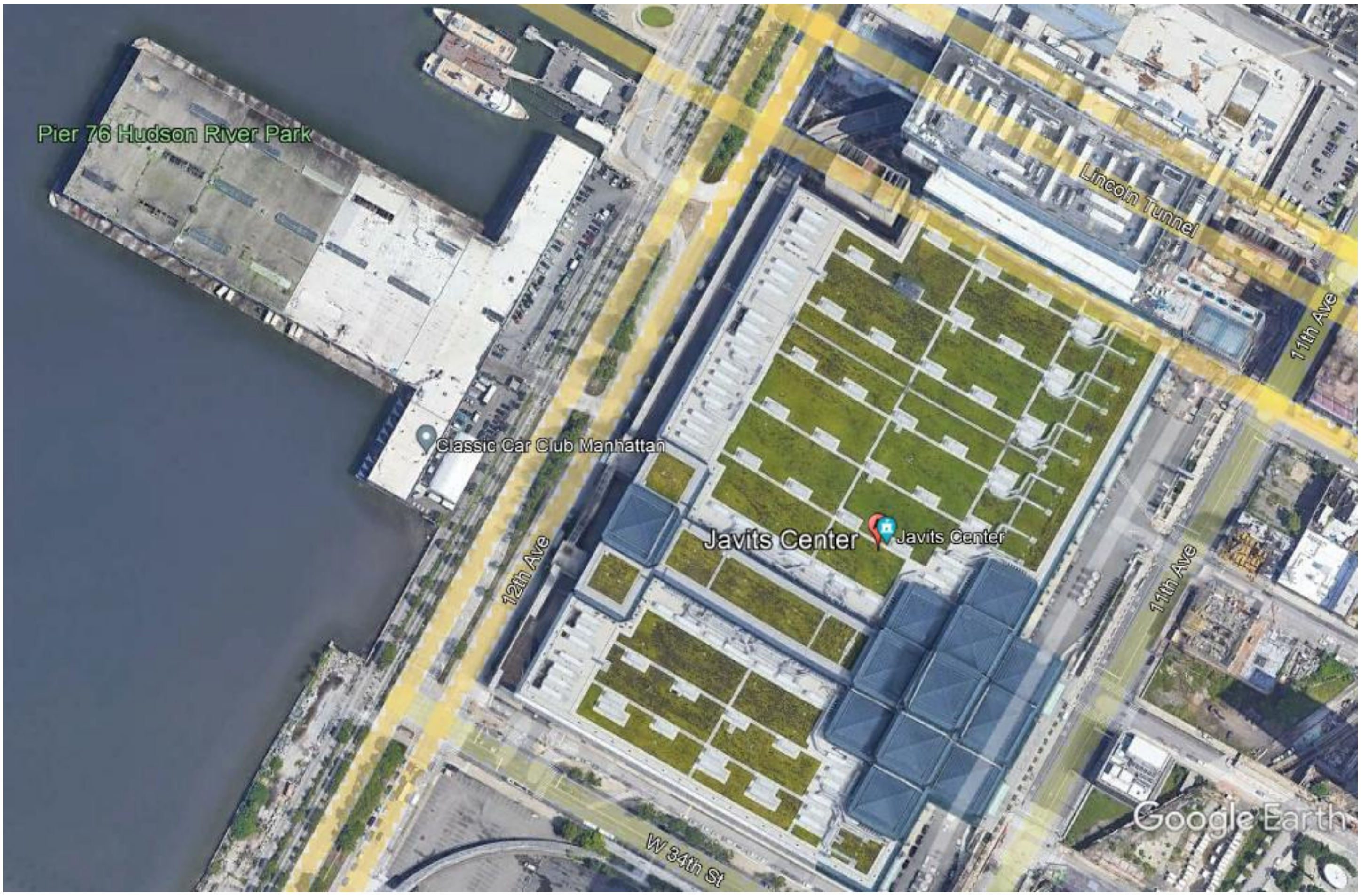
In a year (or two or three) these criticisms will hopefully be addressed, but not in the current annual report format, which is a long version hybrid of an informal newsletter and a formal research paper. Perhaps no example better explains this hybrid aspect than the kestrel vs. starling videos accessible in the below links. YouTube and other similar videos do not belong in formal research papers, but in the 2018 kestrel nest box program annual report a link to a video was included of a falconer using his kestrel to capture many starlings in a suburban neighborhood. That interesting video is no longer available online, but others have replaced it. Detailed analyses of the content in these videos are warranted but would be too lengthy for inclusion here. Filming kestrels hunting down starlings on suburban lawns stirs emotions and raises questions, but it sure is revealing for those of us wrestling with the invasive starling issue.

