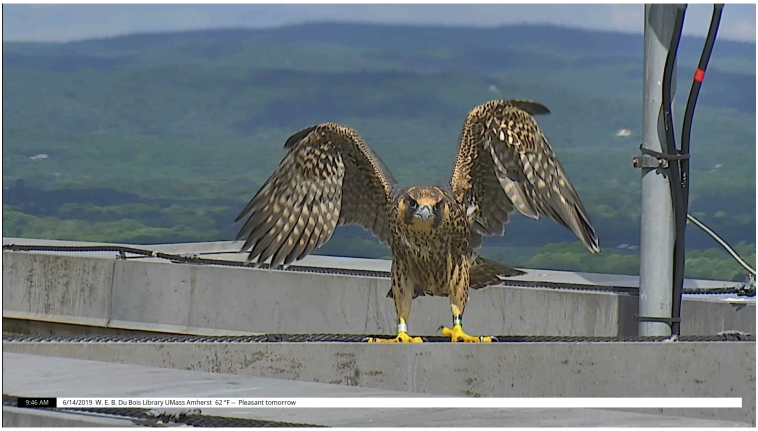
The UMass Amherst Libraries Falcon Curriculum: An Open, Common Core PreK-12 Curriculum on Peregrine Falcons



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Acknowledgements

First of all, this project would not be possible without the generous support of donors to the Library Sustainability Fund. Thank you!

The Falcon Curriculum began when three Massachusetts educators teaching kindergarten, first, and fifth grade, respectively, connected with the Du Bois Falcon team. They had started showing the falcon cam in their classrooms, and their students had many questions. Interacting with these students throughout the nesting season made the falcon team want to expand educational outreach opportunities to more classrooms, and the concept of developing an open-access falcon curriculum was unanimously (and enthusiastically) accepted.

With generous support from Nandita S. Mani, PhD, Dean of University Libraries at UMass Amherst, the project took flight. Margaret Krone, doctoral candidate, Sustainability Curriculum Fellow, and open-access and universal design advocate, was recruited to map the Common Core standards. Lauren Weiss, Associate Editor, Digital Content at the Libraries and Du Bois Falcon Team member, served as the project's researcher and lesson plan developer. Max Weiss, a popular creator for an online educational video company, developed, edited, animated, and produced the curriculum's video content. Chloe Deeley '18, artist, provided the majority of the illustrations. Erin Jerome, Open Access and Institutional Repository Librarian, Theresa Dooley, Open Education Librarian, and Therese Kaufman, UX & Web Services Librarian, provided support for Pressbooks and accessibility. Leslie Schaler, Communication Program Coordinator, designed the cover. Kim Fill, Assistant Director of Library Annual Giving and Donor Relations, works with the Library Sustainability Fund and its donors.

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- *The Greenfield Recorder*
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History of the Peregrine Falcons at University of Massachusetts Amherst

UNIVERSITY OF MASSACHUSETTS AMHERST LIBRARIES

Peregrine falcons have successfully nested on the roof of the W. E. B. Du Bois Library at UMass Amherst since 2003. The most well-known pair, which nested on the Library roof from 2003-2014, hatched a total of 37 chicks.

The Pioneer Valley has been active in falcon restoration efforts since the adverse effect of DDT, an agricultural pesticide, became public knowledge in the sixties; one of the first release sites was on Mt. Tom in Holyoke between 1976 and 1979, according to the Massachusetts Division of Wildlife and Fisheries. The peregrine falcon chicks were bred, raised, and released by The Peregrine Fund, a nonprofit organization created in 1970 dedicated to saving birds of prey from extinction. Peregrine falcons are one of the most widely distributed birds, living in every continent except Antarctica, but DDT in the United States decimated their numbers, leaving no nesting pairs east of the Mississippi River and creating a desperate need for restoration organizations.

With the strong conservation efforts in the Pioneer Valley, it's no wonder that by 1988, UMass Amherst had begun its own falcon program, setting up a hack site on the 13th floor of the Lincoln Campus Center. Inside were five chicks, flown in from The

Peregrine Fund headquarters in Boise, Idaho, to be raised and released that summer. Kate Doyle ’90, G’97 and Katherine Kripp ’90, G’97, then graduate students in Biology at UMass Amherst, were given the task of feeding and monitoring the chicks until they fledged. The women, wanting to avoid human contact with the birds, watched and recorded their activity through a spotting scope from a rise near the Campus Pond and secretly dropped food into their nesting box.

“The job was partly about outreach,” says Doyle. “People would see us with this huge scope in the heat of summer and ask us why we were out there. It allowed us to explain the project and teach them a little bit about peregrines and their endangered status.”

That July, the five falcon chicks took flight, eventually leaving the Campus Center never to return, and marking an 11-year falcon chick hiatus for UMass Amherst. In March of 1998, a nest box was installed on top of the W. E. B. Du Bois Library with an adult falcon observed going in and out of the box that same year. The next May, a nesting pair was seen flying frequently to the nest box with prey, signaling the potential return of falcons to campus.

And return they did, with a total of more than 50 chicks raised to date!

A live web camera was installed atop the Du Bois Library in 2012, allowing the public to watch the falcons raise their chicks, and a Twitter page was later set up for the social media “flock stars” @DuBoisFalcons. The webcam is made possible by the UMass Amherst Facilities Planning Division, UMass Amherst Information Technology (IT), the Libraries’ Systems and Web Management Department, the Massachusetts Division of Fisheries and Wildlife (MassWildlife), and the Friends of the Libraries, all of whom have helped in supporting, installing, and maintaining the camera.

Timeline

The official timeline of the UMass Amherst Falcon Program was created by Tom French, at the Massachusetts Division of Fisheries and Wildlife, who has assisted the UMass Amherst falcons since 1988 until his retirement in 2019.[1] French continues to collaborate with the falcon team, which has maintained the timeline since his retirement.[2]

- 1988 – Five chicks were hatched on the 13th floor of the Lincoln Campus Center.
- 1988 – Nest box installed March 27, 1988 on the 26th floor lower roof parapet wall of the 28-story W. E. B. Du Bois Library at UMass Amherst.
- 1991 – Two Peregrines seen on campus February 21nd.
- 1998 – One adult seen going in and out of nest box in spring.
- 1999 – Pair in and out of nest box with prey in May.
- 2000 – A pair present.
- 2001 – A pair present and eggshells were found in the box on May 3rd.
- 2002 – A pair present but abandoned the nest box early. They were frequently harassed by a territorial Red-tailed Hawk. Peregrines seen on January 25, 2002, and October 21, 2002, but it is unknown if they were the same pair.
- 2003 – One unbanded female fledged on July 15 and one unhatched egg was collected.
- 2004 – On June 5, two females and two males were banded.
- 2005 – On May 31, two females and one male were banded.

1. United States of America. Commonwealth of Massachusetts. Division of Wildlife and Fisheries. Peregrine Falcon. Natural Heritage and Endangered Species Program, Dec. 2007. Web
2. Bookmark © 2016 by Lauren Weiss is marked with CC BY 4.0

- 2006 – On June 5, one female and one male were banded. On June 20, the male was picked up on the ground and returned to the roof. The female fledged.
- 2007 – On May 30, two females and one male were banded. On September 1, one of the females was found deceased at the Providence, Rhode Island airport in Warwick.
- 2008 – On June 5, one female and two males were banded. On June 11th, one of the male chicks fell to the sidewalk and was returned to the nest.
- 2009 – On May 27, three females and one male were banded. A new nest box with a camera was installed in October. One of the females was found nesting on a smokestack at a power plant in Martin's Creek, Pennsylvania in 2012, raising four chicks.
- 2010 – On May 28, two females and one male were banded. The un-hatched egg seen on May 20 disappeared over the previous week. One of the females was picked up on July 28 on the ground near the Library with a broken corticoid and taken to Tufts. She was released in Grafton around October 2, 2010. The male was picked up injured in Virginia and was in rehab; his outcome is unknown.
- 2011 – On June 8, two females and two males were found in the box. Three flew away and one female hid in the box and was caught and banded by Ralph Taylor and Dave Fuller. Over the next several days, each bird ended up on the ground and was banded. A wing of the first Upland Sandpiper documented as prey by MA Peregrines was recovered on June 8, along with the wing of a Least Sandpiper. One of the males was found dead on September 8, 2011, in Cohasset.
- 2012 – On May 23, one female and three males were banded.
- 2013 – On May 5 one chick hatched, followed by two more on May 6th. An unhatched egg was still intact on May 10th,

but was gone by banding day. On May 29, one female and two males were banded.

- 2014 – Three chicks hatched on May 6, 7, and 10. The unhatched egg broke on May 14 and the youngest chick died on the same day. On May 30, two males were banded.
- 2015 – Current Female #1 – Banded in 2013 in Sorel, Quebec; two years old. Current Male #1 –Unbanded; estimated to be about two years old. A female chick hatched on June 2, and the male chick hatched on June 4. On June 9 and 10, both chicks were treated for a mite infestation, after MassWildlife and UMass Veterinarian Dr. Paul Spurlock called for intervention. (The mite was later identified as the Carnid Fly, Carnus hemapterus.) On June 29, officials from Mass Division of Fisheries and Wildlife banded both chicks. The female chick is Black 76/Green BS and the male chick is Black 01/Green BE.
- 2016 – In May 2016, the 14th generation of Peregrine Falcon eggs was laid; the second brood for the three-year-old falcon pair that took over the nest box following the departure (after the 2014 season) of the previous falcons that lived in the nest box for twelve consecutive years, the quick arrival of this new couple is a soaring testimony to how far the species has come since near extinction in the 1960s. Current Female #1 – Banded in 2013 in Sorel, Quebec; three years old. Current Male #1 – Unbanded: estimated to be about three years old. Of the four eggs that were laid, two were not viable. The first chick hatched on May 18 and perished a day later, having accidentally choked on a piece of food. The second chick, a male, hatched on May 21, thrived, and was banded by on June 13. His band number is 90 Black over BS Green. He fledged on the morning of June 30, 2016.
- 2017 – There were originally four eggs in the nest box for the 2017 season. Over the weekend of May 6-7, two of the

eggs were lost. One disappeared and the other was eaten by the female parent. We cannot be certain of the cause of the loss of the eggs. On Wednesday, May 10, two chicks pipped and hatched. On May 30, Tom French and David Paulson of MassWildlife banded the two chicks. The female chick is band number 08 Black over BV Green, and the male chick is band number 07 Black over BU Green. They both successfully fledged in mid June.

- 2018 – When the camera was installed on April 23, one egg was found in the nest. Because of the cold temperatures and wet weather in April, the single early egg was inviable. No more eggs appeared in 2018, though falcons were spotted around the library every month of the year.
- 2019 – The camera was installed on May 6 and found 2 newly-hatched chicks in the nest box. They were both banded on June 4 – male BU 69 and female BV 77 – and fledged successfully in mid-June.
- 2020 – The camera was installed on April 1. Although 3 eggs were laid, territorial disputes between 2 males disrupted the breeding season, and none of them were viable.
- 2021 – The camera was installed on March 25. Although 3 falcons were seen initially, it settled down and a new female, 72/BV, banded in 2019 in Brockton, MA, laid 4 eggs. All hatched and were banded on June 8. UMass Hockey named the male, 86/CB, Champ, in honor of their historic win. The 3 females were named by the public: 38/CD: Kizzy (recognizing the incredible work of Dr. Kizzmekia Corbett, who developed the Moderna vaccine); 39/CD: Nut (Egyptian sky goddess); and 40/CD: Uma (Thurman, who grew up in Amherst). Unfortunately, Kizzy was found dead near the Campus Center, likely the result of confusion due to window glare encountered during hunting.
- 2022 – The camera was installed on March 16. The previous male was found dead on the roof. A new male, 45/BU,

banded in 2019 on the Coolidge Bridge in Northampton, MA, arrived. Due to renovations on the Du Bois Library nest box, the falcons nested in the old nest box on Thompson Hall. 4 eggs were laid. All hatched and were banded on May 25. In honor of their incredible season, UMass Women's Basketball named the female, 58/CD, June. The 3 males were named by the public: 71/CB: Han Solo; 72/CB: Chewbacca; 73/CD: Dewey Duck (like Donald's nephew).

Core Principles of the Falcon Curriculum

MARGARET KRONE, LAUREN WEISS, AND SARAH HUTTON

The core guiding principles of developing the Falcon Curriculum Project were collaboration and sustainability.

The Sustainable Development Goals (SDG) Report asserts that "Leveraging the power of collaboration and partnerships" is an essential approach to address the challenges imposed on the world due to the Covid-19 pandemic. The pandemic has had catastrophic consequences in educational communities, wiping out 20 years of education gains and causing a 9% increase in the number of children in first through eighth grade not proficient at grade-level reading. [1]

This Falcon Curriculum will demonstrate how the collaboration of educational communities can create sustainable resources that are meaningful, engaging, and relevant that also align with established educational curriculum framework standards. We drew from the aforementioned SDG report and connected with K12 educators, the Du Bois Falcon Team, and wildlife experts and entities to explore how we could create an open, free curriculum to bring the falcons into the classroom.[1] The goal of this curriculum design is to give teachers flexibility and creativity in how they want to teach standard lessons in the Massachusetts Common Core but also remain focused on meeting the requirements.

In developing the curriculum, the first step was to meet with our collaborators and examine what sources of falcon data and

1. United Nations (2021). The Sustainable Development Goals Report. New York, NY: United Nations. https://unstats.un.org/sdgs/report/2021/

information we could use to create a diverse, multimodal open educational resource (OER) for all to use. Our collaborators, local elementary and early childhood teachers, shared that they were using the Du Bois falcon cam in their classrooms and following the season through the falcons' Twitter account. They expressed how much their students loved to observe and discuss the birds, especially how the chicks developed into fledglings. Throughout the nesting season, the teachers would reach out to the Twitter account with questions that their students had, and the falcon team would promptly answer them.

The teachers also spoke about how they were able to connect the falcon cam with ongoing lessons and curricula in the science and social science history areas of the Common Core. Building out these connections was the second step; we needed to ensure that the Falcon Project aligned with the current Massachusetts Common Core standards and systems already implemented in public schools. We reviewed all of the Common Core lesson standards for the disciplines of Science/ Engineering and Technology and History and Social Sciences for grades Pre-K to High School, selecting specific grade-level lesson standards to which the Falcon Project could apply. We identified four general areas in which the Common Core and the Falcon Project aligned best: geography, anatomy and life cycle, animal behavior, and conservation and policy.

To ensure sustainability beyond its open-access status, the falcon curriculum is built on the [Universal Design for Learning](https://www.cast.org/impact/universal-design-for-learning-udl) (UDL) guidelines, "which offer a set of concrete suggestions that can be applied to any discipline or domain to ensure that all learners can access and participate in meaningful, challenging learning opportunities." [2]. Some small examples of this

2. CAST. 2023. https://www.cast.org/impact/universal-design-for-learning-udl

include using multiple means of action and expression, engagement, and representation.

This Falcon Curriculum is a successful case study of creating an accessible, open-access curriculum that uses a unique and local resource, the peregrine falcons that nest on the W. E. B. Du Bois Library at the University of Massachusetts Amherst, to explain concepts in both the Science and Engineering/Technology and Social Science and History standards for PreK-12 as outlined by the Common Core[3]. The curriculum answers the call to participate in "open in action" and promote creative and engaging learning opportunities while also addressing the need for "exceptional measures…needed to get students back on track after a catastrophic year for education" [1].

We hope you find joy in learning from our curriculum and find ways and inspiration to make your own![4]

3. Massachusetts Department of Elementary and Secondary Education (2022). SCIENCE AND TECHNOLOGY / ENGINEERING Grades Pre-Kindergarten to 12 Massachusetts Curriculum Framework. https://www.doe.mass.edu/frameworks/current.html. CC BY-NC-ND 4.0
4. Krone, M. & Hutton, S. (April 2022). Open source teaching K-12 curriculums: A case study of using local wildlife data to teach science and history aligned with Common Core curriculum. [Reflective Practice Session]. OER22, London, UK. https://altc.alt.ac.uk/oer22/#gref

User Manual

LAUREN WEISS

About Falcons

The "About Falcons" chapter of this Pressbook contains a moderate overview of peregrine falcons for instructors and older students, and is referenced in the majority of the lessons. The information in this chapter was gathered from reputable sources, including the Massachusetts Division of Fisheries and Wildlife and The Peregrine Fund. If you would like further information regarding peregrine falcons, we encourage you to connect with your local Fisheries and Wildlife departments and raptor/bird organizations. Some may even be available for classroom visits.

Curriculum

Index

The curriculum section of this Pressbook begins with a categorical index listing all of the lessons by Common Core Standards, Falcon Curriculum Core Categories, description of lesson, and related activities. This is designed to make the lessons more easily searchable.

Common Core Lesson Labeling

The falcon curriculum lesson plans were designed to correlate to the Massachusetts Common Core Standards. Each lesson begins with a colored learning objectives box denoting the grade level theme at the top, followed by the disciplinary core idea, and then the standard(s). These standards are labeled using the NGSS system; if (MA) appears at the end of the standard label, it means that this standard was added by the state of Massachusetts and does not align with NGSS.

Relation to Falcon Curriculum

After the learning objectives box, you will find the applicable Falcon Curriculum Core Categories and Falcon Curriculum Essential Question relating the standard(s) to the falcon curriculum.

Materials

After the question, you will find a table containing a list of materials needed for the lesson by instructors and students, respectively.

Many of the materials listed (text, photos, videos, worksheets, etc.) are provided in this Pressbook in the “Resources” section and linked to in the Materials tables. Other materials used, such as the craft materials, were recycled or obtained at discount/ dollar stores for minimal cost.

Sample Lesson Plans

After the Materials table, you will find a sample lesson plan with discussion topics and activities.

Some activities are repeated in different grade levels because they align with more than one grade's standards, albeit with more advanced instruction for older students.

We encourage you to use the sample lesson plans as starting points for what would work best in your own classroom environments.

Resources

The "Resources" section contains a comprehensive list of the videos, images, activity sheets, glossary, etc. referenced throughout the Pressbook. All images found throughout the "About Falcons" section and the curriculum section are listed in the "Resources" section and link to their full resolution.

Feedback

We welcome your feedback as you use the Falcon Curriculum. Please use this form.

PART I

ABOUT FALCONS

1. Basic Information

LAUREN WEISS

The **peregrine** (PAIR-uh-grin) **falcon** is a fascinating bird.

Its scientific name is ***Falco peregrinus*** (FAL-co pair-uh-GREEN-us). "Falco" comes from the Latin word "falx," which means "sickle-shape," referring to the curved shape of the bird's wings in flight, its beak, and/or its talons. "Peregrinus" comes from the Latin word for "traveling" or "wandering," referring to the way many peregrine falcons migrate.

Peregrine falcons are part of groups of birds called **birds of prey** (birds that prey on other animals) and **raptors**. (No, not the cool dinosaurs from *Jurassic World!*) The newest proposed definition of raptors is "all species within orders that evolved from a raptorial landbird lineage and in which most species maintained their raptorial lifestyle as derived from their common ancestor."[1] In other words, raptors are birds that evolved

1. McClure, Christopher J. W.; Sarah E. Schulwitz; David L. Anderson; Bryce W. Robinson; Elizabeth K. Mojica; Jean-Francois Therrien; M.

from a common ancestor (a bird that lived on land and ate vertebrates, or animals with backbones), and many of that ancestor's descendants continue to have a raptorial lifestyle (meaning they also eat vertebrates). The word raptor comes from the Latin word "raptare," meaning "to seize and carry off," which is how these birds grasp and carry their prey using their feet.

There are five orders, or types, of raptors: **Accipitriformes** (axe-SIP-ih-trih-forms)**, Cariamiformes** (carry-AM-ih-formes)**, Cathartiformes** (cuh-THAR-tih-forms)**, Falconiformes** (fal-CON-ih-forms)**,** and **Strigiformes** (STRI-jih-forms). Accipitriformes are hawks, eagles, and Old World vultures. Cariamiformes are seriemas. Cathartiformes are New World vultures. Falconiformes are falcons. Strigiformes are owls. Accipitriformes, Cariamiformes, Cathartiformes, and Falconiformes are **diurnal**, which means that they are active during the day. Strigiformes are **nocturnal**, which means they are active during the night.

Peregrine falcons are Falconiformes. Their full classification is as follows:

Kingdom: Animalia
Phylum: Chordata
Class: Aves
Order: Falconiformes
Family: Falconidae
Genus: Falco
Species: Peregrinus

David Oleyar; Jeff Johnson. (2019). "Commentary: Defining Raptors and Birds of Prey." https://bioone.org/journals/journal-of-raptor-research/volume-53/issue-4/0892-1016-53.4.419/Commentary-Defining-Raptors-and-Birds-of-Prey/10.3356/0892-1016-53.4.419.full

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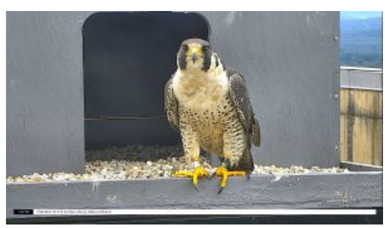
2. Appearance

LAUREN WEISS

Peregrine falcons are medium-sized falcons. They exhibit a trait called **sexual dimorphism**, which means that there is a difference in size or physical appearance between male and female falcons. With peregrine falcons, the difference between them is their size. Male falcons are approximately one-third smaller than female falcons. That is why they are sometimes called **tiercels**, which is an old word meaning "third."

Adult male falcon

Male falcons are approximately 15-18 inches long, slightly smaller than a crow, with a wingspan of 35-42 inches. Female falcons are approximately 18-20 inches long, slightly larger than a crow, with a wingspan of 42-48 inches.



Adult female falcon

Female falcons are larger than male falcons because their larger size offers them more protection. Also, it is easier for a small, fast male to provide for his family because small, fast prey is often more abundant than large, slow prey.

Adult peregrine falcons have bluish-gray to slate-gray backsides with a buffy white underside speckled with black. They have black crowns, or tops of their heads, and black **malar**

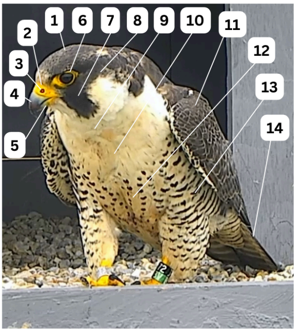
stripes down their face like sideburns. These “sideburns” act like the black stripes that athletes paint under their eyes to help reduce glare from the sun so they can see better.

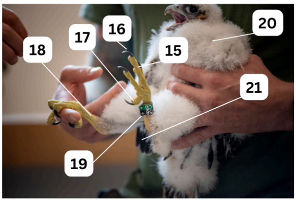
They also have a white throat and a dark bill with a prominent yellow fleshy base called a **cere**. The upper beak is called the **maxilla**, which is curved and hook-tipped. The lower beak is called the **lower mandible**, which is shorter than the maxilla; the hook tip goes right over it. The maxilla also has **tomial teeth**, which are sharp points that fit into corresponding notches on the lower mandible when the falcon closes its beak. These allow the falcons to have a very strong bite.

Falcons have yellow legs and feet, as well as sharp curved claws called **talons.** Falcons have 3 toes in front and one in back called a **hallux**. A falcon’s toes are long and help it strike and grab. It can curl its talons into “fists” to knock small prey out of the sky and then carry it back to the nest. Other birds of prey have short, stronger toes so they can hunt larger animals without breaking a foot.

Juvenile falcon

Immature, or juvenile, peregrine falcons are young falcons that have not gone through their first molt yet. **Molting** is when a bird loses its old feathers and grows new ones to replace them. Before they molt, immature falcons have brown backsides and heavily streaked, or speckled, undersides. This coloring allows immature falcons to pass through adult falcons’ territories without being considered a threat.