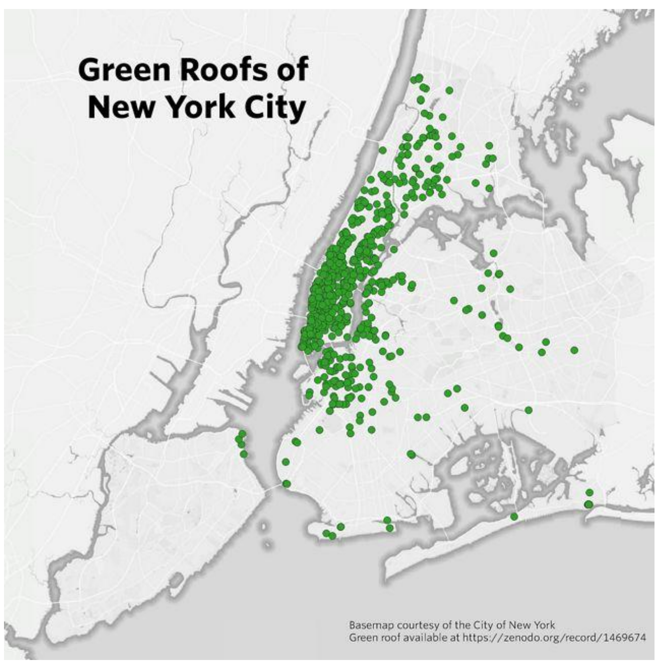
Kestrels seem to avoid catching starlings in non-falconer situations since starlings are two heavy to carry away. Kestrels typically carry off prey caught on the ground to a higher elevation location where they are more secure: less susceptible to larger raptor and other attacks. Occasionally, during my February/March kestrel box cleanout trips I'll find a box full of starling feathers or, on three occasions, a starling body with the brain removed (the tastiest part of the bird). But I never know for sure whether this is evidence of kestrels or of eastern screech owls, who often roost and occasionally nest in my kestrel boxes.

- Kestrel falconry - YouTube
- Falconry: Kestrel hunting starlings in the rain. - Bing video
- https://www.bing.com/videos/search?q=starlings+captured+by+kestrels+video&&view=detail&mid=44CC249ABE2E31EA0DF644CC249ABE2E31EA0DF6&&FORM=VRDGAR&ru=%2Fvideos%2Fsearch%3Fq%3Dstarlings%2520captured%2520by%2520kestrels%2520video%26%26FORM%3DVDVVXX
- Kestrel vs Starling - YouTube

New York City kestrel population's habitat expansion?

Kestrels are a rural non-woodland species, particularly in the nesting season. Occasionally they nest in urban areas, but only in limited numbers, except for New York City where a significant breeding population – estimated between 50 and 100 pairs – has been documented for over 100 years. One explanation for their early NYC urban presence is that they were attracted by all the horses, stables and rodents in the city before the automobile age, and have persisted since then, continuing to feed mostly on rodents and house sparrows, and nesting in whatever cavities they can find (often rusted-out building cornices). Most of the NYC kestrels appear to be breeding in or near Manhattan borough. The high percentage of flat roofing may be the main attraction. Of the roughly 40,000 acres of flat rooftop space in NYC, much is in Manhattan. The relatively recent increase in green vegetation on flat city roofs is impressive, with one building, the Javits Center, offering free tours of its 6.75-acre green roof "home to 27 species of birds, five bat species, thousands of honeybees and a sanctuary for area wildlife" (see: Take a Walk on the Largest Green Roof in New York City ~ at The Javits Center – GothamToGo).





The above map is both revealing and misleading. The concentration in the Manhattan area is clear but the size of the dots overstates the coverage. As described by Frazer (2019): "One important finding of the mapping project is the size of the opportunity. New York City is home to about 730 buildings with green roofs. It's a great start but represents just 60 acres of the 40,000 acres of rooftop space available (or less than 0.1% of NYC's one million buildings). So, there's room to grow, quite literally." [Green Roofs in New York City (nature.org)] The 3-acre green rounded roof of the Barclays

Center, primarily planted in sedum, a flowering succulent attractive to butterflies, is another example of NYC's green roof growth (see below Google Earth image).

Other cities are expanding their green roofs. In 2009, Toronto adopted a bylaw requiring 20-60% vegetation coverage on all new buildings or additions with gross floor areas greater than 2,000 square meters (Next Level Stormwater Management – City Leads Green Roof Movement (nlsm.ca)). These rooftop meadows attract insects, birds and other wildlife. The NYC kestrel population can only benefit from this elevated meadow expansion, particularly with all the hunting and feeding perches available on structures around them.

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