1. Crown
2. Cere
3. Nare
4. Maxilla (upper beak)
5. Lower mandible (lower beak)
6. Eye
7. Malar stripe ("sideburns")
8. Ear opening (underneath feathers)
9. Crop
10. Breast
11. Wing
12. Belly (with barring, a.k.a. the black spots/stripes)
13. Flank
14. Tail
15. Toe
16. Talon
17. Hallux
18. Tarsus
19. Bands
20. Down (white fluff)
21. Feathers (dark feathers growing in)

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- Peregrine Falcon Anatomy (1) © Lauren Weiss; Chick Photo Credit: Samm Smith is licensed under a CC BY (Attribution) license

3. Five Senses

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Sight

A peregrine falcon's vision is eight times better than that of humans. They can spot small prey from 2 miles away.

Falcons have three eyelids. The top and bottom eyelids are white. The third eyelid is a **nictitating membrane** (NICK-tih-tay-ting MEM-brane) that protects and moistens their eyes. It is translucent so they can still see when it's closed. This helps them especially when they are flying very fast.

Eyes in the front, they hunt.

Like other birds of prey, a falcon's eyes are towards the front of its head, so it has to turn its head to see behind it. However, the birds that they eat, like pigeons, have eyes on the sides of their heads, so they can focus on what they're doing and also keep a lookout for predators at the same time in case they need to flee. Tom Ricardi, a raptor rehabilitator who takes care of injured raptors, likes to teach a special saying he heard from a student to help remember that: "Eyes in the front, they hunt. Eyes on the side, they hide."

Hearing

Birds don't have external ear structures like humans and other mammals. Their ear openings are hidden under the feathers on either side of their head.

A falcon's hearing is good, but not as strong as its sight, because it relies primarily on its vision to hunt.

Falcons are silent while hunting, but make various sounds at other times. When bonding with their mate, they make special chirping noises. Females will also caw to the males to bring them food while they are nesting. Chicks will also caw to their parents for food once they hatch, and especially as they get older. Additionally, falcons will issue a warning caw to intruders to their territory.

Smell

Nares ("nostrils") on cere clearly visible.

Falcons don't have a prominent nose like humans or other animals, but they do have nostrils (also called nares) on their ceres. Interestingly, they also have special nasal glands from which they sneeze out a mist of sodium chloride (salt) to help regulate the sodium and chloride content in their bodies, since they can't get rid of it by urinating.[1]

A falcon's sense of smell is very basic, since they rely on their vision to hunt. This is unlike other raptors like vultures, who rely heavily on their sense of smell.

1. Cade, Tom. *Falcons of the World.*

Taste

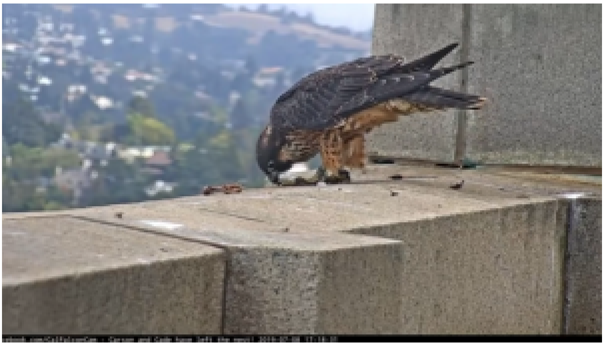
A falcon's sense of taste is also fairly basic. Falcons do not have as many taste buds as humans.

Touch

Falcons use their sense of touch quite a bit.

They use their **talons** to grip perches and prey, and even scratch an itch.

They use their beaks to **preen** their feathers, which means cleaning arranging, and oiling their feathers to keep them in good condition. They rub their beaks on an oil gland at the top base of their tail and rub the oil on their feathers.



They also rub their beaks against other surfaces to clean or wipe it and maintain beak shape. This is called **feaking**.

They also use their wings and spread them over prey to protect it from rivals, including siblings. This is called **mantling**.

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4. Habitat

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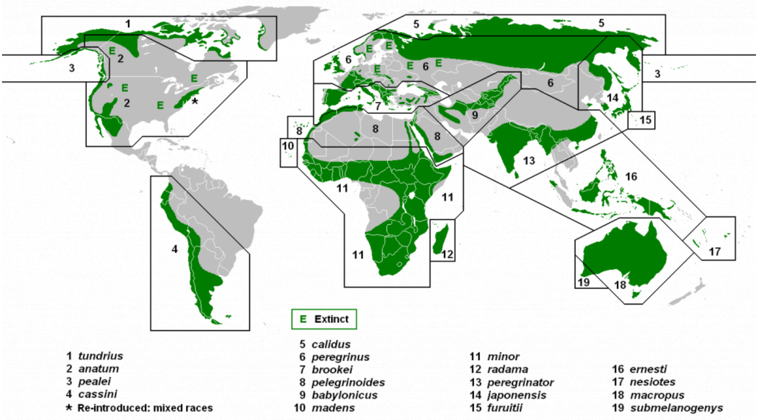
Location



Peregrine falcons are found on every continent except Antarctica.

Subspecies

There are 19 known subspecies of peregrine falcons:

1. Anatum
2. Babylonicus
3. Brookei
4. Calidus
5. Cassini
6. Ernesti
7. Furuitii

8. Japonensis
9. Macropus
10. Madens
11. Minor
12. Nesiotes
13. Pealei
14. Pelegrinoides
15. Peregrinator
16. Peregrinus
17. Radama
18. Submelanogenys
19. Tundrius

For more information on these subspecies, please see the “Peregrine Falcon Subspecies” section.

Nest

A peregrine falcon’s nest site is called an **eyrie** (EYE-ree).

A peregrine falcon’s nest is called a **scrape**. This is because in the wild, peregrines nest on cliff ledges. Unlike other raptors, they don’t bring any materials to build nests; instead, they find a cliff site with accumulated soil or gravel and scrape out a shallow depression in which to lay their eggs. They may also use unused raven or red-tailed hawk nests.

In urban areas, where there aren't any cliff ledges, peregrine falcons nest on tall man-made structures, such as tall buildings and bridges. Since there is no natural accumulation of soil or gravel on man-made structures that they can scrape out, they will sometimes lay eggs on unused Rock pigeon nests and accumulated droppings, or even on bare steel, although those nests often fail. In many places, wildlife experts put out nest boxes or trays with a few inches of pea gravel for urban falcons to use, which allows them to nest safely. Examples of nest boxes can be found on both the UMass Amherst Libraries and the UC Berkeley Campanile.

Territory

A peregrine falcon's **territory** is a large area around the nest site. It's like having a very large yard around a house. The size of a falcon's territory can vary, but has to have at least a 1.4 mile radius. The female peregrine falcon chooses the location of the nest site from several options in the territory shown to her by the male.

Falcons tend to nest in the same spot every year, but will occupy alternate nest sites within their territory during some years. For example, the falcons at UMass Amherst usually use the nest box on top of the W. E. B. Du Bois Library, but nested in an old, unused box on nearby Thompson Hall in 2022 while the Du Bois box was being renovated.

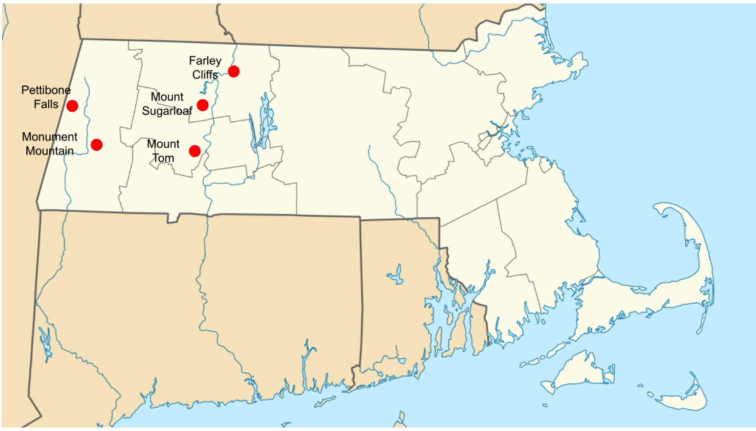
Falcons that don't have their own territories or mates are called **floaters**. They may be looking for breeding territories, and so they may stay in and around other falcons' territories until they are driven off by the breeding falcons. Now that the falcon population has made a comeback, there are many more falcons looking for territories, which means there are more altercations between a falcon pair defending their nest and floaters trying to take over the territories and win a mate. Most often, males will fight males and females will fight females.

Aside from floaters, peregrine falcons must also defend their nests and territories from predators. Gyrfalcons, eagles, and great horned owls are all predators of peregrine falcons.

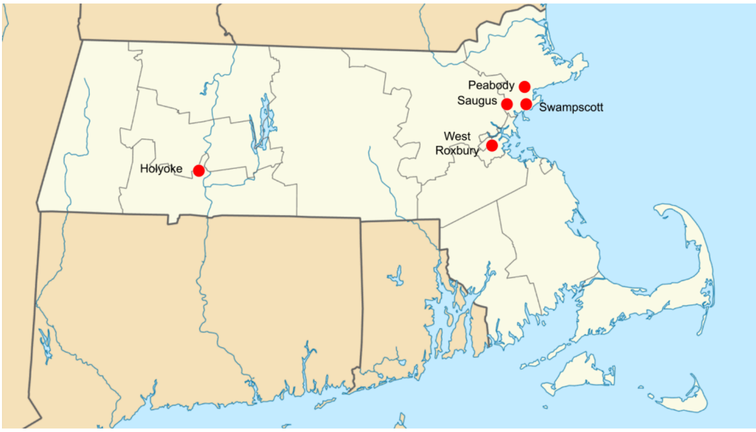
Migration

Many peregrine falcons **migrate** (seasonally move from one location to another), especially those that live farther north. Falcons that live farther north typically have the longest migrations, while those more south don't migrate as far. For example, peregrine falcons in high latitudes (Greenland, Labrador) migrate every winter as far south as South America. North American peregrines may or may not migrate; many urban peregrines do not need to migrate, since they have plentiful sources of prey year-round.

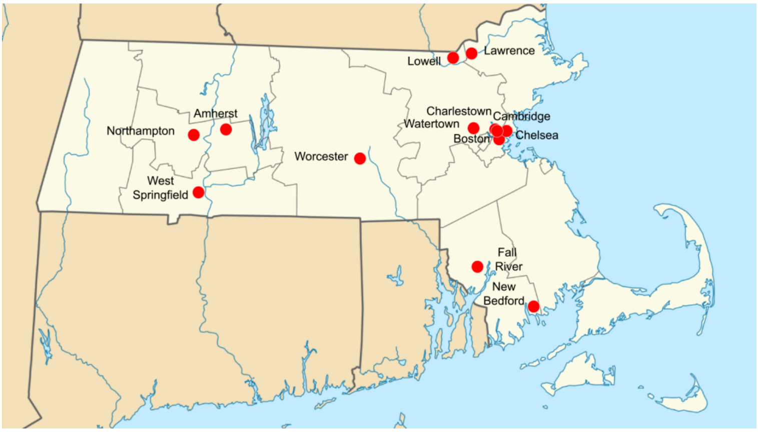
Local Information: Massachusetts



In Massachusetts, there are 14 cliff nest sites historically used by peregrine falcons. Of those 14, 5 are still in use: Mount Tom, Mount Sugarloaf, Farley Cliffs, Monument Mountain, and Pettibone Falls.



They have also been seen nesting on the cliffs of quarries in Holyoke, West Roxbury, Saugus, Peabody, and Swampscott.



In urban areas of Massachusetts, falcons nest on buildings in Boston, Chelsea, Cambridge, Watertown, Lawrence, Lowell, Worcester, Amherst, and New Bedford, as well as bridges in Charlestown, Fall River, West Springfield, and Northampton.

Most young falcons disperse to other areas of Massachusetts during their first fall/winter, particularly along the coast, where there are plenty of shorebirds. Others disperse around the other Northeastern states, where they will eventually nest. A very small number will migrate as far south as Florida, but return to the Northeast in spring and never migrate south again.

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5. Life Cycle

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Age

Peregrine falcons generally live about 10 years. One of the longest known living peregrines lived to be 17 years old. This was the second male who occupied the Customs House tower territory in downtown Boston, and he raised 50 chicks.

Peregrine falcons are considered adults after their first molt, usually around 13 months of age. Molting is when a bird loses its old feathers and grows new ones to replace them. For falcons, this happens during and after the breeding period in spring and summer.

Nesting

Most peregrines first **nest** (find a mate and territory and raise chicks) at 2-3 years old.

Mating

Peregrines mate for life but will find a new mate if their current one is replaced by a challenger or passes away.

Courtship Display: Head Bows

To attract a mate, falcons will perform a **courtship display**: a series of behaviors including head bows (they bow their heads low to each other), aerial displays, scraping of the ground, and beaking (playfully nipping at each other). These behaviors continue throughout nesting to strengthen the connection between the mates; this is called **pair bonding**.

Egg Laying

Before laying, females may become lethargic (very tired and sluggish) and spend a lot of time alone in the nest, scraping out the depression for the eggs. Females usually lay 3-5 eggs, called a clutch, in early spring. Eggs are pinkish to brownish in color and approximately 2 inches long, a little smaller than a chicken egg.

Incubation

Incubation means sitting on the eggs to keep them warm so they can develop and hatch. Peregrine falcon eggs have an incubation period of approximately 28 days.

Hard incubation (constant incubation) doesn't start until the second-to-last egg is laid, which ensures that all the chicks will develop and hatch around the same time.

The female peregrine falcon does most of the incubation. The male will also take turns incubating the eggs so the female can stretch her wings, but his primary job during incubation is hunting and providing food for the female.

During incubation, adult falcons will pull, push, roll, and rotate the eggs around underneath them so that they develop properly. The scientists at UC Berkeley who monitor the peregrines nesting on the Campanile call this **enfluffeling**.

To keep the eggs warm during incubation, falcons develop something called a **brood patch**. This is an area on their bellies that loses feathers after egg-laying and develops additional blood vessels close to the surface so that the patch is nice and warm in direct contact with the eggs.

Hatching

Pip in a Peregrine Falcon Egg

After the incubation period, the chicks are ready to hatch. A **pip** develops in the egg, which is the first hole in the egg made by the chick using its **egg tooth** (a temporary sharp tooth-like projection on the beak), allowing it to breathe outside air for the first time. It takes approximately 24-48 hours for a chick to hatch after pipping. During that time, the female falcon will chirp to the chicks in the eggs to encourage them to hatch.

Chicks

A peregrine falcon chick is also called an **eyas/eyass** (EYE-us) (plural: eyases/eyasses). When it hatches, a chick can also be referred to as a **hatchling** or **nestling**.

Newly-hatched peregrine falcons are very small and only weigh about 1.5 oz. They are covered in white down (fluff). According to the scientists at UC Berkeley, due to their small size, “there is relatively more surface area than in a large animal, resulting in more heat lost through the skin than is created by the body.” That is why adult peregrines will continue to incubate the chicks for about 10 days after they hatch until the chicks are large enough to generate more heat than they lose and control their own body temperatures, or **thermoregulate** themselves.

Peregrine falcon chicks develop incredibly quickly. From hatching at 1.5 oz, they double their weight in just 6 days, and increase tenfold in 3 weeks.

Like human babies, peregrine falcon chicks cannot walk right away. Instead, they scoot around on their **tarsi** (parts of their legs between backwards “knee” and ankle”; single: **tarsus**) until their legs are strong enough for them to stand up and walk.

When the chicks are 21-35 days old, feathers grow in and replace the white down. They grow brown juvenile feathers that will be replaced by the gray adult feathers after their first molt.


21-35 days is also when wildlife experts may band them before they grow too big and start to fly. **Banding** is when wildlife experts put specially colored, numbered and lettered metal bands around a chick's legs. These bands do not hurt the chicks; it's like wearing jewelry! The colors, numbers, and letters on the bands help the experts and other birdwatchers identify the chicks as they grow and eventually leave the nest.

Fledging

As they get older, the chicks start to explore the environment around their nest, often climbing around on top of objects. This is called **branching**. Although peregrine falcons don't nest in trees, and, therefore, branches, the term was coined by birdwatchers who observed other raptors that did, and just decided to apply it to this behavior done by all raptors.

Once their feathers come in, they also start doing a lot of flapping exercises (jokingly called "flappercize" or "wingercize") to strengthen their wing muscles so they can get ready to fly. They will start taking short hopping flights around the nest site.

When they are approximately 7 weeks old, the chicks reach adult size and **fledge** (fly). Once they do, they are called **fledglings**. To start off, they follow their parents around while flying. The parents begin giving them their food through mid-air prey exchanges and teach them to hunt.

Approximately 2 months later, the fledglings become independent of their parents and leave the nest.

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6. Prey and Hunting

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Peregrine falcons are the fastest animal on earth, reaching dive speeds of 240 miles per hour. (That's as fast as a car in the Indianapolis 500!)

Their incredible speed is how they hunt. They soar up high over territory and wait for prey to fly by below. With their excellent vision, they can spot prey from 2 miles away.

When prey is spotted, falcons beat their wings to gain speed and drop straight down in a controlled dive called a **stoop**.

The falcons make a "fist" with their talons and strike their prey hard enough to kill it. They then streak right past it and pull out of their dive to catch it and carry it back. If the strike was not enough to kill it, the falcons use the "tomial teeth" on their beaks.

The male falcon does the majority of the hunting during nesting season. He brings back prey for the incubating female, who will either consume it immediately or **cache** (store) it for later.

They may perform a **mid-air prey exchange**, where the female flies underneath the prey-carrying male, turns upside down, and grabs the prey from him with her talons. These exchanges happen very quickly, and only take about 1 second.

When the chicks are young, their parents will tear off small pieces of the prey and feed them. As the chicks get older, they will begin to grab the prey from the adults and take care of that themselves. Once the chicks get to be juveniles, they will literally chase their parents out of the nest box, screaming for them to bring them more prey. After they fledge, they continue to chase their parents, except now in flight, and the parents begin doing mid-air prey exchanges with them to teach them to catch prey and hunt for themselves.

Prey

Peregrine falcons mainly eat other birds. This helps regulate bird populations so the ecosystem is balanced. Over 2,000 species worldwide have been identified as prey for falcons. In general, they typically eat shorebirds, ducks, grebes, gulls, pigeons, and songbirds.

Pigeon Poop

Speaking of pigeons, let’s talk about pigeon poop! Birds cannot produce urine, or pee. Instead, they produce uric acid, which is a white paste-like substance that is made up of nitrogenous wastes. Since it doesn’t dissolve easily in water, it sticks to everything from buildings to car windshields. That’s a problem because uric acid is **corrosive**, which means the chemicals in it can damage cars’ paint jobs, causing them to rust quicker, as well as make bridges and other structures deteriorate faster. That’s why peregrine falcons tend to be welcomed (and even introduced) into urban settings! By controlling the pigeon population, they help keep the cities' structures from being damaged by the chemicals in pigeon poop.

(By the way, a scientific study done in England discovered that the colors of cars most likely to be pooped on by birds are red, blue, and black; green is the least likely.)

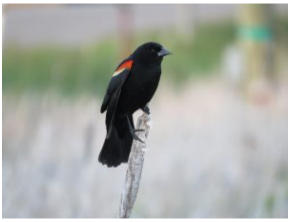
Local Information: Massachusetts

In Massachusetts, the most common types of prey for peregrine falcons are blue jays, European starlings, and rock doves (pigeons). Other common prey species include red-winged blackbirds, common grackles, American robins, mourning doves, common flickers, chimney swifts, house finches, cedar waxwings, woodcocks, and both black-billed and yellow-billed cuckoos.

Blue Jay

Starling

Rock Dove



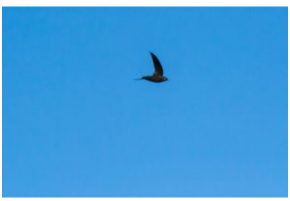
Red Winged Blackbird

Common Grackle

American Robin

Mourning Dove

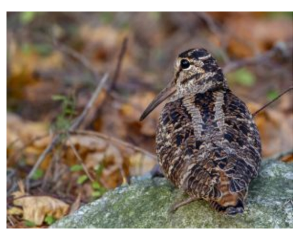
Common Flicker



Chimney Swift

House Finch

Cedar Waxwing



Woodcock

Blac k Bille d Cuck oo

Yello w Bille d Cuck oo

With regard to the above part about pigeons, in 2019, Massachusetts taxpayers were actually encouraged to support peregrine falcons on their tax forms to help the state combat pigeon poop!

Digestion

Peregrine falcon chicks start off by eating small meals frequently throughout the day. As they age, they will eat fewer meals per day, but the meals will be longer. Falcons also don't drink much, since they get almost all their water from their food.

When birds swallow food, it takes a pit stop at an organ called the **crop** before heading to the stomach. The crop aids in breaking down and storing food for digestion.

Falcons also don't have teeth; instead, they use **gastroliths**, more commonly called "gizzard stones." These are small pieces of gravel/rocks/sand that birds eat and store in their gizzard. Stones held within the gizzard break down the food the birds eat before it gets to the stomach.

Peregrine Falcon Chicks with Full Crops

When the parents are feeding young chicks, they make sure that they are only feeding them small pieces of meat. However, as they get older, they may also ingest materials like bones and feathers. That's why falcons **cast pellets**. Pellets are collections of indigestible material gathered in the stomach of birds that occasionally need to be disposed of. Once they are old enough, falcons will regurgitate them regularly every 1-2 days to keep their digestive tract clean.

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7. Other Behaviors

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Loafing

According to the scientists at UC Berkeley, **loafing** is "the scientific term for when a bird is displaying relaxed behaviors not specifically related to feeding, breeding, or predator evasion."

Panting

Falcons keep themselves cool the same way dogs do, by panting.

Sleeping

Peregrine falcons are **diurnal**, which means they are active during the day, unlike owls and other animals which are **nocturnal**, or active at night.

When birds sleep, they fluff out their feathers, turn their head around, tuck their beak into their back feathers, and pull one leg up to their belly. This is because they have down feathers, which are short, fluffy feathers underneath their sleek outer feathers that hold in heat to keep them warm. By tucking in their beak and legs, the birds keep those parts warm under the **down feathers**, even as it gets colder at night.

How can birds sleep while holding onto a perch? They don't fall off because when they put weight on their feet, their leg muscles make their feet tendons tighten and keep their feet locked in position.

Peregrine falcons also do something called **unihemispheric slow-wave sleep (USWS)**. This is where a bird sleeps with half of their brain alert and half of it asleep, so actually sleeping with one eye open. This is useful to birds because it lets them get the rest they need while also staying alert in case a predator approaches. As a matter of fact, there are some birds that even do USWS while they are migrating so they can sleep and fly at the same time!

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8. Flight

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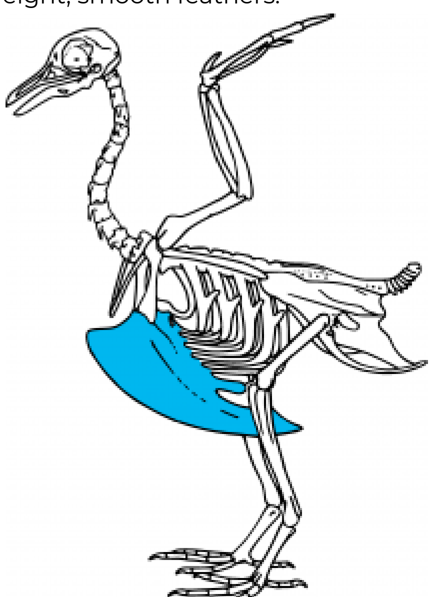
Peregrine falcons are the fastest animal on Earth. They can reach diving speeds of over 240 miles per hour. That's faster than a car in the Indianapolis 500! Their regular flying speed is usually between 40-60 miles per hour.

How Do Birds Fly?

There are several reasons many birds are able to fly. First, they have light, hollow bones filled with pockets of air. They also have a streamlined body and body shape, including light-weight, smooth feathers.



Of course, not all birds are able to fly, so what sets a falcon apart from an ostrich? It's all in the keel! A bird's wing muscles are attached to a **keel**, an extension of the sternum (breastbone) that acts like an anchor for those muscles. Flightless birds like ostriches don't have keels, so they lack the power required to get them off the ground.

Now, how do birds deal with gravity? **Gravity** is a force that pulls things towards each other. Earth's gravity pulls things towards Earth, which is why when you jump up, you come back down. Birds are able to counteract gravity with another force called **lift**. Lift is an upward force where air moves faster over the top of a bird's wing and slower under the bottom of the wing. This means that air pressure is lower over the top of the wing. Since air automatically goes to places with lower pressure (like when you deflate a balloon and the air comes out of it fast), the air moves from over the top of the wing to underneath it, which pushes the bird up.

Wing Shapes

There are 5 general types of bird wings: passive soaring wings, active soaring wings, elliptical wings, high-speed wings, and hovering wings.

Passive Soaring Wings

Passive soaring wings are wings with long primary feathers that spread out so hot air can get through and help the birds fly higher. Bald eagles have passive soaring wings.

Active Soaring Wings

Active soaring wings are long and narrow so birds can **soar**

(fly without flapping their wings) for a long time; these birds depend on wind currents more than birds with passive soaring wings. Seagulls have active soaring wings.

Elliptical Wings

Elliptical wings are rounded/oval-shaped. They are good for flying fast for short amounts of time, but can't keep up that high speed for too long. Elliptical wings also allow for fast take-offs and tight maneuvering. American robins have elliptical wings.

High-Speed Wings

High-speed wings are long, thin, and pointed (but not as long as active soaring wings). They allow a bird to fly very fast and keep up the high speed for a while. Peregrine falcons have high-speed wings.

Hovering Wings

Hovering wings are small and quick. The nerves and muscles of birds with hovering wings are specially adapted to move very fast, as well. Hummingbirds have hovering wings.

How Do Peregrine Falcons Fly So Fast?

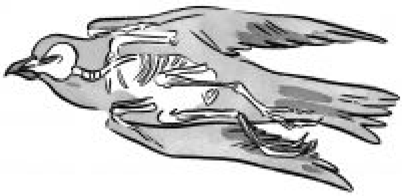
Keel

Peregrine falcons have very large keels. The larger the keel, the more muscles and flapping power a bird has, and the faster it is able to fly.

Wing Shape

Peregrine falcons have high-speed wings that are swept back and have slim, stiff feathers. This makes them more streamlined and more **aerodynamic**, which means they have less **drag** (a force that slows down the movement of an object when it passes through a liquid or a gas). It's like how bicyclists wear tight sports clothing made of special materials so they can go faster than they would if they were wearing loose, regular clothing.

Anatomy



Peregrine falcons have highly efficient respiratory and circulatory systems. They have a one-way air flow into their lungs with air sacs that keep their lungs inflated even when exhaling, which allows them to breathe when they reach very high speeds. They also have a strong heart. A peregrine falcon's heart beats between 600 and 900 times per minute. This allows it to keep the oxygen traveling through its body very quickly so it doesn't get tired as quickly. It also allows the falcon to flap its wings up to four times per second.

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9. Conservation

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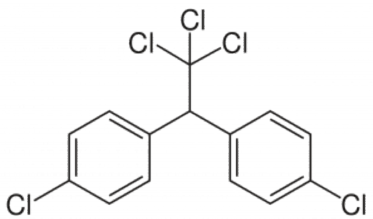
Conservation

Conservation is the act of protecting nature so it will be around in the future.

This is important when talking about peregrine falcons, since they were endangered for many years and were even **extirpated**, or wiped out, from eastern North America during the mid-1900s.

DDT

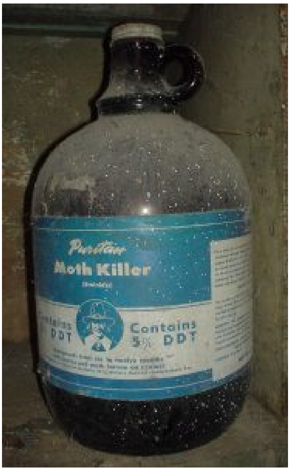


dichlorodiphenyltrichloroethane (DDT) Chemical Structure

The reason peregrine falcons became endangered was **DDT**. DDT, or dichlorodiphenyl-trichloroethane, is a **synthetic** chemical, which means that it was made in a lab.


Paul Hermann Müller

It was first synthesized in 1874 by Austrian chemist Othmar Zeidler, but it wasn't until 1939 that Swiss chemist, Paul Hermann Müller discovered DDT's use as an **insecticide**, a substance that could be used to kill insects. Since there were a lot of diseases people were getting from insects, such as malaria and typhus, this was an important discovery. DDT was used in the second half of WWII to limit spread of these insect-borne diseases among civilians and troops, and was made available to the public in the United States by October 1945, where it was promoted for use as agricultural and household pesticide. Müller actually won the Nobel Prize in Physiology or Medicine in 1948 for this seemingly very useful discovery.



Antique jug of Moth Killer containing 5% DDT

DDT ad from Penn Salt Chemicals in Time Magazine on June 30th, 1947.

DDT and the Environment

1955. Fort tri-motor spraying DDT. fir the Western spruce budworm control project. Powder River control unit, Oregon.

Although DDT did seem to help with controlling the insect population, it actually did a lot more harm than good. When DDT was sprayed on farmers' crops, marshes, and other areas to control insect infestation, small birds would eat the DDT-contaminated insects, and then larger birds would eat those smaller birds. As a result, the amount of DDT in each step of this food chain became more and more concentrated. This is called **biomagnification**.

Biomagnification of DDT affected peregrine falcons and their ability to lay eggs. Since DDT prevented the falcons from getting enough calcium, the shells of the eggs they laid were too thin and broke before hatching. This happened to many birds of prey, including eagles, condors, and ospreys, and caused their populations to decline rapidly. By the 1960s, peregrine falcons had completely disappeared from the eastern US and large areas of the western US.

Peregrine falcon eggshells

Opposition to DDT

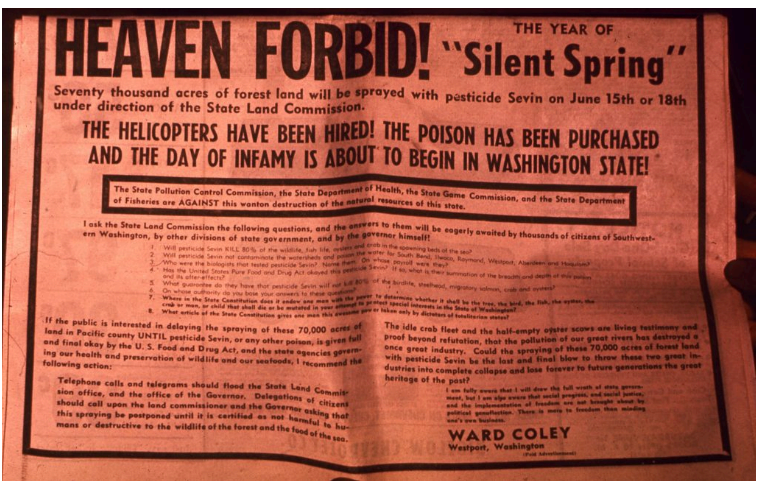

Rachel Carson

Rachel Carson was an American marine biologist, writer, and conservationist who realized the harm that DDT was doing to the environment. In 1962, she published *Silent Spring*: a book that documented the harm that synthetic pesticides like DDT did to the environment and humans. She did a lot of research for this book, speaking to farmers, scientists, and government workers, and concluded that pesticides must be used responsibly and as little as possible. She also accused the chemical industry of spreading disinformation and propaganda, and public officials of agreeing with it, so that people would not know that pesticides were harmful; that way, the public would continue to buy the companies' products.

Once the book was published, it brought this problem to the attention of the public in a widespread way that had not been done before. It received fierce opposition from the chemical industry, which threatened to sue Carson's publisher and tried to discredit Carson, making false statements about her not being qualified to speak about biochemistry and that she was a communist.

However, this strategy backfired on the chemical industry; it only drew more attention to Carson and her book. This led to a CBS television special on April 3, 1963 called The Silent Spring of Rachel Carson. This special, in turn, led to a congressional review of pesticides and the President's Science Advisory Committee to release publicly a pesticide report on May 15, 1963 for which Carson herself provided testimony.

Silent Spring was what really started the environmentalism movement of the 1960s. **Environmentalism** is support for the environment and laws and other actions that protect it. In 1967, the Environmental Defense Fund, a nonprofit nonpartisan (not belonging to any political party) environmental advocacy group, was formed. Then, in 1970, the Environmental Protection Agency (EPA) was created by the Nixon administration to develop official laws and policies to protect the environment.



Half-page ad in the Daily Olympian in 1963

Thanks to the efforts of groups like the Environmental Defense Fund and the Environmental Protection Agency, by 1972, the use of DDT was banned except in emergency cases.

Conservation of Peregrine Falcons

Bringing peregrine falcons back from near extinction in North America was a challenge.

Tom Cade

It all starts with a man named **Tom Cade**. Tom Cade was a falconer, field biologist, Cornell professor, and the founder of The Peregrine Fund.

Cade became interested in falconry at 9 years old after reading an article in the 1937 National Geographic magazine, "Adventures with Birds of Prey," by John and Frank Craighead. He decided to become a falconer, or someone who keeps, trains, and hunts with falcons.

Cade used techniques he learned from falconry to help restore the peregrine falcon population. One of these techniques is called **hacking**. The name for this technique comes from the old English word "hack," meaning "wagon." In Elizabethan times, falconers put these wagons on top of hills with falcon chicks who haven't fledged yet. They would leave food for the chicks and allow them to fledge and gain flying experience before they were recaptured and trained for falconry.

Cade took the concept of hacking and changed it a bit so that instead of recapturing the falcons, the falcons would just be allowed to go free once they fledged. This way, the chicks would be fed and protected with minimal human contact until they were able to fly off on their own.

Cade worked with SUNY New Paltz Professor Heinz Meng, who was the first person in North America to breed peregrine falcons successfully in captivity, to get the chicks he would put in the hack towers. This technique has saved many species since Cade developed it, including bald eagles.

Professor Heinz Meng

In 1970, Cade founded The Peregrine Fund at Cornell because people kept sending in checks to Cornell to help with the efforts to save the peregrines. The Peregrine Fund is now the world's most important raptor conservation organization.

In 1980, 3 pairs of Cade and Meng's captive-bred peregrines nested and produced 6 chicks in the wild. This was the first natural reproduction of peregrines east of Mississippi in over 20 years! Since then, the peregrine falcon population has increased 5-10% a year.

By 1999, the peregrine falcon's recovery was considered complete, and it was officially removed from the Endangered Species List.

Local Information: Massachusetts

The Pioneer Valley was part of those early peregrine falcon conservation efforts. As a matter of fact, chicks from The Peregrine

Fund were released on Mt. Tom between 1976-1979: one of the first release sites for these falcons.


14 The Recorder, Greenfield, Mass., Saturday, July 9, 1988

Recorder/Chuck Blake

Peregrine program

The 5-month-old peregrine falcon, above, is among the chicks from Idaho that will be lodged atop the Campus Center at the University of Massachusetts at Amherst. They will be kept there for about 10 days before being released as part of project to restore the birds to western Massachusetts. In right photo, surrogate mothers Katherine Becker of Deerfield, left, and Katherine Kripp of Shrewsbury pose with their baby during a media session Friday.

Peregrine Program – The Recorder, Saturday, July 9, 1988

In the 1980s, Dr. Curtice Griffin, a professor in the Department of Environmental Conservation at the University of Massachusetts Amherst, and Dr. Tom French from the Massachusetts Division of Fisheries and Wildlife (MassWildlife) were in communication with Tom Cade at Cornell. They had the opportunity to get some falcon chicks from The Peregrine Fund and hack them at UMass Amherst.

Griffin and French then got in touch with Richard Nathhorst from the Physical Plant at UMass Amherst, who was very eager to get the project going. Nathhorst convinced the director of the Physical Plant to accept the project proposal because having peregrine falcons on campus would help control the area's huge pigeon population, especially because UMass Amherst was spending over $100,000 a year to clean and fix the damage caused by corrosive pigeon poop (see Prey and Hunting).

In 1988, 5 chicks from The Peregrine Fund in Boise, Idaho came to UMass Amherst. A hack site was set up on the 13th floor of the Lincoln Campus Center. The chicks were raised and monitored with minimal contact by Kate Doyle ’90, G’97 and Katherine Kripp ’90, G’97 (then biology graduate students). They fledged in July and didn’t return.

In March of 1998, the first nest box built by Chris Davis of New England Falconry and David Ziomek, then director of the Hitchcock Center, was given to Nathhorst and installed on top of the W. E. B. Du Bois Library. That year, an adult falcon was seen going in and out of it. In May of 1999, a nesting pair was seen flying frequently to the box with prey. In 2001, eggshells were found in the box. In 2003, the first chick (unbanded) officially seen fledged. In 2004, the first banded chicks fledged.

In 2012, a livestream camera and camera arm were installed on the roof, broadcasting the falcons’ nesting season to the public.

In 2022, a new nest box was installed on the Library roof; while it was being renovated, the falcons nested in an old box on Thompson Hall (also built by Davis and Ziomek) that had not been used prior to that nesting season.

In total, over 50 chicks have successfully hatched at UMass Amherst.

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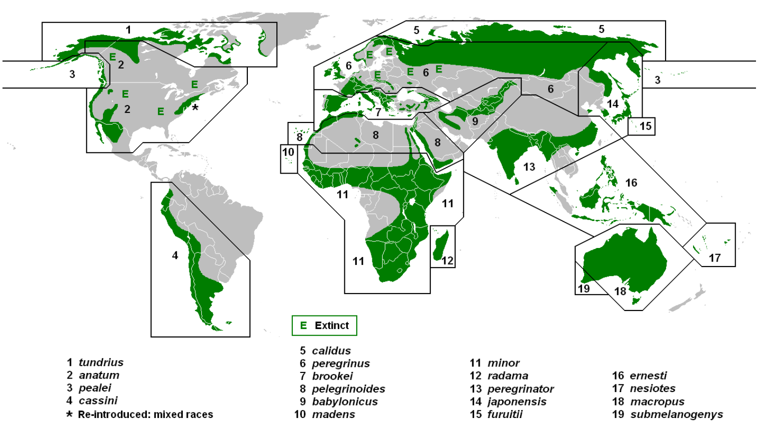
10. Peregrine Falcon Subspecies

Since peregrine falcons can be found all over the world, there are many different variations of them. Currently, they are referred to as **subspecies**. A subspecies is a classification rank below species used to describe populations of a species that live in different areas and have different physical characteristics, but are still able to interbreed. Although there is some disagreement in how peregrine falcon subspecies are named and classified, here are descriptions of the subspecies as they currently stand.[1]

Here is a map showing the locations where the various subspecies are found.



1. White, Clayton M., Tom J. Cade, and James H. Enderson. *Peregrine Falcons of the World.* Barcelona: Lynx Edicions, 2013.

1. *Tundrius*

(North) American Tundra Peregrine
Falco peregrinus tundrius

Name

Although there are descriptions matching the North American tundra peregrine dating back to the 1600s from European falconers in America, this subspecies was not formally described until 1968: the last peregrine subspecies to be formally recognized. It was named by C. M. White in 1968. “Tundrius” (TUN-dree-uhs) means “comes from the tundra.”

Habitat

Tundrius is found in North America north of the tree line, so in upper North America in areas like northern Alaska, northern Canada, and southern Greenland.

They mostly nest on cliffs and bluffs, but will also nest on pingos (hills with ice cores), gravel banks, lake shores, some abandoned stick nests, and human-made structures.

They tend to migrate long distances during the winter. They mostly migrate to southerly areas on the east coast, the Gulf Coast, and even eastern Mexico, but have also been spotted by the Great Lakes, west coast, and western Mexico. Some also go even further into South America as far as southern Chile.

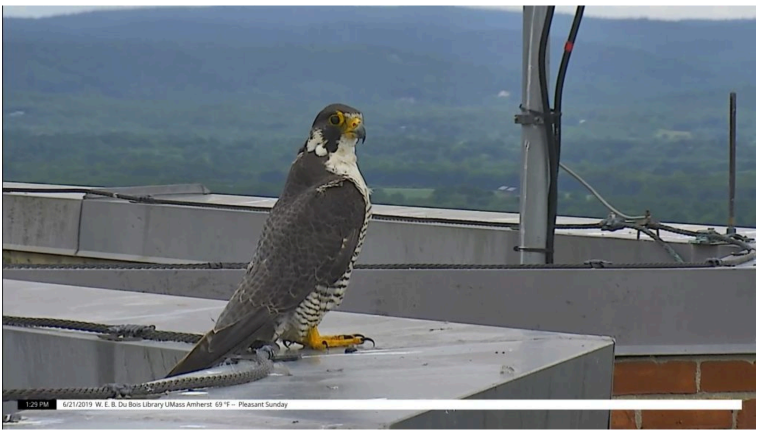
The most common prey of North American tundra peregrines are passerines and shorebirds, both in their breeding grounds and in wintering grounds. In their breeding grounds, some will also prey on small mammals like lemmings and Arctic ground squirrels. In their wintering grounds, they also prey on bats.

Average Appearance

Tundrius is similar in appearance to *calidus*, and is paler in color than *anatum*. In fact, some *tundrius* found near the Arctic are extremely pale in color. In general, their undersides have a more yellowish tint, unlike the reddish tint of *anatum*. Their malar stripes are also narrower, and sometimes have a stripe that almost connect that patch of color to the color at the back of the head. They also have narrower wings than the other two North American subspecies.

2. *Anatum*

(North) American Peregrine
Falco peregrinus anatum



Name

The first formal listing of this name was by Charles Lucien Jules Laurent Bonaparte (Napoleon Bonaparte's nephew) in his 1838 book, *Geographical and Comparative List of Birds of Europe and North America* (although the subspecies itself was first described in Alexander Wilson's 1814 book, *American Ornithology*). The name "anatum" refers to the Latin word "anas" for "ducks," and this subspecies was once commonly called the duck hawk.

Habitat

Anatum is found throughout many parts of North America from Alaska's northern taiga to eastern Canada, down through the U.S., and south into Mexico.

They used to nest mostly on cliffs, although some did nest in tree cavities and abandoned stick nests. Nowadays, they frequently nest on human-made structures, partially due to the reintroduced populations being released at such sites.

Anatum from regions that freeze over or from which their prey migrates will also migrate. They migrate southwards; some travel long distances to South America. Before extirpation, eastern American peregrines used never to migrate farther south than central Georgia.

Although the American peregrine varies in region, and, therefore, so does their prey, they generally tend to prey on pigeons and doves, especially urban peregrines.

Average Appearance

There are three different geographic groups of *anatum*: eastern, western, and boreal forest/taiga.

The eastern American peregrine ("rock peregrine") was extirpated due to the use of pesticides in the mid-1900s. The conservation and repopulation effort for that region included introducing captive-bred peregrines from different subspecies, including *tundrius*, western *anatum*, *pealei*, *macropus*, *cassini*, *peregrinus*, and *brookei*. The resulting new population in the east tends to have dark facial coloring, a pale reddish tint to the breast, and barring underneath.

The western *anatum* is generally smaller, with a stronger reddish tint to the breast and a brownish tint to its bluer back color.

The boreal forest/taiga *anatum* is generally larger, more slender, and more lightly colored than the western American peregrines.

3. *Pealei*

Peale’s Peregrine
Falco peregrinus pealei

Name

The Peale’s peregrine was formally recognized by Robert Ridgway in 1873. He named it after the 1800s collector, Titian Ramsay Peale (son of Charles Willson Peale, the well-known Philadelphia museum owner).

Habitat

Pealei is found along seacoasts from the Commander Islands through the Aleutian Islands and along the coast of Alaska. They are highly adept at traveling and hunting at sea, even in thick fog.

It typically does not migrate.

Its habitat has a limited prey selection. *Pealei* mostly prey on alcids ("web-footed diving birds with short legs and wings"[2]).

When these peregrines hunt at sea, they use what is called "ground effect," which is "the increased lift and reduction of drag resulting from compressed air when within one wingspan of the sea's surface."[3] This helps them fly low over the sea and surprise attack their prey. They will also do the usual peregrine stoop in mid-air, and then retrieve the prey after it falls into the water.

Average Appearance

There are at least two subgroups of *pealei*.

The first is an Aleutian form found in the outer Alaska Peninsula (Shumagan Island, etc.) westward through the Aleutians to the Commander Islands. These *pealei* have spots on their upper breasts, crops, and throats that are round or shaped like

2. Merriam Webster. https://www.merriam-webster.com/dictionary/alcid
3. White, Clayton M., Tom J. Cade, and James H. Enderson. *Peregrine Falcons of the World*. Barcelona: Lynx Edicions, 2013. 185

teardrops. Their undersides have a dirty white color with a gray tint. Their backs are dark lead/slate-colored. Their legs and feet are paler yellow than other subspecies.

The second subgroup ("Haida Gwaii") is found in the southern part of the *pealei* range up to at least Cape Spencer and Icy Point, Alaska. These *pealei* have less bold spots and barring. Males' crops are usually white and only have slight streaks. Females usually have wide, whitish bands on their foreheads.

Peale's peregrines also have a relatively short middle toe in comparison to other subspecies of peregrines, possibly because of the types of prey they catch and that shorter toes retain heat better in colder environments.

4. *Cassini*

South American Peregrine
Falco peregrinus cassini

Name

This peregrine was named by Richard Bowdler Sharpe in 1873. He named it after John Cassin, who had described what we now know to be this subspecies in 1855 (although Cassin called it *Falco nigriceps*). According to White, Cade, and Enderson, *cassini* in this case is pronounced "CASS-in-ee," not "cuh-SEE-nee." This peregrine has also been referred to as the "Austral peregrine," from the Latin *austrālis* ("southern"), even though there are several subspecies of peregrine falcons that are found in the southern hemisphere.

Habitat

Cassini is located in South America. There are a few subgroups within this subspecies.

There is a group located in the Fuegian region and the Falkland Islands.

Another group is found from central Argentina up through Bolivia and along the Pacific coast and Chile.

Another group is found in northern Chile, Peru, and Ecuador.

Cassini does not migrate.

Average Appearance

In general, South American peregrines have dull black heads, blue-black backs, and bluish rumps. They have broader, more extensive, wavy barring across their breasts and bellies than North American peregrines. They have a grizzled-gray look to their lower undersides.

The Fuegian region peregrines are the largest and darkest.

The central Argentina peregrines are smaller and have more reddish than tawny undersides.

The northern Chile peregrines are even smaller and have paler backs.

Pallid Variant

There is a “pallid” (pale) variant of *cassini*. It used to be considered a separate species, called the Pallid Falcon or Kleinschmidt’s Falcon (*Falco kreyenborgi*). Their leucistic pale coloring is a genetic trait, possibly the result of natural selection during the Ice Age, where the shifting of coasts and continents produced a climate that favored the pale coloring. Pale variations of species are not completely uncommon, especially near the edges of that species’ habitat range.

The pallid variant of *cassini* is lighter in color than regular *cassini*. It ranges from extremely light, with white breasts and very pale bluish backs, to intermediate, with light barring, cream coloring, and a darker back. All of them have white, unmarked undertail feathers and a peach tint to the back. Their talons and bills are white-yellow with gray tips.

5. *Calidus*

Siberian Tundra Peregrine
Falco peregrinus calidus

Name

This peregrine was first mentioned in 1788 by John (Joannis) Latham in his book, *A General Synopsis of Birds*. He later formally described it in 1790 in another book, *Index Ornithologicus*. "Calidus" (CAL-ih-duhs) is a Latin word referring to something fiery. Latham named it this way because he got the specimens he used for the descriptions from India, which can be a hot environment. However, this subspecies only migrates down there during the winter; it regularly lives far up north. That is why there has historically been some disagreements on this falcon's Latin name; some wanted to call it *leucogenys* ("white cheeks") instead of *calidus*, because it seems to fit the bird more accurately. However, due to the International Code of Nomenclature (Berlin, 1901), which is a set of rules and recommendations on how to name species, Latham's name is used because he was the first to name it (the Code's "rule of priority"), and *calidus* is also the name that was used for this subspecies most frequently (the Code's rule of "history of usage").

Habitat

Calidus can be found in the Eurasian tundra west to east from the Kanin Peninsula and the eastern boundary of the White Sea to the Jana River basin region, and, from the northernmost region, southwards to the Yenisey (Jenisei) River valley. It can also be found on major islands in the Barents, Kara, and Laptev Seas, including the southern part of Novaya Zemlya; however, it is not found on Wrangel Island.

It usually nests along rivers, and some on lake shorelines. Some will even use old snowy owl nests.

Calidus migrates south- and southwestward during the winter, including to South Asia and sub-Saharan Africa.

Prey varies for *calidus*, but typically includes waders and passerines. If there is a high rodent population, almost half of their diet may consist of rodents. In their winter grounds, they prey on bats, as well as other birds not found in their regular nesting grounds.

Average Appearance

Adult *calidus* are just a little larger than the European peregrine, but paler, especially with regard to their backs (pale bluish-gray) and crowns. Their faces have a white forehead band, narrower and longer dark malar stripes, and a wider white patch near their ear openings with no streaks. Their underside can have a yellow tint and is less marked.

6. *Peregrinus*

European (Eurasian) Peregrine
Falco peregrinus peregrinus

Name

The European peregrine is considered to be the **nominate sub-species**. This means that this particular type of peregrine falcon is the type that was first described by observers. You can tell that it is the nominate subspecies because its subspecies name is the same as its species name (*peregrinus*).

This subspecies of peregrine was first described in 1771 by Marmaduke Tunstall from Wycliffe, York, England in his book, *Ornithologica Brittanica*. This is also the first formal adoption and listing of the name *Falco peregrinus*.

Habitat

Peregrinus can be found in temperate latitudes West to East across temperate Eurasia from the British Isles to the Amur River region. Since this is such a large area, observers used to classify some geographical groups of this subspecies differently, such as *Falco peregrinus brittanicus* in the British Isles, *Falco peregrinus germanicus* in central Germany, *Falco peregrinus scandinavie* in Fennoscandia, and *Falco peregrinus ussuriensis* in the Ussuri River region of Asia.

It typically nests on cliffs and human-made structures. However, this subspecies will also nest in trees (taking over unused nests of other birds) and even on the ground.

In Europe, *peregrinus* typically does not migrate, but does migrate in Scandinavia and Asia.

Since *peregrinus* is found across such a large area, its prey varies, but mostly consists of pigeons.

Average Appearance

Adult *peregrinus* have a dark slate blue back with a paler gray rump and tail. On their faces, they have broad, pale blue to black malar stripes and white cheeks and throat. The area around where their ear openings are might have dark streaks.

Their forehead is a dirty white color. Their chest has fine black spots with some streaking, and they have black barring on the rest of their underside.

Additional Information

European peregrines are the source of many aspects of the rich history of falconry. Their remains were found in the dwellings of 9th and 10th century Shetland Island Vikings, who used them for hunting. From the Middle Ages to the mid-20th century, they were heavily used and admired in falconry; people like Frederick II (known for his famous treatise on falconry), William Shakespeare, and Sir Walter Scott described them at length in their works.

Unfortunately, after the mid-20th century, they were increasingly persecuted throughout Europe for various reasons, including to preserve game for hunting and, during World War II, to reduce the loss of messenger pigeons carrying important information to troops. Additionally, like the peregrines in the United States, they also suffered from the use of pesticides.

However, thanks to conservation and the restriction of pesticides, the European peregrine population has made a comeback.

7. *Brookei*

Mediterranean Peregrine
Falco peregrinus brookei

Name

This peregrine was named after A. Basil Brooke, who brought some from Sardinia to the British Museum in 1869 and 1871, respectively.

Habitat

Brookei is found in southern Europe and the Mediterranean basin. It can also be found in northern North Africa and a little bit into Asia's Koptag Mountains.

It nests from sea level (sandy knolls along beaches) to high elevations and anywhere in between. It is typically found on cliff ledges, and will even use cliffside stick nests abandoned by other birds.

It does not migrate.

The most common prey for these peregrines are various types of pigeons, especially rock doves. However, *brookei* in the Caucasian region do hunt bats, as well; in fact, bats can be up to 30% of their diet.

Average Appearance

Although *brookei's* appearance varies throughout the region where it is found, in general, it is smaller than *peregrinus* with short, broad wings, dark heads, broad malar stripes, and a rusty tint to its undersides.

8. *Pelegrinoides*

Barbary Falcon
Falco peregrinus pelegrinoides

Name

This peregrine was first described in 1829 by Coenraad Jacob Temminck of the Rijksmuseum van Natuurlijke Historie, Leyden, The Netherlands. Its name combines the English and French words for "peregrine" ("peregrine" and "pèlerin," respectively), and the suffix "oides" ("like/similar to"). It is called the

Barbary falcon because it is found in what used to be called the Barbary States (North Africa from the Atlantic Ocean to Egypt) before the 19th century. In Latin, "barbaria" means "foreigner" (later with a negative connotation, referring to pirates sailing along the coasts beginning in the 1300s).

Some experts consider this bird to be a near-peregrine, peregrine superspecies, or possibly a separate species altogether.

Habitat

Pelegrinoides is found along the southern Mediterranean region, including North Africa, the Middle East, and the Canary Islands.

Some *pelegrinoides*, such as those in Israel, Morocco, and the Canary Islands, do not migrate. Others, such as those in Sudan, will migrate farther south into Africa, including Kenya.

They typically nest on rocks and cliffs, but have been known to nest on human-made structures, as well.

They prey most commonly on pigeons, doves, sandgrouse, and bats.

Average Appearance

Due to its large range, *pelegrinoides* tends to vary in color, so much so that different regions of *pelegrinoides* were once labeled as individual subpsecies, including *punicus* (Western North Africa) and *arabicus* (northern Egypt-Arabian Peninsula).

On average, this peregrine's back is anywhere between light bluish and pale blue-gray (except on the Canary Islands; those are typically darker and more of a blue-black). The amount of reddish coloring on their heads also varies, from none to a lot, including a possible reddish stripe above the eye. Their fronts are usually an off-white/peach/orange color. Male *pele-grinoides* have the narrowest wings according to wing width-length ratio.

Additional Information

Pelegrinoides is famous for its role in Arab falconry over the centuries.

9. *Babylonicus*

Red-Naped Shaheen (Red-Capped Peregrine)
Falco peregrinus babylonicus

Name

This peregrine was first described by Philip Sclater, *Ibis* editor, in his 1861 paper, “Capt. L. H. Irby on birds observed in Oudh and Kumaon.” It was named after Babylonia (present-day Iraq), the location where the specimen was found.

Habitat

Babylonicus is found in central Asia, from eastern Iran to the Mongolian Altai ranges.

They nest on cliff ledges as well as abandoned stick nests of other raptors.

Some migrate to north and northwestern India; they enjoy the deserts and semiarid areas.

They most commonly prey on passerines, such as rock doves, swifts, and starlings.

Average Appearance

According to White, Cade, and Enderson, there are three different groups of *babylonicus*: large, dark birds from western Turkmenistan through adjacent countries in middle Asia; smaller, paler birds in Iran and possibly Afghanistan; and large birds in Mongolia.

Babylonicus looks similar to *pelegrinoides*, except it is slightly larger and its eyes are not quite as large/”buggy”. Additionally, it generally has a more reddish color on its head and neck, the brown color on its head is lighter, and its upper and lower back do not contrast as much in color. Paler *babylonicus* have entirely peach/off-white heads and pale blue-gray backs.

10. *Madens*

Cape Verde Peregrine
Falco peregrinus madens

Name

Peregrine falcons were first seen on the Cape Verde Islands in 1902, but it wasn't until 1963 that the first breeding pair was discovered by Abbé Réné de Naurois. The subspecies was formally described in 1963 by the Smithsonian Institute's Sidney Dillon Ripley II and George E. Watson.

Its name comes from the Latin word "madeo," meaning "saturated," because it has a saturation of brown coloring on its feathers.

Habitat

Madens is the second rarest type of peregrine falcon and is considered endangered. It is found on the Cape Verde Islands off of the coast of Africa.

They do not migrate.

Average Appearance

Madens is between *peregrinus* and *brookei* when it comes to size. Its upper front has a saturated brown color over the usual pale blue; otherwise, its lower back is like *peregrinus*. Its head also has a brown/reddish tint, including on the back edges of the malar stripes.

11. *Minor*

African Peregrine
Falco peregrinus minor

Name

Charles Lucien Bonaparte (Napoleon Bonaparte's nephew) officially gave the African peregrine its name in 1850, but Hermann Shlegel was the first to give an actual description of it in 1851. The name "minor" means "small," referring to the fact that African peregrines are, in general, some of the smallest peregrines.

Habitat

Minor is found in sub-Saharan and Southern Africa. They are rather rare, possibly due to human population increases and interference.

They usually nest on cliffs, inselbergs, and kopjes, but also nest in woodlands and South African shrubbery (Fynbos), as well as human-made structures.

They usually don't migrate.

They mainly prey on pigeons and doves, where available, as well as passerines like starlings and near-passerines like swifts.

Average Appearance

The African peregrine is similar to the European peregrine, except smaller and darker, with black backs, white-to-reddish undersides, and dense, bold barring. Their tails often have gray-white bands. Some don't have the white patches by their ear openings.

12. *Radama*

Malagasy (Madagascan) Peregrine
Falco peregrinus radama

Name

Radama was named by Gustav Hartlaub in 1861 after the newly-crowned King Radama II of Madagascar.

Habitat

Radama is found on Madagascar and the Comoro Islands, although they are not very abundant.

They typically prey on small passerines, such as weaver finches, but not really pigeons and doves.

Average Appearance

Radama looks a bit like *minor*, but slightly smaller and with a blacker back, whiter breast, and more, broader barring. It also has more visible white tips on its wing feather edges.

13. *Peregrinator*

(Black) Shaheen
Falco peregrinus peregrinator

Name

The name “shaheen” comes from the Persian “Shah” (king) and “een” (birds), so “king of birds.” The use of “ator” makes its Latin name mean “black peregrine,” although it can also be considered a superlative for peregrine, so it would also mean “extreme wanderer." It was named by Carl Jacob Sundevall in 1837, who came across this subspecies in 1828 while sailing through the Indian Ocean.

Habitat

Peregrinator can be found from the western edge of the Tharr Desert, India and southern Sindh Pakistan across South Asia to China's eastern coastal edge.

They often nest in abandoned raptor stick nests. They are usually found in lower elevations, but can winter in higher elevations.

They tend not to migrate, but sometimes, after breeding, they may travel to urban areas.

The most common prey for black shaheens are passerines (songbirds) and near-passerines, including pigeons, partridges, quails, and doves. They will also even prey on bats.

Average Appearance

In general, black shaheens are medium-sized and have longer middle toes than other subspecies like the European peregrine.

There are several distinct geographic groups of the black shaheen.

First, there are the black shaheens in southern India. Their heads are almost all black. Their malar stripes are more like a ski mask, sometimes with a very small pale patch around the ear openings. Their backs are solid gray with a solid ash-gray rump, and their fronts are solid chestnut to reddish-brown, except for white chins and throats. Their wings are also solid in color, with chestnut undersides.

Second, there are the northern black shaheens in the Himalayas, Nepal, and Assam. Their backs are less ash-gray and more blue, with barring. Their breasts are less chestnut and whiter in color.

Third, there are black shaheens in Myanmar and China. Their breasts are considerably whiter with wider barring Some black shaheens in China are very white in front with a light gray tint and small, narrow bars like peregrines in Eurasia.

14. *Japonensis*

Eastern (Japanese) Peregrine
Falco peregrinus japonensis

East Siberian Peregrine
Falco peregrinus harterti

Name

In *Peregrine Falcons of the World*, White, Cade, and Enderson group *japonensis* and *harterti* together because "few agree that they are distinct and putative subspecies."

Japonensis was first described by Latham in his 1788 book, *General Synopsis of Birds* as a "Japonese [sic] Hawk," since it was found on Captain James Cook's ship during his 1779 voyage, but it wasn't officially given its Latin name until 7 years afterwards by Professor Johann Friedrich Gmelin.

Harterti was named by S.A. Buturlin in 1907, who found falcons in the Kolyma region of Siberia that were lighter than the Japanese peregrine but darker than the Siberian tundra peregrine. He named it after Ernst Hartert, a German falcon worker.

Habitat

Japonensis is found throughout Japan southwards from Hokkaido to Kyushu and Tokara Islands, Kagoshima Prefecture.

It is often found on cliffs, either by the sea or more inland.

Harterti is mostly found in the Chukotka Autonomous Region (Chukchi), Koryakski Autonomous Region, and the Kamchatka Peninsula, as well as parts of the mainland Chukchi Peninsula.

It nests in lowlands, such as along rivers on the Chukchi Peninsula, as well as mountainous areas higher up.

Both of these subspecies have been found flying over the oceans of their respective locations.

Harterti populations in the north and some *japonensis* migrate southwards (China, Southeast Asia, and India), but some *japonensis* from northern Japan, as well as some *harterti* spotted on the south coast of the Chukchi Peninsula where ducks were plentiful, do not migrate.

The most common prey in Japan for peregrines are pigeons. Brown-eared bulbuls are also a common prey item. These peregrines that nest along the shorelines will also commonly prey on shorebirds, like red phalaropes and pectoral sandpipers.

Average Appearance

Japonensis are darker than *harterti* and *peregrinus*, but their barring is still visible. They have slate-gray backs, with darker heads and shoulders and lighter rumps. Females tend to be darker than males. Their undersides have a pale yellow, olive green, or pink tint; males' bellies tend to be whiter than females.

Harterti are darker than *calidus*. They also have dark heads and shoulders and paler backs, but the contrast between them is more distinct. They also have a smaller white area around their cheeks and broader "sideburns." They have barring on their lower undersides shaped like crescents, spots, and teardrops; their upper undersides are usually clearer.

Additional Information

Peregrine falcons have been documented in Japan since as early as the 16th century. They were used in falconry, but not nearly as much as northern goshawks or mountain hawk-eagles, since those birds performed better in forest environments and were easier to trap.

An interesting point is that the Nakajima Ki-43 fighter aircraft used during World War II was called *Hayabusa*, which means "peregrine falcon" in Japanese.

15. *Furuitii*

Iwo Peregrine
Falco peregrinus furuitii

Currently, there are no known photographs of living *furuitii*.

Name

This peregrine was named by Tokuutaro Momiyama in 1927 after Mr. I. Furuiti, the gentleman who obtained the specimen for him. In Japanese, it is called “Shima-hayabusa” (“Island Peregrine”).

Habitat

This is the rarest subspecies of peregrine falcon, and little is known about it. It is found on the Iwo Islands group south of Honshū, Japan, although it could possibly be extinct. None have been decidedly spotted on the islands since World War II.

Average Appearance

Furuitii is smaller than *pealei* and has a blacker head and tail, as well. They have relatively long tails compared to wing length.

A few distinct characteristics (of juveniles) as noted by White, Cade, and Enderson that distinguish them from nearby subspecies include: juveniles have a wider variation of color and markings than what would be expected for an isolated population; juveniles do not have lighter edges on their dorsal feathers like nearby Asian peregrines; and juveniles have a more reddish tint to their undersides, unlike *japonensis* and *pealei*.

16. *Ernesti*

Ernest's Peregrine
Falco peregrinus ernesti

Name

This peregrine was named by Richard Bowdler Sharpe in 1894 after Ernest Hose, who collected the specimens he described.

Habitat

Ernesti is found off the coast of southeast Asia, including the Sunda Islands, Philippines, Malaysia, eastern New Guinea, and the Bismarck Archipelago.

They nest on high cliffs on the islands, typically around where volcanic activity used to take place, since such activity produced many craters and ledges they can use.

They prey most commonly on pigeons, doves, parrots, swifts, and even bats.

Average Appearance

Ernesti is the darkest-colored subspecies of peregrine falcons. Their heads are fully black without any pale forehead stripes; the malar regions appear squared off and connect directly to the black on the back of the head. Their backs are also black, almost purplish-black. Their underparts have a grayish tint.

17. *Nesiotes*

Island (Melanesian) Peregrine
Falco peregrinus nesiotes

Name

This peregrine was first described in 1941 by Ernst Mayr, who worked at the Museum of Natural History in New York. The name comes from “nesos,” which is Greek for “island,” and “nesiotes” means “insular.”

Habitat

Nesiotes is found on New Caledonia, Vanuatu, and Fiji; however, it is not overly common.

They typically nest on cliffs along the coast and on mountains more inland.

They do not migrate. As a matter of fact, genetics suggest that there is no interbreeding between the peregrine populations of each of these islands, or between *nesiotes* and any other peregrine subspecies nearby.

Prey depends on where they are nesting (coast, grasslands, or tropical forests), but includes parrots, doves, bats, pigeons, and seabirds/shorebirds.

Average Appearance

Nesiotes is a very dark peregrine with lots of markings. Their heads, shoulders, and upper backs are more soot-colored than *macropus*, while their lower backs are more blue than black and have more barring than *ernesti*. Some coloring varies depending on their location: New Caledonia and Vanuatu *nesiotes* have whiter crops than Fijian *nesiotes*, and that white color extends into the upper breast. Fijian *nesiotes* have spots on their upper breasts, as well as a darker reddish tint to their breasts than those from New Caledonia and Vanuatu.

18. *Macropus*

Australian Peregrine
Falco peregrinus macropus

Name

William Swainson was the first to describe *macropus* in his 1838 work, “Two centenaries and a quarter of new or little known birds.” This work was published three months before Gould’s, which is why *macropus* is used over *melanogenys*. *Macropus* translates to “big foot,” referring to the large feet of this subspecies.

Habitat

These peregrines are found in Australia, except in the south-west.

They mostly nest on cliffs, but also nest in urban areas on buildings, dams, quarries, powerline polls, etc., and unused stick nests of other birds (in trees and some even underground!).

They do not migrate.

When not near coastlines, these peregrines prey on parrots, as well as pigeons and European starlings.

Average Appearance

White, Cade, and Enderson group *macropus* and *submelanogenys* together.

These peregrines have black cheeks and proportionally large feet. They typically have white crescent-shaped patches that frame their black cheeks. Their upper breasts are mostly not marked, but they have barring on their lower breasts and bellies. They are also noted to have bills with more arc and depth to make it easier for them to hunt prey like parrots.

19. *Submelanogenys*

Black-Cheeked Peregrine/Southwest Australian Peregrine
Falco peregrinus submelanogenys

Name

Gregor M. Mathews was the first to describe the black-cheeked peregrine in his 1912 book, *The Birds of Australia*. He chose the Latin name as a version of *melanogenys* ("black cheeks"), which came from John Gould's name for peregrines in Australia in 1838.

Habitat

These peregrines are found in southwest Australia.

They mostly nest on cliffs, but also nest in urban areas on buildings, dams, quarries, powerline polls, etc., and unused stick nests of other birds (in trees and some even underground!).

They do not migrate.

When not near coastlines, these peregrines prey on parrots, as well as pigeons and European starlings.

Average Appearance

White, Cade, and Enderson group *macropus* and *submelanogenys* together.

These peregrines have black cheeks and typically have white crescent-shaped patches that frame their black cheeks. Their upper breasts are mostly not marked, but they have barring on their lower breasts and bellies.

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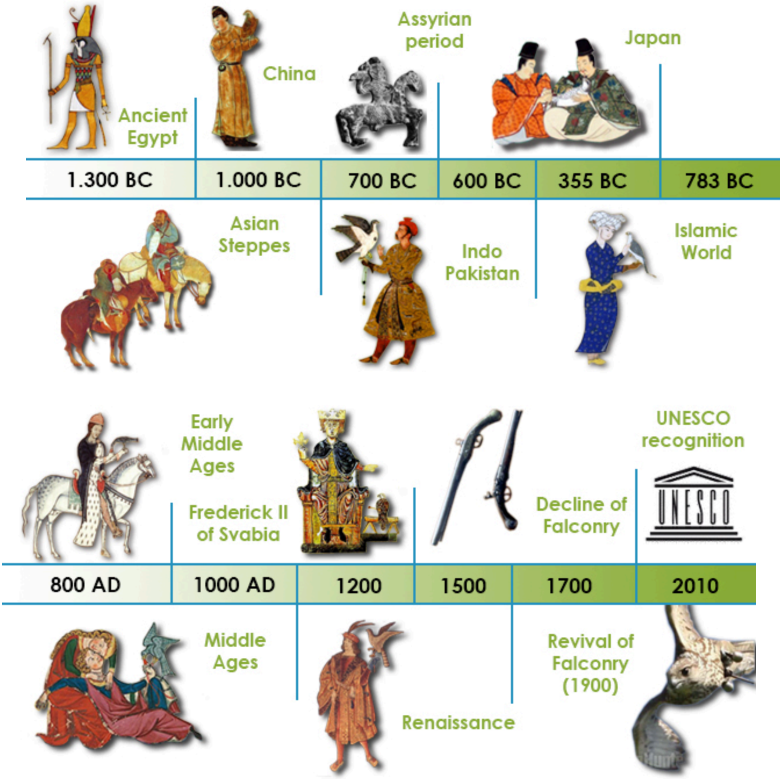
11. Falconry

History of Falconry

This section is provided through the courtesy of the International Association for Falconry and Conservation of Birds of Prey.[1]

1. International Association for Falconry and Conservation of Birds of Prey. https://iaf.org/a-history-of-falconry/



At the Abu Dhabi Symposium on "Falconry: a World Heritage" in September 2005, experts on many aspects of falconry met and gave presentations on their various specialities. Falconry from all regions of the world was represented, and many exciting facts came up that were previously unknown to those of us restricted to learning from our own compatriots and from books written in our own language. Here is a short summary from a layman's point of view. Apologies to those countries whose names and histories do not appear; the number of experts that were able to attend the symposium was sadly limited.

A significant problem with recorded history is that history can only be recorded where records exist. We are certain the origins of falconry go back much further than the origins of writing because the earliest written records found describe a highly organized and technical falconry that must have taken many hundreds, if not thousands of years to evolve to that level of sophistication. Many experts present at the Symposium are engaged in full-time research into this elusive subject.

History has its uses.

Falconry is not a museum piece; it is alive. We can enjoy and promote all the best of modern falconry and support its traditional forms as well. We must protect and promote these vulnerable, minority aspects and practices of falconry as precious embodiments of world cultural history. The project to have aspects of falconry recognised by UNESCO encourages research into the social history of falconry, enriches the historical consciousness of falconers and promotes and safeguards falconry for future generations.

Falconry in Mongolia

Falconry was practiced in Mongolia at a very remote period and was already in high favor some 1,000 years BC; that's 3,000 years ago. It achieved a very high level of refinement on the military campaigns of the Great Khans, who practiced falconry for food and for sport between battles. One such military expedition reached almost to the gates of Vienna. By the time of Marco Polo, there were over 60 officials managing over 5,000 trappers and more than 10,000 falconers and falconry workers.

Falconry in Korea and China

Falconry was combined with legal and military affairs, diplomacy, and land colonization, and moved accordingly, reaching Korea in 220 BC and Japan much later.

In China, falconry once occupied a very significant role—there are many historic remains in literature, poems, painting, and porcelain describing it in the culture of the imperial family, the nobility and the social life of the ordinary people. Chinese falconry had an inseparable relationship with politics and power and written records go back prior to 700 B.C. These depict a very mature and technical falconry, exactly parallel with techniques used today. The imperial family of the time (Chu Kingdom) were already using falcons, eagles, and shortwings in exactly the same way we do. This would put the birth of falconry in the region (if indeed this was where falconry was born) at over 3,000 years ago.

Falconry was strong in China right into the early 1900s. It enjoyed imperial patronage and was popular among the aristocracy and even common people all through the centuries, largely due to the medieval society China endured all this time. With the decline and fall of the imperial family in 1912, falconry at the aristocratic level became feeble and died. At the same time, the falconry of the common people declined through conflict between ethnic groups, invasion by eight different foreign countries, and ultimately World and Civil Wars. It survived in ethnic minority groups—the Hui, Weir, Naxi, etc., until in the late 20th century, falconry in China revived, and it has been estimated that there are almost as many falconers inside China than outside it.

Falconry in Japan

Japan's isolation by the sea meant that the natural advance of falconry did not come till quite late; the first written records are from 355 A.D. (Nihon Shoki) from Paekche (old kingdom in Korea), documented hawks exported from Korea to Japan.

There is archaeological evidence then from the 6th century onwards. In ancient times, Japanese hawking was done by falconers on horseback and armed with bows on their back. This gave a deliberate martial effect to a hawking party, designed to intimidate and overawe lesser mortals. The scene of a hawking departure deeply impressed spectators, so hawking was used very effectively to symbolize and publicly demonstrate military power and dominance over the land. Hence the central rulers always tried to monopolize or even ban hawking through laws and Buddhist ideology, while the emerging local lords kept hawking in practice either through connections with those in influential positions or through finding religious excuses in Shintoism. This importance of public demonstration in Japanese falconry created a tradition of beautiful costumes and elaborate equipment the aesthetics of which have survived to the present day.

Imperial Falconers existed under the Imperial Household Ministry until the Second World War, after which it became open to distribution to the public by a system of apprenticeships to retired imperial falconers leading to the "Schools of Falconry", the Yedo school, the Yoshida School, etc., the ideals of which exist to the present. There was also a tradition of subsistence hunting with Mountain Hawkeagles from the early 19th century. Unfortunately, this bore the brunt of opposition by birdwatcher fanatics and it has almost disappeared.

Falconry in Iran and Persia

Despite a belief that falconry originated in the Mongolian steppes, Iran/Persia is sometimes also cited as the cradle of falconry. A theory put forward at the Symposium suggested a possible "parallel evolution"—with the first hunting birds of prey trained at around the same time in both the Mongolian steppes and in Iran. In documented Iranian history, the one who used birds of prey for the first time was Tahmooreth, a king of the Pishdadid dynasty, 2,000 years before Zoroaster, who himself lived around 6000 B.C.

This could mean hunting with falcons has a background of 8,000 to 10,000 years. This was one of the most interesting hypotheses at the Symposium and was presented with several proofs, dates of dynasties, approx lengths of generations, and reigns.

Falconry in India

In India, falconry appears to have been known from at least 600 years B.C. Falconry became especially popular with the nobility and the Mughals were keen falconers. Surprisingly, the humble sparrowhawk was the favorite of the mighty Emperor Akbar. In the Indus Valley, falconry was considered a life-sustaining instrument for the desert dwellers, while those from the green belts considered it as a noble art and used the falcons as symbol of high birth and luxury. Organized hunting parties would go out for game. Richard Burton, the famous 19th Century historian and translator, wrote extensively about falconry in the Indus Valley, citing the interesting practices of its communities in his book “Valley of the Indus.”

In the Rajput States—in Jaipur, Bhavnagar, etc., the royal families continued to cherish the sport of hawking till the 1940s, but then partition and subsequent political problems all but did for falconry in India. Nowadays, while there are many people who have paper knowledge of the birds, there are very few with practical knowledge left.

Arab Falconry

Falconry appeared with the emergence of civilizations and was already popular in the Middle East and Arabian Gulf region several millennia B.C.

In the Al Rafidein region (Iraq), it was widely practiced 3500 years B.C; in 2000 B.C., the Gilgamesh Epic clearly referred to hunting by birds of prey in Iraq.

The Babylonians created a Divan for falcons and made game reserves for quarry species. Al Harith bin Mu'awiya, an early King of the present region that includes Saudi Arabia, was one of the first who trained and hunted falcons. The Omayyad caliphs and princes, Mu'awiya bin Abi Sufyan and Hisham bin Abdul Malek, practiced falconry, and falconry had a good position in the Abbasid period. The caliph Haroun Al Rasheed was fond of the sport and exchanged falcon-gifts with the other kings.

The Arab poets composed a lot of poems lauding the falcon and all Arab classes—Kings, Sheikhs and cavalry—practiced falconry and bequeathed it to the next generations. The Arabian Gulf region became famous for its falconers and falconry traditions.

Through Arab influence, it spread out through the Islamic World, eastwards into the great Islamic Empires of Central Asia and westwards across North Africa to the Magreb, giving us the distinctive styles of falconry of the Bedouin, of the Kingdom of Morocco and the Magreb, and of Tunisia (passage sparrowhawks at quail—note similarities with the falconry of eastern Turkey and Transcausasia).

The Holy Koran itself includes a falconry-related verse that permits falconry as a hunting method. Falconry is considered a symbol of this region's civilization more than any other region in the world; 50% of the world's falconers exist in the Middle East, which includes the Arab region.

In the philosophy of the region, hunting trips teach patience, endurance, and self-reliance, and bravery can be learned from falcons.

Falconry in Russia

Falconry in Russia has an ancient history, its roots found probably in the 8th and 9th centuries. It came to the Eastern Slavic tribes from their southern neighbours and from the Huns and Khazars, the Turkic speaking nomadic nation who created in the 5th century a country whose boundaries stretched over the modern Dagestan, Cis-Azov Sea area, the Crimea, the Don River region, and the Lower Volga River area. At the end of the 9th century, the ancient Russian knight Oleg built the falcon yard in Kiev. Vladimir, son of Yaroslav Mudryi, who ruled between 1019-1054, issued the first legislative acts regulating falconry. Historical chronicle returns many times to the mention of falconry as an important feature of the everyday life of Russian princes. Falconry was loved by Prince Igor, famous for his unsuccessful military trip to Polovets in 1185. Even when in captivity, this prince did not change his habits and continued to fly hawks.

An interesting legend exists about Saint Trifon, whose day is celebrated by orthodox Christians on 14th February: the boyar (nobleman) Patrikiev had the bad luck to lose a falcon belonging to Tsar Ivan the Terrible. Fearing the worst, he prayed to a local saint, Trifon (or Triphon), to show him where it was. Sure enough the saint appeared in a dream and showed him where to look. In return, the boyar built and dedicated a church. Religious icons of St. Trifon show him in a falconer's pose with a falcon on his fist.

During the middle ages, falconry flourished in Russia, especially in the Moscow Principality. One of the Moscow districts is even now known as "Sokolniki", which translates as "Falconers" or "Site of Falconers". Falconry had its heyday during the reign of Alexei Mikhailovich Romanov (1626-1676), father of Peter the Great, but, as elsewhere, it had practically died out among the elite of Russian society by the end of 19th-beginning of 20th century. After October 1917, falconry was not officially prohibited, but was not supported by the government, and that, in reality, meant one and the same thing. However, in two regions where falconers were simple common people, it continued to exist: in Transcaucasia and in the republics of the Middle Asia, where falconry was one of several hunting methods for acquiring food or furs.

Falconry in Turkey

Excavations at the ancient Hittite city of Alacahöyük, which was inhabited in 4,000 B.C., show various relief sculptures dating back to 1600-1200 B.C., such as a double headed Eagle, a symbol that is very ancient and also present at the Assyrian colony at Kanesch (Kültepe).

Discoveries at the Karatepe (meaning ”black hill” in Turkish) complex date back to 1600-1400 BC and were excavated from 1947 to 1957. The excavations revealed the ruins of the walled city of king Azatiwataš, where two city gates have many reliefs covering the lower walls of the gate complex. An image of a god riding a bull, with what looks like a Bird of Prey in one hand and a Hare in another is present.

This symbolic and actual relationship with Birds of Prey extended into the Seljuk period of Turkey and beyond, with the crowning of Tuğrul (which means Falcon) Beg at Mosul in 1058 as “King of the East and the West”. The double-headed Eagle became the standard of the Seljuk Turks and has been much used afterwards right up until today including Government institutions.

During the Ottoman Empire, falconry in Turkey reached its pinnacle at what is seen as the Golden Era, when it was practiced by the elite of the ruling class. Falconry during this period had been responsible for ransoms, bribes, as well as the death of intended heirs to the throne.

This love and passion in which the Ottoman court held Falconers and Falconry was recorded by the eyewitness statements of both John Sanderson (1594) and Thomas Dallam (1599). The Turks were responsible for much intercultural exchange with the Europeans, including falconry during the Crusades.

With the decline of the Ottoman Empire came the decline of falconry in Turkey, with this decline still continuing today. It is estimated that there are approximately 4,000 Falconers currently in modern day Turkey (2012), mainly around the Black Sea region and practiced also around Istanbul. Falconers are only allowed to use sparrowhawks (Atmaca), which they trap under license from the Turkish Government to hunt migrating Quail. This tradition is centuries old, which has been passed down orally through generations.

Falconry in Georgia

Falconry is known in Georgia since the 5th century and is most remarkable for its tradition of flying passage sparrowhawks at quail. This was clearly described in literature of the early 19th century and similar living traditions exist today in Tunisia and Turkey.

For many centuries, ordinary people in Western Georgia have hunted with sparrowhawks, while the more elite of society of Eastern Georgia flew goshawks and falcons. Georgia was the first of the former Soviet states to formally legalize falconry in 1967. In the town of Poti, there is a monument devoted to bazieri (sparrowhawkers).

There are over 500 registered bazieri at the present time.

Falconry in Kazakhstan

Kazakhstan is a country the size of Europe—mountain and steppe, barely touched by modern civilization and whose inhabitants are mostly farmers and part-time farmers. Its falconers continue the Central Asian tradition of flying golden eagles at hare for food and at fox and wolf for furs and flock. Until modern times, this was a subsistence necessity for the peoples of Kazakhstan, as well as in Kyrgyzstan, Tajikistan, and Uzbekistan and Mongolia and the ethnic minorities in Western China.

Falconry tradition in Turkmenistan differs greatly from the neighboring traditions of eagles in Kazakhstan and the other central Asian republics to the north and east. It is much more like the traditional falconry of Iran and Afghanistan using sakers and tazy (the Turkmen version of the saluki) at the desert hare. Falconers traditionally spend five months of the year in the desert staying with their hawks, their tazy, and their falconry mentors. The Oguz Khan tribes, forefathers of the Turkmen people who lived 5,000 years ago, had falconry symbols on their ancestral emblems, carpets, pottery, and other archaeological finds. In literature, falconry appears in many Turkmen classics of the 15th-17th centuries; authors such as Sayilly, Makhtumkuli, Seyidi, and Mollanepes were also falconers.

There are more than 60 proverbs and sayings in Turkmen folklore that cite falcons and falconry. Falconry is seen as a sign of equality. You find the falcon carried by the countryman as well as the city-dweller, by workers as well as academic or cultural workers; it is seen as instilling ideals of nature protection.

Falconry in Europe

The earliest evidence of falconry in Europe is usually considered to be from the 5th century A.D., written quotations from Paulinus of Pella and Sidonius Apollinaris in France and the famous mosaics in the Falconer's Villa in Argos (Greece). For over a thousand years, falconry was extremely popular in Europe and carried enormous cultural and social capital. A marker of high social status, falconry was considered an essential part of a gentleman's education, for it was thought to prevent sickness and damnation and demanded the cultivation of personal qualities such as patience, endurance, and skill.

Using the term 'European' falconry is in one sense misleading, because falconry techniques and technologies have been traded across European and other countries for centuries. For example, in the 13th century, Arab falconry techniques were imported into Europe through Spain and through the court of Frederick II of Hohenstaufen in Sicily. He employed Arab, English, Spanish, German, and Italian falconers, and translated important Arab falconry works. His masterwork "De arte venandi cum avibus" distills the falconry knowledge of many cultures.

Falconry was a means of cultural communication, because its symbolic system was shared between most cultures of the known world and falcons made ideal diplomatic gifts. Its geographical reach was extraordinary. 17th century falcon-traders brought falcons to the French Court from Flanders, Germany, Russia, Switzerland, Norway, Sicily, Corsica, Sardinia, the Balearic Islands, Spain, Turkey, Alexandria, the Barbary States, and India. Falconry wasn't merely an amusement; it was a fierce articulation of social and political power; a deadly serious pastime, considered among the finest of all earthly pursuits—and big business.

By the end of the 17th century, the use of falcons as diplomatic gifts gradually faded, and falconry's connection with nobility won it no favors after the French Revolution. It faded away in favor of the new sport of shooting. By the 19th century, only a very few individuals still practiced the sport in Europe.

Now, falconry clubs became necessary not simply to maintain both the social traditions of falconry, but the knowledge of falconry itself.

Somehow, falconry's living tradition survived with just sufficient falconers to pass on their treasured knowledge. Falconry had a renaissance in most European countries in the 1920s and 1930s, and its popularity increased further in the 1950s and 1960s.

During the 19th and early 20th centuries, much of falconry's intangible heritage was safeguarded by what UNESCO calls living treasures—proficient falconers who could teach apprentices not only the practical methods of falconry, but also its intangible dimensions. They communicated the ethical codes of falconry sportsmanship and could instill in their pupils an awareness of the emotional bonds falconers have with their falcons, quarry, and hawking land.

Falconry in Spain and Portugal

Spain and Portugal. Recent exciting discoveries of images from the 3rd century B.C. in Eastern Spain, that show falconry scenes, are currently under scrutiny by academics. Until these were found, scholars believed falconry entered Spain in the 5th century A.D., coming from North Africa with the Moorish Kings and along the northern Mediterranean coast from Eastern Europe with the Goths at approximately the same time. Much of the history of pre-16th century Iberian falconry is intertwined with Arab falconry of the time and written references abound in the Arabic language, for example, in the 10th century.

Calendar of Cordoba and from Abd al-Yalil ibn Wahbaun in the 11th century. There are Islamic falconry images like the Leyre Chest. (1004-1005 A.D.), now in the Pamplona Museum, and the Al-Mugira jar. (968 A.D.), now in the Musée du Louvre in

Paris. Whereas in other parts of Western Europe, many falconry terms have their origins in medieval French, in Spain and Portugal, there are many terms derived from Arabic.

Old Spanish and Portuguese books on falconry are numerous and stretch from the very early "Libro de las animalias que cazan" in Spanish, 1250, through Viscount Rocabertí's "Libre de cetreria" in Catalan c.1390 to Diogo Fernandes Ferreira's "Arte de caça de altaneria" 1616 in Portuguese and now in an English translation.

After a gap of two centuries, falconry in Spain was recovered from scratch by Dr. Félix Rodríguez de la Fuente in the 1950s. Not having any practicing falconer around in Spain, his sources were Spanish medieval falconry literature and foreign falconers like the late Abel Boyer of France. In 1964, de la Fuente wrote his outstanding "El Arte de Cetrería" a masterpiece and a book of great influence not only in the Spanish, but for serious falconers everywhere. Félix, known as "the friend of animals", was one of the most popular celebrities in Spain thanks to his TV series on wildlife.

In the 1980s, falconry started to flourish in Spain and Portugal, and currently, Spain is numbered in the top five falconry nations.

Falconry in Netherlands

For centuries, the Netherlands was the center of European falconry. Currently, it has some very draconian laws regulating falconers; nevertheless falconry survives and thrives at a high level. The number of falconers allowed is 200 over the whole of the Netherlands and they are permitted to fly only goshawks and peregrines at quarry.

Five clubs exist, the largest two being the Nederlands Valkeniersverbond, Adriaan Mollen and the Valkerij Equipage Jacoba van Beieran. The heyday of falconry in the Netherlands came in the first half of the 19th century, when it was a hub for falcon trading and trapping.

With royal patronage from the House of Orange and participation by gentlemen falconers from Holland, England, France, and elsewhere in Europe, the Loo Club was founded in 1839 and enjoyed a standard of “high flight” falconry at passage herons not seen since the 1600s.

The Netherlands has two falconry-related collections: the world famous falconry museum in Valkenswaard, the 18th and 19th century center for hawk trapping, which supplied hawks and professional falconers to the whole of Europe. There is also a globally important collection of over two hundred falconry-related books and other items in the National Library of the Netherlands, centered on a bequest in the late 1940s by Professor A. E. H. Swaen.

There is also a Falconry Historical Foundation concerned with the history of the sport.

Falconry in Belgium

Belgium, so near to Valkenswaard and the main passage routes for migrating birds of prey, also became renowned for commerce in hawks and its falconers in the early-modern period. Arendonkís falconers were renowned from the 12th century and the region of the Kempen was the homeland of Europe’s finest professional falconers. Some families provided falconers for about 5 centuries. Nearly all of the well-spoken, multilingual, and cultured falconers who worked for Europe’s 15th to 18th century ruling families were Flemish or Dutch.

The city of Turnhout even had a special court for falconers. The last falconmaster of the King of France in the 1880s was a falconer from Arendonk. By the 1900s, falconry had almost died out in Belgium, but found a new start in 1912 with Viscount Le Hardy de Beaulieu, who entertained an “Équipage” for crows and magpies led by a professional falconer till 1927. The true revival came with Charles Kruyfhooft in the late 1930s. Charles was probably the last European falconer to trap passage peregrine falcons following the famous method used in Valkenswaard with a very sophisticated trapping hut. He flew crows and rooks each winter for about sixty years till his death in 1995.

By the end of the second World War, there remained only three active falconers in Belgium, but by 1966, Belgian falconry had grown sufficiently for its falconers to form their own national organization, the Club Marie de Bourgogne, named for the queen who died while hawking in 1482. Political lobbying by falconers persuaded the government to grant a limited number of licenses to keep peregrines, goshawks, or sparrowhawks in order to keep the cultural heritage of falconry alive.

There are many private collections of falconry art, tapestries, books, and literature in Belgium, and two small falconry collections at the chateau of Lavaux Sainte Anne and at Taxandria Museum in Turnhout. The holy falconer's patron, "Saint Bavo", was born and lived in Belgium; he is buried in Gent.

Falconry in Ireland

In Ireland, falconry was already familiar by late Celtic times (7th century on), but written references are more to the monetary value of hawks than to descriptions of the sport, pointing at an export trade rather than a native use.

Falconry was responsible for the earliest legislation protecting raptors, there are references in the Brehon Laws Ireland supplied the nobility of Western Europe with peregrines and goshawks until the end of the 19th century, and the aristocracy of several nations brought their hawks there to hunt.

An Irish Hawking Club was formed in 1870 at a meeting chaired by Lord Talbot de Malahide. Maharajah Prince Duleep Singh, a familiar figure in falconry circles across two continents, pledged £50 to its founding. There has been a strong tradition of flying the sparrowhawk in Ireland, and Irish falconers have enjoyed international renown.

Falconry in France

In France, falconry reached its heights of complexity, scale and magnificence in the 17th century under Louis XIII. His falconry consisted of 300 birds, subdivided into six specialized équipages: for the flight at the heron, the flight at the kite and the crow, the flight at the river, the flight at the partridge, and so on. Numerous paintings, tapestries, and works of literature survive from this period.

It slipped off the law after the revolution when a scribe neglected to include falconry in the list of acceptable hunting techniques in 1844 hunting legislation and although it continued under the Empire there was no legal provision for it. A revival came after the last war.

In 1945, the Association Nationale des Fauconniers et Autoursiers Français (ANFA) was formed. It aimed to legalize, revive, and popularize falconry and protect raptors. It was instrumental in obtaining full legal protection for French birds of prey. Today, ANFA has around 300 members, who fly a wide variety of hawks and falcons.

France has a special significance for the cultural heritage of falconry. In 1999, it submitted the Pierre-Amédée Pichot collection at the Museum of Arles for inclusion in the UNESCO World Register; it is undoubtedly among the most significant falconry-related archives in the world. The International Musée de la Venerie in Gien also has a falconry collection, including significant fine art and tapestries.

Falconry in Italy

Falconry reached Italy from three different routes: from Arab falconers through the Norman Court in Sicily; from the north through German influence, and through Venetian contacts with falconers in Asia and the Orient. A wealth of literature, art, and records exists on falconry in both medieval and early modern times.

Among the most famous—or infamous—falconers of the period include Lorenzo de Medici, Lucrezia Borgia, Francesco Foscari, the Doge of Venice, and Cardinal Orsini. And of course, the most famous falconer, claimed by both Italy and Germany, Federico II, Holy Roman Emperor (1154-1250).

Starting from 1700, we see a progressive decline of falconry in Italy. By the 1900s, falconry had almost died out. A new interest revived in the early 20th century and the publication of falconry books by Chiorino and Filastori in 1906 and 1908 helped reawaken an interest in the sport. The "Coppaloni" style or "Italian" style, was a training and flying style as well as a "philosophical" new way to interpret the magic of falconry.

Dr. Coppaloni was a pharmacist, physician, eclectic sculptor, dog lover, and judge of racing dogs, breeder of pointers, and he never left a paper on his work or his hunting techniques. Coppaloni's advice was to look primarily for flight style purity; this should be always pursued even at the cost of limiting the number of kills. In the 1960s, he demonstrated his hunting style during a meeting in Spain, where Felix Rodriguez de la Fuente was flying cul levé at the red-legged partridge with falcons; his performance was received with enthusiasm. Fulco Tosti di Valminuto, the first disciple of Coppaloni, spent two years on Torrejon flying field near Madrid exhibiting to Spanish falconers the Coppaloni's technique.

In 1967, Coppaloni organized a meeting in Settevene, near Rome. Among the people attending the meeting there was the great Renz Waller, President of German Falconers, Jack Mavrogordato, Mrs. Woodford, Charles De Ganay, and others. At the end, after many hunting flights, there was the unforgettable flight of Frikki Pratesi peregrine, named Fulvia. She performed all her pitch over the falconer, but remained completely out of sight, till the descent to stoop her gray partridge in an astonishing way.

Today, Italian falconers fly longwings at pheasant, partridge, quail, crows, and magpies, and goshawks at rabbits and hares. Classical game hawking is exceptionally hard to practice, due to competition for land with strong shooting interests.

Italian museums with important falconry collections include the Castel del Monte and Castello di Melfi, both in the Puglia region, the Fortezza del Girifalco in Arezzo, Museum of Bargello in Florence and the Vatican library in Rome. Castello di Melfi is of particular importance; it was Frederick von Hohenstaufen's castle and continues to host an annual falconry field meeting.

There are many local falconry clubs and two national ones. As in other countries, falconers have pioneered conservation reintroduction programs for peregrines and eagle owls.

Falconry in Germany

The period from 500 to 1600 saw the zenith of falconry in Germany. Particularly notable past German falconers include, of course, Emperor Frederich II, and the fanatical 18th-century falconer, Margrave Karl Wilhelm Friedrich von Brandenburg-Ansbach. By 1890, however, only a single hawking establishment remained in Germany, that of Baron C. von Biederman. A small number of falconers practiced the sport in near-isolation until a falconry revival began in 1923, and the establishment of the Deutscher Falkenorden, and today the DFO is a thriving organization with over 1,000 members and is the oldest falconry club in the world. The Orden Deutscher Falkoniere has around 250 members, and the Verband Deutscher Falkner, a former

GDR club, has approximately 100 members. German falconry remains highly traditional. Dedicated hunting-horn music is played to greet falconers when they arrive at falconry meets, when they depart to the field to hunt, and to honor the quarry as it is laid out by torch or firelight at the end of the day. After the meet, falconers attend a celebratory feast, hawk on fist.

Falconry in Denmark

In Denmark, 6th century documents record that Rolf Krake and his men on a visit to King Adils in Uppsala each carried a falcon on his shoulder. Remains of hawks are found in the graves of important Vikings.

Later on, in 985, there is a record of 100 marks and 60 hunting falcons paid in annual levy by Hakon Jarl to Harald Blåtand as rental for a part of Norway. King Knud the Holy (1040-86) was a competent falconer, as were several kings up to Frederik the Second (1559-88) who established a royal falconry.

In 1662 Crown Prince Christian, later King Christian V, spent some time at the court of Louis XIV and on his return to Denmark founded a small falconry. A royal mews existed till 1810, and the last royal hunt with falcons was in 1803 to mark a visit by the Duke of Gloucester.

Falconry in Iceland and Norway

Both Iceland (Danish territory) and Norway were well known for gifts of goshawks and gyrfalcons to foreign sovereigns. In the 18th century, at least five shipments of falcons were sent to the Emperor of Morocco. No less than fifty different courts received these presents. In 1764, fifty falcons went to the French King, 30 to the German Emperor, 60 to the King of Portugal, 20 to the Landgrave of Hesse and 2 to the French Ambassador. Gifts of falcons to France continued until a few months before the execution of Louis XVI when the falconry in Versailles was abolished (1793). The last time the Emperor of Morocco received falcons was in 1798 and the Portuguese court in 1806.

In modern times, a few people kept falconry alive in Denmark after the cessation of royal patronage, but so few that a Hunting Act in 1967 effectively prohibited it. The Danish Hawking Club quickly established good relations with politicians and civil servants and is working hard to reverse this ban.

Falconry in Central and Eastern Europe

Central and Eastern Europe form a distinct region of influence—for much of recorded history forming or being part of a single empire, whether Czech-Moravian, Austro-Hungarian, Germanic, or even Soviet.

Many sovereigns immortalized their favorite falcons by showing them on coins, the Silver Dinar of Béla the IV, King of the House of Árpád (present day Hungary). On one side of the coin, you can see a hawk catching a rabbit.

There is also a falconer on horseback on a coin from 12th century Czech-Moravia and on the current Hungarian 50 Florin coin there is a falcon. A widespread legend in Eastern Europe is the "Turul" cycle, which cannot even be understood without a significant knowledge of falconry. The huge amount of medieval paintings that still exist in the region indicates the great impact falconry had on the development of fine art.

We know that birds of prey used for falconry were very important goods of exchange of medieval trade, and Eastern European sovereigns regularly imported gyrfalcons from Scandinavia, Iceland, or Northern Siberia and other falcons from Southern Europe and Northern Africa. Trading with falcons was a significant part of medieval commerce and involved entire families.

Whole villages specialized in catching, training, and trading of falcons and falconry-related handicraft, hand manufacturing of hoods, gloves, satchels, and leg straps, was practiced to a high artistic level. Hungary has been famous from medieval times to the present day for highly artistically decorated equipment, and falconers still make these items in an almost unchanged form.

From 16th century Transylvania, during the Turkish occupation, sakers were regularly delivered to the Turkish Sultan. This tax, paid annually in return for peace, was called “Falco nagium”. Sales contracts have even been found where the parties mentioned exact cliffs where the falcons nested, stipulating to the buyer he would have to give the seller young birds from the nest each year for a set time.

The present-day Czech Falconry Club of the Czech-Moravian Hunting Union is one of the largest and most influential of the central European clubs and has researched the history of falconry in the region.

The earliest artifact is a 5th century clip in the shape of a falcon, now in the National Museum in Prague. The Fulda Annals report Prince Svatopluk rejoicing in his hunting falcons around 870 A.D. and later (13th century) the city of Sokolov began near the site of the Falcon’s Manor of Loket Castle. NB the Czech word “sokol” = falcon. Another falconry at Poděbrady continued until the 17th century with patronage of the Emperor Ferdinand 1st and his son Ferdinand the Vice-Regent of Prague.

Falconry held on with one or two dedicated individuals until 1967, when 71 falconers and guests founded the present club.

In Poland, the earliest written records from the 11th century mention falconry as being widely practiced all over the country. There are physical artifacts of falconry from that time, like a 13th century horn knife handgrip in the shape of a lady falconer feeding a falcon on her fist. Permission to hunt was a privilege given to aristocrats, clergy, and nobles. Falconry, equipment, and trained falcons, also played a role in politics. In the 14th century, the royal fief gifts sent every year by the Order of Teutonic Knights of Mary to Polish kings included 18 fine trained falcons. In 1584, Mateusz Cyganski published in Polish a book on bird hunting, which describes ways to hunt different species of birds, as well as methods of training birds of prey for falconry. The revival of Polish falconry started in the 1970s; in 1972, Gniazdo Sokolnikow of the Polish Hunting Association was created and falconry was legalized.

Falconry in Canada, USA, and Mexico

The nature of the early American settlers and their struggles to establish themselves militated against the practice of falconry. Despite their desperate struggle just to survive, we do find at least one record of falconry among the initial settlers; in 1622 an attorney, Thomas Morton, arrived in New England and left in his writings accounts of hawks and falconry in the New World. Subsequently, in the 1650s, a Jan Baptist sent back to Holland for his falcon and flew her at quarry in the Hudson Valley. Even farther south, there is an allusion to the hawk trained by one of Cortez' captains early in their stay in the Valley of Mexico.

Of all those early Europeans in North America, falconry might most logically have been found among the Spanish in Mexico. Falconry, on the wane in Spain, still represented a legitimate and "noble" pastime for these nouveau elites in Mexico. The first Viceroy of New Spain, Velasco, had a falcon so tame that he rode with her unhooded on his fist. His son, Luis de Velasco II, employed a royal falconer to look after his birds.

American falconry in the Twentieth Century: Colonel R. L. "Luff" Meredith is recognized as being the "father" of American falconry. Among other notable figures were Dr. Robert M. "Doc"

Stabler, Alva Nye, the twin brothers, Frank and John Craighead, and Halter Cunningham.

In the 1940s they formed the Falconers' Association of North America, which ceased due to the Second World War. These men possessed the traditional bird of falconry, the peregrine. The peregrines were taken from local eyries, but falconry for them in those early years was mere possession of hawks, because they did not advance to the stage of hunting game until much later for some of them. Their countryside was not suitable for longwing falconry.

Though Meredith had visited British and European falconers, and the Craigheads spent several months hawking and hunting with an Indian prince, actual hawking for the most part escaped these men as the logical step after training a bird. In the 1960s, after the founding of the North American Falconers Association (NAFA), true game hawking exploded across the continent and the ubiquitous red-tailed hawk became a mainstay, and a decade later the Harris hawk was "discovered".

In Mexico, Guillermo José Tapia was the president of the Asociación Mexicana de Cetrería, formed in the 1940s. Later, in 1964, Robeto Behar became involved in falconry and had the opportunity to travel and contact international falconers—Renz Waller, Kinya Nakajima, and Félix Rodríguez de la Fuente.

Falconry in South Africa

Falconry's most recent expansion has been to South Africa, where it went with colonists. Of the 59 diurnal raptors, 31 species have been flown for falconry purposes with variable success and game birds include guinea fowl, francolin, quail, sand grouse, and duck. Furred quarry includes scrub hares and spring hares.

There is evidence of an ancient culture, with an economy based on agriculture and trade in gold and ivory. There was pre-Islamic Arabic influence on the earlier ruins and trade existed with outsiders, including India, China, and Persia. The largest of the stone complexes is The Great Zimbabwe in the center of Zimbabwe, near the town of Masvingo. In the site museum is a metal object identified as an "Arab Falconry Bell" and several soapstone birds found within the ruins.

In modern times, falconry was imported to Southern Africa by a widely dispersed group of individuals who came from different origins and settled in different areas. W. Eustace Poles is the earliest, settling in Northern Rhodesia (now Zambia) in the early 1950s. Heinie Von Michaelis was an immigrant to the Western Cape from Germany, at much the same time and his contemporary, David Reid Henry, the well-known bird artist, settled in Southern Rhodesia (Now Zimbabwe) in the 1960s.

Rudi De Wet was one of the first falconers in the Transvaal region of South Africa. He was a Methodist minister and learned about falconry while studying Chinese in an effort to become a missionary to China. He put theory into practice and became a focus for youngsters in the area who wanted to take up falconry.

Falconry became more formalized and experience was gained with indigenous birds like black sparrowhawks, red-breasted sparrowhawks, passage lanner falcons and African hawk eagles. The first African peregrines were obtained and efforts were started to breed these. The lack of structure was recognized and the Zimbabwean (Rhodesian), Transvaal, and Natal Falconry Clubs were formed.

The South African Falconry Association was formed in 1990. Falconers in Southern Africa have striven to develop good relations with raptor biologists, conservationists, rehabilitators, and amateur bird watchers. This has laid a good foundation for falconry today. Ron Hartley was a powerhouse in the development of falconry in Zimbabwe and is largely responsible for the good standing of falconry in the sub-region. Today, there are 186 South African Falconers and the 35 Zimbabwean Falconers.

Media Attributions

- IAF 1
- IAF 2

12. Peregrine Falcons in Popular Culture

LAUREN WEISS

Movies and Television

Star Wars

Perhaps one of the most famous falcons in popular culture is the Millennium Falcon, the ship in *Star Wars* piloted by Han Solo and Chewbacca. The ship is well-known for making the Kessel Run in less than 12 parsecs, which is understandable, considering that peregrine falcons are the fastest animals on Earth!

Marvel

Before becoming the new Captain America, Sam Wilson, Air Force veteran, is known as the Falcon. He fights with his fellow Avengers using a special flying suit with wings. He also has a remote control drone called "Redwing" that resembles a bird.

Power Rangers

In Mighty Morphin' Power Rangers, Tommy Oliver, perhaps the most famous Power Ranger, gains the power of the Falconzord in *Mighty Morphin' Power Rangers: The Movie* to battle Ivan Ooze, and later, in Season 3 of the television show. As a leader of the team, it makes sense that Tommy's Zord is the powerful falcon! At one point, the evil Lord Zedd captures the Falconzord and turns it into an actual falcon that he keeps in a cage in his lair until Tommy and the Rangers rescue it.

Pokémon

There are a couple of Pokémon based on falcons. Talonflame (Fletchling -> Fletchinder -> Talonflame) is actually mostly based on the peregrine falcon, plus some details from other birds of prey like kites, goshawks, and bazas. Also, although Starly is mostly based on the white-cheeked starling common in Asia, its final evolution, Staraptor (Starly -> Staravia -> Staraptor), has "raptor" in its name and has details based on hawks, falcons, harpy eagles, and long-crested eagles.

Angry Birds

In Angry Birds 2, Silver is a peregrine falcon and Chuck's younger twin sister. She looks more like a peregrine than he does, but according to Nickelodeon, the super speed of Chuck is modeled after the peregrine falcon because of its ability to fly and dive incredibly fast.

Wild Kratts

Chris and Martin Kratt discover the amazing creature powers of the peregrine falcon in the episode, "Falcon City," where they have to protect an urban falcon nest and chick from Zach's building-cleaning robots.

Literature

The Maltese Falcon

The Maltese Falcon (1930) is a book by Dashiell Hammett about a detective named Sam Spade who becomes involved in a plot to locate an extremely rare and expensive statue of a peregrine falcon. This book was adapted into the famous Humphrey Bogart movie from 1941 that has been named one of the top 100 films in history.

My Side of the Mountain

My Side of the Mountain (1959) is a young adult book by Jean Craighead George about a boy named Sam Gribley who attempts to live on his own in the Catskill Mountains. At one point, he decides to get a falcon to help him hunt for food. He takes a peregrine falcon chick from a nest, names it Frightful, and trains it. Interesting fact: does the author's name sound familiar? It should. The Craighead family was famous for studying nature. Jean's brothers, Frank Jr. and John, were responsible for the article in the National Geographic magazine that made Tom Cade decide to take up falconry and save the peregrine!

Sports

Atlanta Falcons

The Atlanta Falcons are a football team from Atlanta, Georgia, in the National Football League. They were given their name on August 29, 1965 after a naming contest. Many people suggested "Falcons," but it was Miss Julia Elliott, a Griffin, GA school teacher, whose response was singled out: "the Falcon is proud and dignified, with great courage and fight. It never drops its prey. It is deadly and has a great sporting tradition."

Freddie and Frieda Falcon

Freddie and Frieda Falcon are the peregrine falcon mascots of Bowling Green State University.

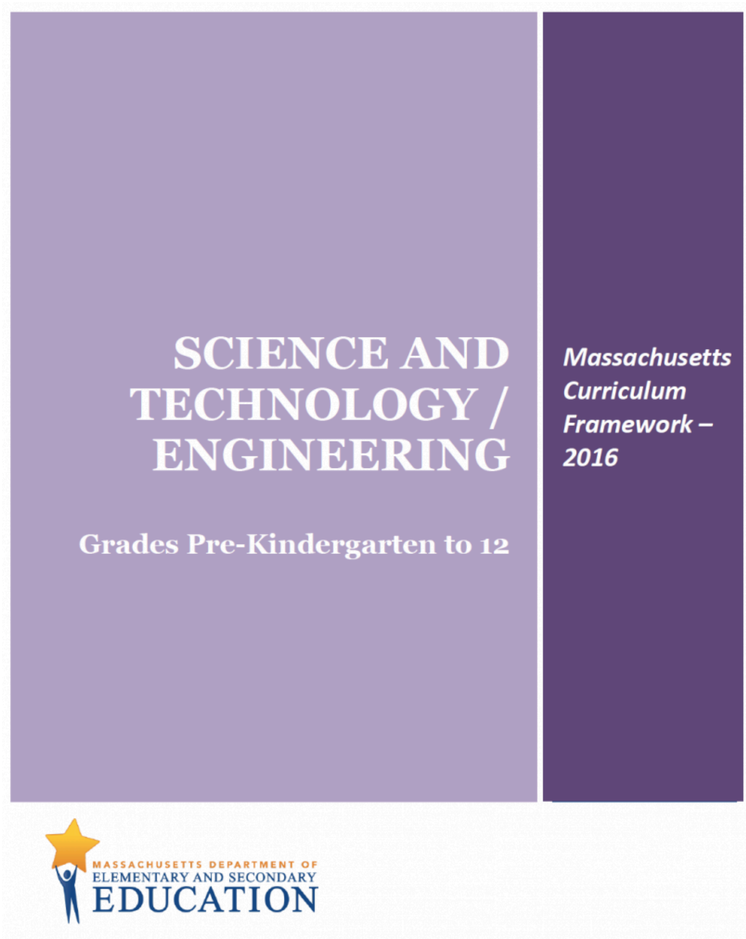
Miscellaneous

Ford Falcon

The Ford Falcon is a car that was produced by Ford between 1960-1970 as a scaled-down version of the Ford Galaxie. It was the best-selling compact car at that time. Interestingly, commercials advertising it featured Charles Schultz's "Peanuts" characters.

PART II

SCIENCE AND TECHNOLOGY/ ENGINEERING


SCIENCE AND TECHNOLOGY / ENGINEERING

Grades Pre-Kindergarten to 12

Massachusetts Curriculum Framework – 2016

MASSACHUSETTS DEPARTMENT OF ELEMENTARY AND SECONDARY EDUCATION

Science and Technology/Engineering Massachusetts Curriculum

Science and Technology/Engineering Education for All Students: The Vision[1]

Our world has never been so complex, and scientific and technological reasoning have never been so necessary to make sense of it all. It is self-evident that science, technology, and engineering (STE) are central to the lives of all Massachusetts citizens when they analyze current events, make informed decisions about healthcare, or decide to support public development of community infrastructure. By the end of grade 12, all students must have an appreciation for the wonder of science, possess sufficient knowledge of science and engineering to engage in public discussions on related issues, and be careful consumers of scientific and technological information and products in their everyday lives. Students' STE experience should encourage and facilitate engagement in STE to prepare them for the reality that most careers require some scientific or technical preparation, and to increase their interest in and consideration of careers in science, technology, engineering, and mathematics (STEM). All students, regardless of their future education plan and career path, must have an engaging, rele-

1. Massachusetts Department of Elementary and Secondary Education (2022). *SCIENCE AND TECHNOLOGY / ENGINEERING Grades Pre-Kindergarten to 12 Massachusetts Curriculum Framework*. https://www.doe.mass.edu/frameworks/current.html

vant, rigorous, and coherent pre-K–12 STE education to be prepared for citizenship, continuing education, and careers.

Qualities of Science and Technology/ Engineering Education for All Students

Student engagement with science and technology/engineering is a critical emphasis that can only be achieved through quality curriculum and instruction. The standards attend to relevance, rigor, and coherence, each of which has a corresponding implication for curriculum and instruction:

Engagement

Students need regular opportunities to experience the dynamic, interdisciplinary nature of science and technology/ engineering. Curriculum and instruction should instill wonder in students about the world around them through engaging and exciting learning experiences. Students should develop a passion about the natural and designed world and model the inquisitive, analytical, and skeptical nature of science. These goals can only be achieved through a rich and varied STE curriculum that includes thoughtful hands-on and minds-on activities, laboratories, investigations, and design challenges. Students take ownership and responsibility in their learning when they have a role in making decisions and reflecting on their learning. Active engagement in learning promotes a "growth mindset" that allows students to feel they can access content and develop skills, and thus succeed in STE. Instruction designed for student engagement is key to achieving this.

Relevance

Students often want to know why they are learning content in the classroom that seems unrelated to the real world. To understand the world around them, and be more interested in learning about it, they must have opportunities to apply their learning to relevant situations and contexts. The STE standards emphasize the application of knowledge and skills that students need to be analytical thinkers and problem solvers for issues that are crucial in today's world. Relevance in curriculum and instruction is also about meeting the needs of diverse learners, including minorities, females, and those on Individualized Education Program, of low socioeconomic status, or otherwise not traditionally represented in science, technology, and engineering. To focus on relevance, the STE standards emphasize fewer core ideas over lists of discrete knowledge. For example, understanding the function of living systems includes understanding the role of feedback mechanisms. Feedback mechanisms in organisms allow them to remain stable and stay alive by making changes to maintain appropriate internal conditions even as external conditions change. A similar principle applies to ecosystems and to designed systems such as home heating and cooling systems. This focus on interactions in living systems is different from an emphasis on identification of body parts or components of an ecosystem. A focus on core ideas helps students to understand mechanisms and causes underlying a range of phenomena and apply their content understandings to real-world and novel situations (NRC, 2012). Knowledge alone is not enough: students need to be able to act on that knowledge. Students need to be able to apply science and engineering practices—skills that let them analyze a natural phenomenon or designed system and determine underlying mechanisms and causes—in civic, college, and career contexts. Coupling practice with content gives the context for performance, whereas practices alone are activities and content alone is memorization. Quality STE education must attend to both in order for students to successfully apply their learning to understand and analyze their world.

Rigor

Rigor in STE teaching and learning is achieved by relating conceptual understanding of core ideas (content), science and engineering practices (skills), and application of those to the natural and designed world. Such rigor is how students will be able to apply or transfer their school learning to civic, college, and career contexts. The STE standards are explicitly designed to relate these three aspects in learning outcomes; curriculum and instruction should do so as well.

Coherence

Quality STE education is purposefully designed to support a progression of learning over time. STE education begins early, when children are natural investigators who build and ask questions in many contexts. This should be nurtured through subsequent years. Students should be engaged in developing and applying the science and engineering practices with the core ideas throughout pre-K–12. Every grade's STE education should build on the prior year, support the development of more sophisticated skills, increase the opportunity to relate and use multiple practices at once, and provide more sophisticated concepts and tasks in which to apply the practices. Integration of practices with concepts in purposeful ways throughout pre-K–12 ensures that all students have the opportunity to learn and apply scientific and technical reasoning in a wide array of contexts and situations that they need for postsecondary success. This can only happen if curriculum and instruction is purposefully designed to be coherent across time.

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13. Categorical Index of Lesson Plans

LAUREN WEISS

This is an index of the falcon curriculum lesson plans as categorized by both Common Core Standards, Falcon Curriculum Core Categories, a brief description of the lesson, and its related activities. Each Common Core Standard links directly to the lesson in question.

Common Core Standards	Falcon Curriculum Core Categories	Description	Activities
PreK-ESS1-2(MA)	Animal Behavior	Diurnal/ noctural; positions of the sun and falcon behavior.	Sun and moon cutouts.
PreK-ESS2-1(MA) PreK-ESS2-2(MA)	Geography	Peregrine falcon habitats.	Peregrine falcon sensory bins.
PreK-ESS3-1(MA) PreK-ESS3-2(MA)	Conservation and Policy	Basic conservation; how peregrine falcons were brought back from endangerment/ extirpation.	Falcon scavenger hunt.
PreK-LS1-1(MA)	Anatomy and Life Cycle	How birds are built; parts of a peregrine falcon.	Falcon toilet paper roll craft.
PreK-LS1-2(MA) PreK-LS1-3(MA)	Animal Behavior	Peregrine falcon 5 senses.	5 senses activity.
PreK-LS2-1(MA)	Anatomy and Life Cycle	Distinguishing living things from non-living things.	Peregrine falcon sensory bins.
PreK-LS2-2(MA) PreK-LS2-3(MA)	Geography Animal Behavior	What peregrine falcons eat.	Birdwatching. Recycled bottle bird feeders.
PreK-LS3-1(MA) PreK-LS3-2(MA)	Anatomy and Life Cycle	Heredity amongst chicks; differences between adults and juveniles.	Cotton ball chick craft.

PreK-PS1-2(MA)	Anatomy and Life Cycle	Describe, compare, sort, and classify natural and human-made objects.	Peregrine falcon sensory bins.
PreK-PS2-1(MA)	Animal Behavior	Peregrine falcon movement and flight.	Bird yoga. Bird wings craft.
K-ESS2-2	Conservation and Policy	Humans changed the environment with pesticides, realized it, and began focusing on conservation.	Soft shelled egg experiment.
K-ESS3-1(MA)	Animal Behavior	How weather affects peregrine falcons.	Illustrate weather-related activities for humans and falcons.
K-LS1-1(MA)	Anatomy and Life Cycle	What peregrine falcons eat.	Birdwatching. Recycled bottle bird feeders.
K-LS1-2(MA)	Anatomy and Life Cycle	How peregrine falcons grow up.	"Head, Feathers, Wings, and Feet" Hatching Chick Craft
K-PS2-1	Animal Behavior	Peregrine falcon flight.	Flying bird craft. Bird yoga.
1-LS1-1	Anatomy and Life Cycle	How peregrine falcons use their body parts and senses.	5 senses activity.
1-LS1-2	Anatomy and Life Cycle Animal Behavior	How peregrine falcon parents take care of their offspring.	Venn diagram between falcon and human parents/ guardians.

1-LS3-1	Anatomy and Life Cycle	Observe similarities and differences between peregrine falcons (sexual dimorphism, etc.)	Coloring actual size falcon silhouettes.
1.K-2-ETS1-1 1.K-2-ETS1-2	Conservation and Policy	Human-made nests for peregrine falcons.	Shoebox dioramas of nest boxes.
2-LS2-3(MA)	Geography Animal Behavior	Peregrine falcon habitats.	Shoebox dioramas.
2-LS4-1	Geography Animal Behavior	Observe and compare different types of falcons in addition to peregrine falcons.	Venn diagrams comparing/ contrasting peregrine falcons and other types of falcons.
3-LS1-1	Anatomy and Life Cycle Animal Behavior	Peregrine falcon life cycle.	Journals chronicling the falcon cam livestream.
3-LS3-1 3-LS3-2	Anatomy and Life Cycle Animal Behavior Geography	Heredity; inherited traits vs. traits resulting from environment.	“Birds of Prey” panel recording. Journals chronicling the falcon cam livestream.
3-LS4-2 3-LS4-3	Anatomy and Life Cycle Animal Behavior Geography	Variation in characteristics providing advantages to survival and reproduction.	LEGO bird building.
3-LS4-4 3-LS4-5	Conservation and Policy	Changes in peregrine falcon habitats caused by pesticides; peregrine falcon conservation.	Soft shelled egg experiment.

3-PS2-1	Animal Behavior	Peregrine falcon flight.	Audubon for Kids paper airplane birds.
4-LS1-1	Anatomy and Life Cycle Animal Behavior	Peregrine falcon anatomy, life cycle, and behavior.	Journals chronicling the falcon cam livestream.
4-PS3-1 4-PS3-3	Anatomy and Life Cycle Animal Behavior	Peregrine falcon flight.	Audubon for Kids paper airplane birds.
4.3-5-ETS1-3 4.3-5-ETS1-5(MA)	Anatomy and Life Cycle Animal Behavior	Peregrine falcon flight.	Audubon for Kids paper airplane birds; designing their own paper airplanes.
5-ESS3-1	Conservation and Policy	Changes in peregrine falcon habitats caused by pesticides; peregrine falcon conservation.	Soft shelled egg experiment.
5-LS2-1	Anatomy and Life Cycle Animal Behavior	Movement of matter.	Movement of matter charts.
5-PS3-1	Anatomy and Life Cycle Animal Behavior	Energy.	Movement of matter charts.
6.MS-LS1-3	Anatomy and Life Cycle	Peregrine falcon anatomy.	Dissect owl pellets.
7.MS-LS1-4	Animal Behavior	Peregrine falcon behavior.	Journals chronicling the falcon cam livestream.

7.MS-LS2-2 7.MS-LS2-4	Conservation and Policy	Relationship between humans and peregrine falcons, historically and currently.	Timelines.
7.MS-PS3-1	Anatomy and Life Cycle Animal Behavior	Advantages of sexual dimorphism in peregrine falcons, especially in relation to hunting.	Wingshot experiment.
8.MS-LS1-5	Anatomy and Life Cycle Geography	Environmental and genetic factors that influence the growth of peregrine falcons.	Case study: 72/BV.
8.MS-LS4-4 8.MS-LS4-5	Anatomy and Life Cycle Geography	Genetic variations in falcon subspecies; humans changing the inheritance of desired traits in them to restore falcon populations.	Falcon family tree.
8.MS-PS2-1	Animal Behavior	Newton's third law and falcon stoops.	Caw-tapult experiment.
HS-LS2-7	Conservation and Policy	Effects of human activity on peregrine falcons; conservation.	Anti-pesticide pamphlets.
HS-PS2-1	Animal Behavior	Newton's second law, sexual dimorphism, and falcon stoops.	Wingshot experiment.

HS-ETS1-1	Anatomy and Life Cycle Animal Behavior	How studying peregrine falcons (and nature in general) can inspire design solutions to complex, real-world problems.	Article Identifying design problems that could be improved by studying peregrine falcons.

14. Grades PreK - 2nd

Grades Pre-K–2: Overview of Science and Engineering[1]

Practices

The development of science and engineering practices begins very early, even as babies and young children inquire about and explore how the world works. Formal education should advance students' development of the skills necessary to engage in scientific inquiry and engineering design. These are the skills that provide the foundation for the scientific and technical reasoning that is so critical to success in civic life, postsecondary education, and careers. Inclusion of science and engineering practices in standards only speaks to the types of performances students should be able to demonstrate at the end of instruction at a particular grade; the standards do not

1. Massachusetts Department of Elementary and Secondary Education (2022). *SCIENCE AND TECHNOLOGY / ENGINEERING Grades Pre-Kindergarten to 12 Massachusetts Curriculum Framework*. https://www.doe.mass.edu/frameworks/current.html

limit what educators and students should or can be engaged in through a well-rounded curriculum.

Pre-K through grade 2 standards integrate all eight science and engineering practices. Pre-K standards ask students to demonstrate an ability to ask questions, set up simple investigations, analyze evidence, observations, and data for patterns, and use evidence to explain or develop ideas about how phenomena work. Kindergarten standards call for students to show further development of investigation and communication skills, as well as application of science concepts to designing solutions to problems, and to now use information obtained from text and media sources. Grade 1 standards call for students to continue developing investigation skills, including their ability to pose scientific questions as well as their ability to analyze observations and data and to effectively use informational sources. Grade 1 standards also call for students to demonstrate their ability to craft scientific explanations using evidence from a variety of sources. Grade 2 standards call for students to use models in a scientific context and further their skills in a number of the practices, including investigations, data analysis, designing solutions, argumentation, and use of informational sources.

Some examples of specific skills students should develop in these grades:

1. Raise questions about how different types of environments provide homes for living things; ask and/or identify questions that can be answered by an investigation.
2. Use a model to compare how plants and animals depend on their surroundings; develop and/or use a model to represent amounts, relationships, and/or patterns in the natural world; distinguish between a model and the actual object and/or process the model represents.
3. Conduct an investigation of light and shadows; plan and conduct an investigation collaboratively to produce data

to answer a question; make observations and/or relative measurements to collect data that can be used to make comparisons.

4. Analyze data to identify relationships among seasonal patterns of change; use observations to describe patterns and/or relationships in the natural world and to answer scientific questions.
5. Decide when to use qualitative vs. quantitative information; use counting and numbers to describe patterns in the natural world.
6. Use information from observations to construct an evidence-based account of nature. Construct an argument with evidence for how plants and animals can change the environment; distinguish between opinions and evidence in one's own explanations; listen actively to others to indicate agreement or disagreement based on evidence.
7. Obtain information to compare ways that parents and their offspring behave to survive; obtain information using various texts, text features, or other media to answer a question.

While presented as distinct skill sets, the eight practices intentionally overlap and interconnect. Skills such as those outlined above should be reflected in curricula and instruction that engage students in an integrated use of the practices. See the Science and Engineering Practices Progression Matrix (Appendix I) for more information, including particular skills for students in grades pre-K–2.

15. Pre-Kindergarten

LAUREN WEISS AND MARGARET KRONE

The World Around Me

Pre-K students focus on experiencing and making observations of the world around them. They are beginning to learn about their own environment as they observe plants and animals, the Moon and the Sun, and the daily weather. They experience their world through their senses and body parts and begin to recognize that animals also use their senses and body parts to meet their basic needs. They investigate pitch and volume, shadow and light, liquids and solids, and how things move. They sort materials by simple observable properties such as texture and color. They share their understanding of these concepts through discussion as they develop their language and quantitative skills. Pre-K students build awareness of the wide variety of natural phenomena and processes in the world around them.[1][2]

1. Massachusetts Department of Elementary and Secondary Education (2022). *SCIENCE AND TECHNOLOGY / ENGINEERING Grades Pre-Kindergarten to 12 Massachusetts Curriculum Framework*. https://www.doe.mass.edu/frameworks/current.html
2. Falcon Curriculum Common Core Standards mapping by Margaret Krone. Falcon Curriculum Lesson Plans by Lauren Weiss.

PreK-ESS: Earth and Space Sciences

ESS1. Earth's Place in the Universe

- **PreK-ESS1-2(MA).** Observe and use evidence to describe that the sun is in different places in the sky during the day.

Falcon Curriculum Core Categories

Animal Behavior

Falcon Curriculum Essential Question

Where is the sun when the falcons do different behaviors (i.e. eat, hunt, rest, etc.)?

Materials

For Instructors	For Students
• About Falcons: Basic Info • Falcon Cam livestream (or, if not taught between March-June when it is up, use falcon cam prerecorded video clips)	• Falcon Coloring Sheet • Cutouts of sun and moon • Glue/tape

Sample Plan

Talk about how there are 2 types of birds: birds that are active during the day and sleep at night (diurnal) and birds that sleep during the day and are active at night (nocturnal). Falcons are active during the day. Ask students which best describes them: diurnal or nocturnal. Ask for examples.

Observe the falcon cam livestream at different points during the day (or scroll through the falcon cam prerecorded video clips) with students, and have them identify the positions of the sun throughout the day as the falcons do different behaviors (eating, resting, etc.). Compare/contrast with the positions of the sun when students do those activities. (Note that falcons will rest and loaf during the day, too, especially as chicks, like when students and/or their younger siblings take naps.)

Have students color the coloring sheet and glue/tape the sun and moon on the appropriate side.

PreK-ESS: Earth and Space Sciences

ESS2. Earth's Systems

- **PreK-ESS2-1(MA).** Raise questions and engage in discussions about how different types of local environments (including water) provide homes for different kinds of living things.
- **PreK-ESS2-2(MA).** Observe and classify non-living materials, natural and human made, in the local environment.

Falcon Curriculum Core Categories

Geography

Falcon Curriculum Essential Question

Where do falcons live, and what non-living materials do they use in their nest sites?

Materials

For Instructors	For Students
• About Falcons: Habitat • Falcon Curriculum: Habitat videos • Falcon Cam livestream (or, if not taught between March-June when it is up, use falcon cam prerecorded video clips) • Images of falcon nests in the wild and in urban areas • If in Massachusetts, you can use the local Massachusetts maps to show students where falcons are in the state	• Peregrine falcon habitat sensory bins ◦ Plastic bins ◦ Materials simulating what falcons use/have in their nests ■ Pea gravel ■ Feathers ■ Eggshells (could use real or fake) ■ White pom-poms or cotton balls with eyes and beaks glued on to be chicks ■ Sticks/dowels for perches

Sample Plan

View the Falcon Curriculum: Habitat videos and look at photos of the peregrine falcon nests in the wild and in urban areas. Ask students why they think falcons like to nest on tall cliffs and buildings. Ask them if they were a falcon, would they prefer to live on a cliff or a tall building, and why.

Watch the falcon cam to see what the falcons have in their nest boxes.

Have students examine, touch, and classify the different materials in the sensory bins (pea gravel, feathers, etc.), asking them about each one and where it came from.

PreK-ESS: Earth and Space Sciences

ESS3. Earth and Human Activity

- **PreK-ESS3-1(MA).** Engage in discussion and raise questions using examples about local resources (including soil and water) humans need to meet their needs.
- **PreK-ESS3-2(MA).** Observe and discuss the impact of people's activities on the Local Environment.

Falcon Curriculum Core Categories

Conservation and Policy

Falcon Curriculum Essential Question

What local resources do humans need to meet their needs, and how have humans using those resources affected the local environment/peregrine falcons?

Materials

For Instructors	For Students

• About Falcons: Conservation
• Falcon Curriculum: Conservation, Beginner videos
• Banding videos
• Banding Scavenger Hunt falcons
  ◦ 1
  ◦ 2
  ◦ 3
  ◦ 4
  ◦ 5
  ◦ 6
  ◦ 7
  ◦ 8
  ◦ 9
  ◦ 10
  ◦ 11
  ◦ 12
  ◦ 13
	• Scavenger hunt sheet
	• Pencils

Sample Plan

Watch the Falcon Curriculum: Conservation, Beginner videos. Talk about how humans used DDT to get rid of insects that ate their crops and made them sick, but DDT was bad for the environment and made peregrine falcons almost disappear from North America. That's when Rachel Carson showed people how bad DDT was, and people listened and passed laws to stop it from being used. Also, Tom Cade started a program to have peregrine falcons lay eggs not in the wild so they would be good and hatch. Now, there are lots of peregrine falcons around.

Talk about how people are still helping peregrine falcons today, like how wildlife experts watch peregrine falcon nests to make sure they are doing well and then band the chicks so they can identify them when they fly away. This helps them study peregrine falcons. Watch the Banding videos.

Do the Banding Day Scavenger Hunt:

1. Print and cut out the Banding Day falcons. Each has a different leg band.
2. Hide them around the room.
3. Print out the scavenger hunt sheets.
4. Tell students they are going to pretend to be wildlife experts and have to find and identify the different falcons. They can either go around as a class/small groups or individually and cross each bird's band off their identification sheet as they find it.

PreK-LS: Life Science

LS1. From Molecules to Organisms: Structures and Processes

- **PreK-LS1-1(MA).** Compare, using descriptions and drawings, the external body parts of animals (including humans) and plants and explain functions of some of the observable body parts.

Falcon Curriculum Core Categories

Anatomy and Life Cycle

Falcon Curriculum Essential Question

How are birds built? What are the body parts of a peregrine falcon?

Materials

For Instructors	For Students
• About Falcons: Basic Info, Appearance • Falcon Curriculum: Basic Information videos	• Falcon Toilet Paper Roll Craft ◦ Toilet paper rolls (empty) (1 per student) ◦ Falcon parts to color, cut, and paste ◦ Gray and white paper or tissue paper ◦ Black paper ◦ Google eyes ◦ Coloring materials ◦ Scissors ◦ Glue

Sample Plan

Watch the Falcon Curriculum: Basic Information videos. Talk about the different parts of a falcon (beak, wings, talons, etc.) and how they are similar and different to humans.

Teach them “Head, Feathers, Wings, and Feet” with motions towards each part mentioned:

“Head, Feathers, Wings and Feet”

(To the tune of “Head, Shoulders, Knees, and Toes”)

Head, feathers, wings, and feet
Wings and feet
Head, feathers, wings, and feet
Wings and feet
Eyes and tail and talons and beak
Head, feathers, wings, and feet
Wings and feet

Do the Falcon Toilet Paper Roll Craft:

1. Have students identify, color, and cut out the falcon parts.
2. Stand the toilet paper roll upright.
3. Glue gray paper/tissue paper around the roll.
4. Glue a rounded section of white tissue paper on the front.
5. Glue 2 strips of black paper vertically on the face; then glue the eyes over them.
6. Glue the other parts in the appropriate places.
7. Students can either take them home or you can “perch” them on high places/hang them from the ceiling around the classroom!

PreK-LS: Life Science

LS1. From Molecules to Organisms: Structures and Processes

- **PreK-LS1-2(MA).** Explain that most animals have five senses they use to gather information about the world around them.
- **PreK-LS1-3(MA).** Use their five senses in their exploration and play to gather information.

Falcon Curriculum Core Categories

Animal Behavior

Falcon Curriculum Essential Question

How do peregrine falcons use their five senses to survive?

Materials

For Instructors	For Students
• About Falcons: Five Senses • Falcon Curriculum: Basic Information videos	• Five Senses Activity ◦ Binoculars and/or telescope ◦ Falcon audio clips ◦ Various natural materials with smells (spices, scratch and sniff stickers, etc.) ◦ Various materials to taste (sweet, salty, sour, etc.) ◦ Various materials to touch (hard, soft, squishy, bumpy, smooth, etc.)

Sample Plan

Review the five senses. Watch the Falcon Curriculum: Basic Information videos. Talk about how falcons use their five senses and how they are similar/different to humans.

Do the Five Senses Activity:

1. Sight: Talk about how a falcon’s vision is 8 times better than humans. Have students use the binoculars/telescope as examples of how much better a falcon’s vision is than theirs.
2. Hearing: Play the various falcon audio clips and see if students can hear the differences between them. Have them try to imitate the different sounds.

3. Smell: Falcons have a basic sense of smell. Humans do not. Have the students close their eyes or blindfold them and see if they can identify various smells.
4. Taste: Falcons have a basic sense of taste. Humans do not. Have students close their eyes or blindfold them; then have them hold their nose and see if they can identify the different tastes. Then have them not hold their nose and do it again to experience the difference.
5. Touch: Falcons use their sense of touch quite a bit. Have students do a “Tonight Show”-style mystery box, where they reach into a box that they cannot see inside and try to guess what is inside based on how it feels. You can also have students try and experience touch like a falcon by asking them to try and pick up an object using only their feet/toes.

PreK-LS: Life Science

LS2. Ecosystems: Interactions, Energy, and Dynamics

- **PreK-LS2-1(MA).** Use evidence from animals and plants that define several characteristics of living things that distinguish them from non-living things.

Falcon Curriculum Core Categories

Anatomy and Life Cycle

Falcon Curriculum Essential Question

What are characteristics of living things that distinguish them from non-living things?

Materials

For Instructors	For Students
• About Falcons: Habitat • Falcon Curriculum: Habitat videos • Falcon Cam livestream (or, if not taught between March-June when it is up, use falcon cam prerecorded video clips) • Images of falcon nests in the wild and in urban areas • If in Massachusetts, you can use the local Massachusetts maps to show students where falcons are in the state	• Peregrine falcon habitat sensory bins ◦ Plastic bins ◦ Materials simulating what falcons use/have in their nests ■ Pea gravel ■ Feathers ■ Eggshells (could use real or fake) ■ White pom-poms or cotton balls with eyes and beaks glued on to be chicks ■ Sticks/dowels for perches

Sample Plan

This lesson is meant to be taught in conjunction with PreK-ESS2-1(MA) and PreK-ESS2-2(MA). As you talk about the falcons' habitats and do the sensory bins, have students discuss characteristics of living things (i.e. falcons) that distinguish them from non-living things (i.e. gravel, etc.).

PreK-LS: Life Science

LS2. Ecosystems: Interactions, Energy, and Dynamics

- **PreK-LS2-2(MA).** Using evidence from the local environment, explain how familiar plant and animals meet their needs where they live.
- **PreK-LS2-3(MA).** Give examples from the local environment of how animals and plants are dependent on one another to meet their basic needs.

Falcon Curriculum Core Categories

Geography
Animal Behavior

Falcon Curriculum Essential Question

What do peregrine falcons eat?

Materials

For Instructors	For Students
• About Falcons: Prey and Hunting • Falcon Curriculum: Prey and Hunting videos • Images of the types of birds that constitute falcons' prey (see Images section)	• Binoculars • Recycled Bottle Bird Feeder ◦ Empty clean recycled plastic bottles (1/student) ◦ Scissors ◦ Sticks/dowels for a perch (1/student) ◦ Birdseed suitable for local wildlife ◦ String

Sample Plan

Watch the Falcon Curriculum: Prey and Hunting videos. Look at images of the prey. Ask students if they've ever seen or heard some of them.

Take a nature walk and go birdwatching/bird listening.

Make recycled bottle bird feeders to attract these birds and have students start to be able to identify local species. Compare the birds they see at the bird feeders to falcons (appearance, sound, etc.).

1. Cut a large hole on one side of the plastic bottle for the birds to feed from, and 2 smaller circular holes opposite each other below it for the perch to go through (adults may want to do this part).
2. Put the perch through those 2 small circular holes.
3. Fill the bottle with birdseed up to the large hole so it doesn't spill out.
4. Tie the string around the top of the bottle.
5. Hang it from a tree and observe the birds that use it.

PreK-LS: Life Science

LS3. Heredity: Inheritance and Variation of Traits

- **PreK-LS3-1(MA).** Use observations to explain that young plants and animals are like but not exactly like their parents.
- **PreK-LS3-2(MA).** Use observations to recognize differences and similarities among themselves and their friends.

Falcon Curriculum Core Categories

Anatomy and Life Cycle

Falcon Curriculum Essential Question

How are young falcons (chicks and juveniles) similar and different from their parents and each other?

Materials

For Instructors	For Students
• About Falcons: Appearance, Life Cycle • Falcon Curriculum: Life Cycle videos • Falcon Cam livestream (or, if not taught between March-June when it is up, use falcon cam prerecorded video clips)	• Cotton Ball Chick Craft ◦ Small paper plates (not coated) ◦ White paper ◦ Cotton balls ◦ Google eyes ◦ Triangles cut out of gray paper (for the beaks) ◦ Glue

Sample Plan

Watch the Falcon Curriculum: Life Cycle videos. See how the chicks develop into juveniles and then adults. If possible, this lesson should be taught during March-June, when the falcon cam livestream is up, and students can see the chicks' development on camera. Talk about the similarities and differences between the chicks, juveniles, and adults (color, etc.).

Do the cotton ball chick craft:

1. Help students trace and cut out their handprints on white paper. These will be the chicks' wings.
2. Paste the handprint cutouts on either side of the paper plate.
3. Have students paste the eyes and beak onto the plate in the appropriate locations.
4. Have students paste on lots of cotton balls to resemble the white down fluff of the chick.
5. Once dry, hang up all the chicks on a bulletin board in the classroom. Point out how they are all peregrine falcon chicks, but each chick looks a little different from each other, just like each student looks different from each

other.

PreK-PS: Physical Sciences

PS1. Matter and Its Interactions

- **PreK-PS1-2(MA).** Investigate natural and human-made objects to describe, compare, sort, and classify objects based on observable physical characteristics, uses, and whether something is manufactured or occurs in nature.

Falcon Curriculum Core Categories

Anatomy and Life Cycle

Falcon Curriculum Essential Question

How can we describe, compare, sort, and classify objects based on observable physical characteristics, uses, and whether something is manufactured or occurs in nature?

Materials

<table>
<tr><th>For Instructors</th><th>For Students</th></tr>
<tr><td>

About Falcons: Habitat
Falcon Curriculum: Habitat videos
Falcon Cam livestream (or, if not taught between March-June when it is up, use falcon cam prerecorded video clips)
Images of falcon nests in the wild and in urban areas
If in Massachusetts, you can use the local Massachusetts maps to show students where falcons are in the state

</td><td>

Peregrine falcon habitat sensory bins

Plastic bins
Materials simulating what falcons use/have in their nests

Pea gravel
Feathers
Eggshells (could use real or fake)
White pom-poms or cotton balls with eyes and beaks glued on to be chicks
Sticks/dowels for perches

</td></tr>
</table>

This lesson is meant to be taught in conjunction with PreK-ESS2-1(MA) and PreK-ESS2-2(MA). As you talk about the falcons' habitats and do the sensory bins, have students describe, compare, sort, and classify the materials based on observable physical characteristics, uses, and whether they are manufactured or occur in nature.

PreK-PS: Physical Sciences

PS2. Motion and Stability: Forces and Interactions

- **PreK-PS2-1(MA).** Using evidence, discuss ideas about what is making something move the way it does and how some movements can be controlled.

Falcon Curriculum Core Categories

Animal Behavior

Falcon Curriculum Essential Question

How do falcons move and fly?

Materials

For Instructors	For Students
• About Falcons: Flight • Falcon Curriculum: Flight videos • Bird yoga chart	• Bird Wings Craft ◦ Paper grocery bags ◦ Scissors ◦ Glue/tape ◦ Coloring materials (optional) ◦ Feathers (optional)

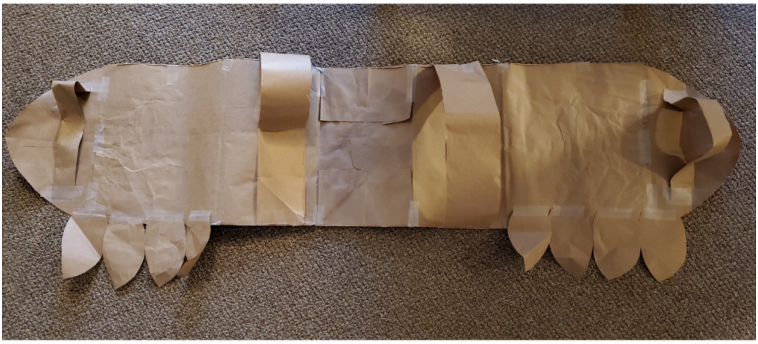
Sample Plan

Watch the Falcon Curriculum: Flight videos. Talk about how many birds' wings and bodies let them move and fly the way they do. Compare/contrast with their bodies (i.e. humans don't have wings/feathers/etc. so they cannot fly like birds). Ask students about different ways that humans can "fly" (i.e. planes, helicopters, hang gliding, parasailing, hot air balloons, etc.).

Do bird yoga with them.

Do the Bird Wings Craft:

1. Cut open a paper grocery bag so the front and back are still attached to the bottom, but the 2 smaller, skinny sides get cut off. This opens up the bag.
2. Shape the opened-up bag into wings; the bottom goes against the student's back.
3. Use the cut-off skinny sides as straps to hold the wings in place on the student. 2 straps like backpack straps and 2 straps for them to hold with their hands are needed to hold the wings in place.
4. Optional: You can have students decorate them if they want.
5. Have them wear them and see how they move/feel.



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- Recycled Bottle Bird Feeder © Lauren Weiss is licensed under a CC BY (Attribution) license
- Cotton Ball Chick Craft © Lauren Weiss is licensed under a CC BY (Attribution) license
- Paper Grocery Bag Falcon Wings © Lauren Weiss is licensed under a CC BY (Attribution) license

16. Kindergarten

LAUREN WEISS AND MARGARET KRONE

Reasons for Change

In kindergarten, students build on early experiences observing the world around them as they continue to make observations that are more quantitative in nature and help them identify why some changes occur. Students begin to learn to use these observations as evidence to support a claim through growing language skills. They learn that all animals and plants need food, water, and air to grow and thrive and that the fundamental difference between plants and animals is a plant's ability to make its own food. Students build their quantitative knowledge of temperature in relation to the weather and its effect on different kinds of materials. They observe that the amount of sunlight shining on a surface causes a temperature change and they design a structure to reduce the warming effects of sunlight. They investigate motions of objects by changing the strength and direction of pushes and pulls. They provide examples of plants and animals that can change their environment through their interactions with it. In kindergarten science, students begin to identify reasons for changes in some common phenomena.[1] [2]

1. Massachusetts Department of Elementary and Secondary Education (2022). *SCIENCE AND TECHNOLOGY / ENGINEERING Grades Pre-Kindergarten to 12 Massachusetts Curriculum Framework*. https://www.doe.mass.edu/frameworks/current.html
2. Falcon Curriculum Common Core Standards mapping by Margaret

K-ESS: Earth and Space Sciences

ESS2. Earth's Systems

- **K-ESS2-2.** Construct an argument supported by evidence for how plants and animals (including humans) can change the environment.

Falcon Curriculum Core Categories

Conservation and Policy

Falcon Curriculum Essential Question

How have humans changed the environment for peregrine falcons?

Materials

For Instructors	For Students

• About Falcons: Conservation
• Falcon Curriculum: Conservation, Beginner videos
	• Soft Shelled Egg Experiment
	  ◦ Eggs (hardboiled is fine)
	  ◦ Vinegar (enough for 1 cup/experiment setup)
	  ◦ Clear jars/containers big enough to hold 1 egg and 1 cup of vinegar
	  ◦ Measuring cups

Sample Plan

Watch the Falcon Curriculum: Conservation, Beginner videos. Talk about how humans used DDT to change the environment by getting rid of insects that ate their crops and made them sick, but DDT was bad for the environment and when peregrine falcons ate the birds that ate the bugs that had DDT on them, it made the falcons lay soft-shelled eggs that couldn't hatch.

Do the Soft Shelled Egg Experiment:

1. Have them all feel how hard an eggshell is normally (you can use a hardboiled one so it doesn't break all over them).
2. Pour 1 cup vinegar into clear jar/container.

3. Add the egg.
4. Talk about what happens (bubbles will rise from the egg).
5. Leave the egg in the vinegar for 1 day.
6. Remove the egg and have them all feel it (soft). IMPORTANT: if you are using a raw egg and not hardboiled, make sure the students are gentle with it when they touch it, or it will break all over.
7. Explain that this is like what happened with the peregrine falcon eggs.

K-ESS: Earth and Space Sciences

ESS3. Earth and Human Activity

- K-ESS3-1(MA). Obtain and use information about weather forecasting to prepare for, and respond to different types of local weather.

Falcon Curriculum Core Categories

Animal Behavior

Falcon Curriculum Essential Question

How does weather affect peregrine falcons?

Materials

For Instructors	For Students
• About Falcons: Other Behaviors • Falcon Curriculum: Behaviors video	• Photos of nest box (see Images section) • Paper • Coloring materials

Sample Plan

Watch the Falcon Curriculum: Behaviors video, as well as videos of the Falcon Cam, and look at photos. Talk about how falcons pant when it's hot and fluff up their feathers when it's cold. Also talk about how, if it's too cold, eggs could freeze and not hatch. That is why the new nest box on the W. E. B. Du Bois Library (2022) has more covering on the sides: to protect the falcons and their eggs from the weather.

Fold a piece of paper in quarters and have students draw:

1. Top Left: what falcons do when it's hot
2. Top Right: what students do when it's hot
3. Bottom Left: what falcons do when it's cold
4. Bottom Right: what students do when it's cold

K-LS: Life Science

LS1. From Molecules to Organisms: Structures and Processes

- **K-LS1-1(MA).** Observe and communicate that animals (including humans) and plants need food, water, and air to survive. Animals get food from plants or other animals. Plants make their own food and need light to live and grow.

Falcon Curriculum Core Categories

Anatomy and Life Cycle

Falcon Curriculum Essential Question

How do falcons eat?

Materials

For Instructors	For Students
• About Falcons: Prey and Hunting • Falcon Curriculum: Prey and Hunting videos • Images of the types of birds that constitute falcons' prey (see Images section)	• Binoculars • Recycled Bottle Bird Feeder ◦ Empty clean recycled plastic bottles (1/student) ◦ Scissors ◦ Sticks/dowels for a perch (1/student) ◦ Birdseed suitable for local wildlife ◦ String

Sample Plan

Watch the Falcon Curriculum: Prey and Hunting videos. Look at images of the prey. Ask students if they've ever seen or heard some of them.

Take a nature walk and go birdwatching/bird listening.

Make recycled bottle bird feeders to attract these birds and have students start to be able to identify local species. Compare the birds they see at the bird feeders to falcons (appearance, sound, etc.).

1. Cut a large hole on one side of the plastic bottle for the birds to feed from, and 2 smaller circular holes opposite each other below it for the perch to go through (adults may want to do this part).
2. Put the perch through those 2 small circular holes.
3. Fill the bottle with birdseed up to the large hole so it doesn't spill out.
4. Tie the string around the top of the bottle.
5. Hang it from a tree and observe the birds that use it.

K-LS: Life Science

LS1. From Molecules to Organisms: Structures and Processes

- **K-LS1-2(MA).** Recognize that all plants and animals grow and change over time.

Falcon Curriculum Core Categories

Anatomy and Life Cycle

Falcon Curriculum Essential Question

How do falcons grow up?

Materials

For Instructors	For Students

• About Falcons: Life Cycle
• Falcon Curriculum: Life Cycle videos
• Falcon Cam livestream (or, if not taught between March-June when it is up, use falcon cam prerecorded video clips)
• Images of adult and young peregrine falcons (chicks and juveniles) (see Images section)
	• Hatching Chick Craft
	  ◦ Paper plates (2 per student)
	  ◦ Brad fasteners
	  ◦ Oval cutouts
	  ◦ Google eyes
	  ◦ Cotton balls
	  ◦ White feathers
	  ◦ Gray triangles for beaks
	  ◦ Coloring materials
	  ◦ Paste

Sample Plan

Watch the Falcon Curriculum: Life Cycle videos. See how the chicks develop into juveniles and then adults. Talk about the similarities and differences between them (color, etc.). If possible, this lesson should be taught between March-June, when the falcon cam livestream is up, so students can observe the chicks grow up on camera.

Teach them "Head, Feathers, Wings, and Feet" with motions towards each part mentioned:

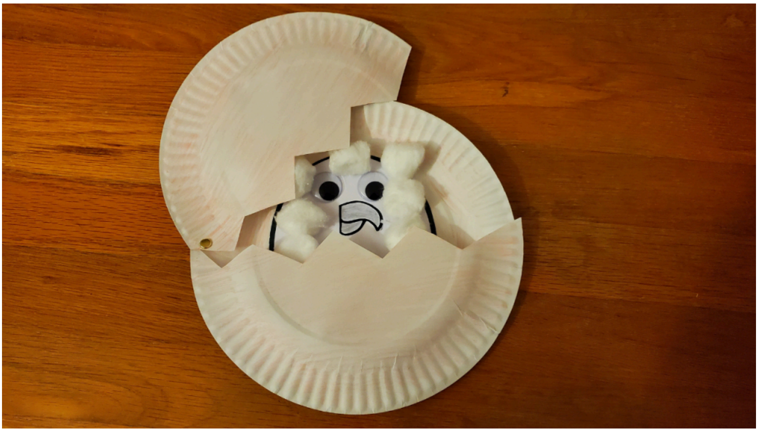
"Head, Feathers, Wings and Feet"

(To the tune of "Head, Shoulders, Knees, and Toes")

Head, feathers, wings, and feet
Wings and feet
Head, feathers, wings, and feet
Wings and feet
Eyes and tail and talons and beak
Head, feathers, wings, and feet
Wings and feet

Do the Hatching Chick Craft:

1. Take one paper plate regular side up.
2. Have students paste in the oval onto the inside center of the plate and decorate it like a chick with cotton balls for down, feathers for wings, triangles for beaks, google eyes, etc.
3. Have students decorate the outside of the other paper plate to look like a falcon egg (pinkish-brown, speckles, etc.).
4. Help students cut the other paper plate in half in a zigzag fashion to resemble 2 halves of a breaking eggshell.
5. Paste the bottom half over the bottom half of the chick plate.
6. Use a brad fastener to attach the top half to the chick plate so it can open and close, looking like the chick is hatching.



K-PS: Physical Science

PS2. Motion and Stability: Forces and Interactions

- **K-PS2-1.** Compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.

Falcon Curriculum Core Categories

Animal Behavior

Falcon Curriculum Essential Question

How do birds fly? What forces do they use/work against to fly?

Materials

For Instructors	For Students
• About Falcons: Flight • Falcon Curriculum: Flight videos • Photos of different types of bird wings (see Images section) • Flying bird craft video, used with permission from Crafts with Toddler • Bird yoga chart	• Colorful paper • Large paper • Scissors • Glue/tape • Coloring materials

Sample Plan

Watch the Falcon Curriculum: Flight videos. Talk about how birds use their wings to push against the air, which allows them to fly. Talk about the different types of bird wings and how they make birds fly differently from each other.

Do the flying bird craft as demonstrated in the first part of the Crafts with Toddler video.

Do some of the flying-inspired bird yoga poses with them.

Media Attributions

- Soft Shelled Egg Experiment Results
- Recycled Bottle Bird Feeder © Lauren Weiss is licensed under a CC BY (Attribution) license
- Hatching Chick Craft © Lauren Weiss is licensed under a CC BY (Attribution) license

17. Grade 1

LAUREN WEISS AND MARGARET KRONE

Describing Patterns

In grade 1, students have more fluency with language, number sense, and inquiry skills. This allows them to describe patterns of motion between the Sun, Moon, and stars in relation to the Earth. From this understanding they can identify seasonal patterns from sunrise and sunset data that will allow them to predict future patterns. Building from their experiences in pre-K and kindergarten observing and describing daily weather, they can now examine seasonal data on temperature and rainfall to describe patterns over time. Grade 1 students investigate sound and light through various materials. They describe patterns in how light passes through and sounds differ from different types of materials and use this to design and build a device to send a signal. Students compare the ways different animals and plants use their body parts and senses to do the things they need to do to grow and survive, including typical ways parents keep their young safe so they will survive to adulthood. They notice that though there are differences between plants or animals of the same type, the similarities of behavior and appearance are what allow us to identify them as belonging to a group. Grade 1 students begin to understand the power of patterns to predict future events in the natural and designed world.[1 2]

1-LS: Life Science

LS1. From Molecules to Organisms: Structures and Processes

- **1-LS1-1.** Use evidence to explain that (a) different animals use their body parts and senses in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water, and air, and (b) plants have roots, stems, leaves, flowers, and fruits that are used to take in water, air, and other nutrients, and produce food for the plant.

Falcon Curriculum Core Categories

Anatomy and Life Cycle

1. Massachusetts Department of Elementary and Secondary Education (2022). *SCIENCE AND TECHNOLOGY / ENGINEERING Grades Pre-Kindergarten to 12 Massachusetts Curriculum Framework*. https://www.doe.mass.edu/frameworks/current.html
2. Falcon Curriculum Common Core Standards mapping by Margaret Krone. Falcon Curriculum Lesson Plans by Lauren Weiss.

Falcon Curriculum Essential Question

How do falcons use their body parts and senses?

Materials

For Instructors	For Students
• About Falcons: Five Senses • Falcon Curriculum: Basic Information videos	• Five Senses Activity ◦ Binoculars and/or telescope ◦ Falcon audio clips ◦ Various natural materials with smells (spices, scratch and sniff stickers, etc.) ◦ Various materials to taste (sweet, salty, sour, etc.) ◦ Various materials to touch (hard, soft, squishy, bumpy, smooth, etc.)

Sample Plan

Review the five senses. Watch the Falcon Curriculum: Basic Information videos. Talk about how falcons use their five senses and how they are similar/different to humans.

Do the Five Senses Activity:

1. Sight: Talk about how a falcon's vision is 8 times better than humans. Have students use the binoculars/telescope as examples of how much better a falcon's vision is than theirs.
2. Hearing: Play the various falcon audio clips and see if students can hear the differences between them. Have them try to imitate the different sounds.

3. Smell: Falcons have a basic sense of smell. Humans do not. Have the students close their eyes or blindfold them and see if they can identify various smells.
4. Taste: Falcons have a basic sense of taste. Humans do not. Have students close their eyes or blindfold them; then have them hold their nose and see if they can identify the different tastes. Then have them not hold their nose and do it again to experience the difference.
5. Touch: Falcons use their sense of touch quite a bit. Have students do a "Tonight Show"-style mystery box, where they reach into a box that they cannot see inside and try to guess what is inside based on how it feels. You can also have students try and experience touch like a falcon by asking them to try and pick up an object using only their feet/toes.

1-LS: Life Science

LS1. From Molecules to Organisms: Structures and Processes

- **1-LS1-2.** Obtain information to compare ways in which the behavior of different animal parents and their offspring help the offspring to survive.

Falcon Curriculum Core Categories

Anatomy and Life Cycle
Animal Behavior

Falcon Curriculum Essential Question

How do falcon parents take care of their offspring? How are falcon families similar/different to human families?

Materials

For Instructors	For Students
• About Falcons: Life Cycle • Falcon Curriculum: Life Cycle videos • Falcon cam livestream, if available • Large paper or white board for Venn diagram	• Paper • Pencils • Coloring materials

Sample Plan

Ask students about specific ways that their parents/guardians take care of them. Once you come up with a few examples as a class, have each student jot down their own and illustrate it. Come back together as a class and talk about some of their examples.

Introduce or review the Venn diagram. Do one side for human families and one side for falcon families.

Watch the Falcon Curriculum: Life Cycle videos. Fill out the Venn diagram with the examples they came up with (some might be in the middle section) and new ones they learned from the videos.

If possible, this lesson should be taught during March-June when the falcon cam livestream is up, so students can observe firsthand how falcon parents care for their chicks.

1-LS: Life Science

LS3. Heredity: Inheritance and Variation of Traits

- **1-LS3-1.** Use information from observations (first hand and from media) to identify similarities and difference among individual plants or animals of the same kind.

Falcon Curriculum Core Categories

Anatomy and Life Cycle

Falcon Curriculum Essential Question

How are falcons similar to and different from each other?

Materials

For Instructors	For Students
• About Falcons: Appearance • Falcon Curriculum: Basic Information videos • Falcon photos showing sexual dimorphism (see Images section)	• Actual size falcon silhouettes

Sample Plan

Talk about how plants and animals of the same kind are both similar to and different from each other. Ask students for examples (i.e. all tigers have stripes, but each tiger has its own individual stripe pattern; roosters and hens look different; roses come in a variety of colors).

Watch the Falcon Curriculum: Basic Info videos. Look at the falcon photos. Ask students what similarities there are between male and female peregrine falcons. Ask about the main difference: size. Ask them why they think male falcons are smaller than females; use the About Falcons: Appearance section to explain.

Have students color and cut out the actual size falcon silhouettes.

1-ETS: Technology/Engineering

ETS1. Engineering Design

- **1.K-2-ETS1-1.** Ask questions, make observations, and gather information about a situation people want to change that can be solved by developing or improving an object or tool.
- **1.K-2-ETS1-2.** Generate multiple solutions to a design problem and make a drawing (plan) to represent one or more of the solutions.

Falcon Curriculum Core Categories

Conservation and Policy

Falcon Curriculum Essential Question

How can humans help falcons by building places for them to nest?

Materials

For Instructors	For Students

• About Falcons: Habitat
• Falcon Curriculum: Habitat videos
• Photos of various nest sites and nest boxes, including the old and new ones on the W. E. B. Du Bois Library (see Images section)
	• Paper
	• Coloring materials
	• Box/shoebox (either 1 for the class or 1 per group/student)
	• Materials simulating what falcons use/have in their nests
	  ◦ Pea gravel
	  ◦ Feathers
	  ◦ Eggshells (could use real or fake)
	  ◦ Sticks/dowels for perches

Sample Plan

Watch the Falcon Curriculum: Habitat videos. Look at photos and talk about the different nest sites falcons use, both in the wild and in urban settings. Discuss the challenges of building a nest in an urban area (need a high place, some sort of gravel/ material to lay eggs in where they can be safe, etc.). Look at the old Du Bois nest box and the new one. What is the same? What is different? Why is the new one more covered? (Weather protection for the falcons as more snow, etc. occurs in the early weeks of nesting.)

Ask students to design their own nest boxes that would protect and provide for the falcons and their eggs: first in a drawing/plan, and then as a shoebox diorama.

Media Attributions

- Nest Box Diorama © Lauren Weiss is licensed under a CC BY (Attribution) license

18. Grade 2

LAUREN WEISS AND MARGARET KRONE

Wholes and Parts

As students grow in their ability to speak, read, write, and reason mathematically, they also grow in their ability to grapple with larger systems and the parts that make them up. In grade 2, students start to look beyond the structures of individual plants and animals to looking at the environment in which the plants and animals live as a provider of the food, water, and shelter that the organisms need. They learn that water is found everywhere on Earth and takes different forms and shapes. They map landforms and bodies of water and observe that flowing water and wind shapes these landforms. Grade 2 students use their observation skills gained in earlier grades to classify materials based on similar properties and functions. They gain experience testing different materials to collect and then analyze data for the purpose of determining which materials are the best for a specific function. They construct large objects from smaller pieces and, conversely, learn that when materials are cut into the smallest possible pieces, they still exist as the same material that has weight. These investigations of how parts relate to the whole provide a key basis for understanding systems in later grades.[1] [2]

1. Massachusetts Department of Elementary and Secondary Education (2022). *SCIENCE AND TECHNOLOGY / ENGINEERING Grades Pre-Kindergarten to 12 Massachusetts Curriculum Framework*. https://www.doe.mass.edu/frameworks/current.html
2. Falcon Curriculum Common Core Standards mapping by Margaret

2-LS. Life Science

LS2. Ecosystems: Interactions, Energy, and Dynamics

- **2-LS2-3(MA).** Develop and use models to compare how plants and animals depend on their surroundings and other living things to meet their needs in places they live.

Falcon Curriculum Core Categories

Geography
Animal Behavior

Falcon Curriculum Essential Question

How do falcons depend on their surroundings and other living things to meet their needs in places they live?

Materials

For Instructors	For Students
• About Falcons: Habitat • About Falcons: Prey and Hunting • Falcon Curriculum: Habitat videos • Falcon Curriculum: Prey and Hunting videos	• Shoebox Diorama ◦ Shoebox (1 for each student) ◦ Various craft materials, possibly including but not limited to: ▪ Paper ▪ Coloring materials ▪ Scissors ▪ Paste ▪ Feathers ▪ Pea gravel ▪ Clay

Sample Plan

Watch the Falcon Curriculum: Habitat and Prey and Hunting videos. Talk about what falcons need to meet their needs.

Have students make shoebox dioramas of a falcon habitat, either on a cliff or in an urban area. Have them include sources of food, shelter, etc. Have them provide a written description (1-2 paragraphs) of their diorama.

2-LS. Life Science

LS4. Biological Evolution: Unity and Diversity

- **2-LS4-1.** Use texts, media, or local environments to observe and compare (a) different kinds of living things in an area, and (b) differences in kinds of living things living in different types of areas.

Falcon Curriculum Core Categories

Geography
Animal Behavior

Falcon Curriculum Essential Question

What are the similarities and differences between different types of falcons?

Materials

For Instructors	For Students
• About Falcons: Habitat • Falcon Curriculum: Habitat videos	• Paper • Pencils • Research on different types of falcons

Sample Plan

Watch the Falcon Curriculum: Habitat videos. Talk about how peregrine falcons are found all over the world except Antarctica.

Talk about how peregrine falcons are only 1 type of bird that scientists classify as a falcon. Many times, various types of falcons live in the same areas.

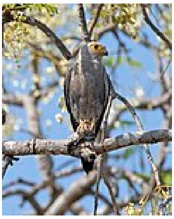
Put students into pairs. Have them make a large Venn diagram with 3 circles: 1 for the peregrine falcon, 1 for another, local type of falcon, and 1 for a falcon that lives in a completely different part of the world. One student in the pair will research a local type of falcon, and the other will research the falcon from a different part of the world.

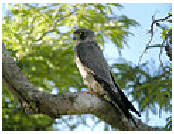
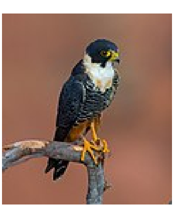
Here is a general chart of various types of falcons.[3]

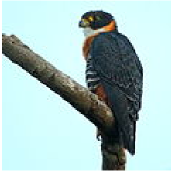
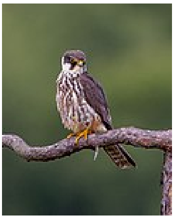
3. Wikipedia. "Falcon." Reference: White, Clayton M.; Olsen, Penny D. & Kiff, Lloyd F. (1994): Family Falconidae. In: del Hoyo, Josep; Elliott, Andrew & Sargatal, Jordi (editors): Handbook of Birds of the World, Volume 2 (New World Vultures to Guineafowl): 216–75, plates 24–28. Lynx Edicions, Barcelona. ISBN 84-87334-15-6. https://en.wikipedia.org/wiki/Falcon#Species. CC BY-SA 3.0

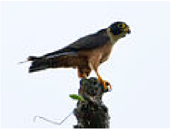
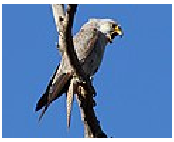
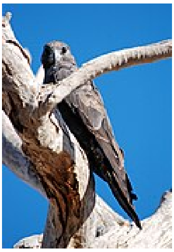
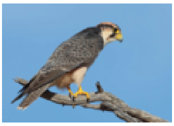
Image	Common name	Scientific name	Distribution
	Malagasy kestrel	*Falco newtoni*	Madagascar, Mayotte, and the Comores.
	Seychelles kestrel	*Falco araeus*	Seychelles Islands
	Mauritius kestrel	*Falco punctatus*	Mauritius
	Spotted kestrel	*Falco moluccensis*	Wallacea and Java
	Nankeen kestrel or Australian kestrel	*Falco cenchroides*	Australia and New Guinea
	Common kestrel	*Falco tinnunculus*	widespread in Europe, Asia, and Africa, as well as occasionally reaching the east coast of North America.

	Rock kestrel	*Falco rupicolus*	northwestern Angola and southern Democratic Republic of Congo to southern Tanzania, and south to South Africa
	Greater kestrel	*Falco rupicoloides*	Namibia, Botswana, Zimbabwe, parts of Angola and Zambia and in much of South Africa
	Fox kestrel	*Falco alopex*	south of the Sahara from Mali eastwards as far as Ethiopia and north-west Kenya. It occasionally wanders west to Senegal, the Gambia and Guinea and south to the Democratic Republic of the Congo.
	Lesser kestrel	*Falco naumanni*	Afghanistan and Central Asia, to China and Mongolia.
	Grey kestrel	*Falco ardosiaceus*	Ethiopia and western parts of Kenya and Tanzania

	Dickinson's kestrel	*Falco dickinsoni*	Mozambique, Zimbabwe, Zambia and Malawi along with north-eastern South Africa
	Banded kestrel	*Falco zoniventris*	Madagascar
	Red-necked falcon	*Falco chicquera*	Africa, India
	Red-footed falcon	*Falco vespertinus*	southern Russia and Ukraine
	Amur falcon	*Falco amurensis*	south-eastern Siberia and Northern China
	Eleonora's falcon	*Falco eleonorae*	Greece,Cyprus, the Canary Islands, Ibiza and off Spain, Italy, Croatia, Morocco and Algeria.

	Sooty falcon	*Falco concolor*	northeastern Africa to the southern Persian Gulf region
	American kestrel or “sparrow hawk”	*Falco sparverius*	central and western Alaska across northern Canada to Nova Scotia, and south throughout North America, into central Mexico and the Caribbean.
	Aplomado falcon	*Falco femoralis*	northern Mexico and Trinidad locally to southern South America
	Merlin or “pigeon hawk”	*Falco columbarius*	Eurasia, North Africa, North America
	Bat falcon	*Falco rufigularis*	tropical Mexico, Central and South America, and Trinidad

	Orange-breasted falcon	*Falco deiroleucus*	southern Mexico to northern Argentina.
	Eurasian hobby	*Falco subbuteo*	Africa, Europe and Asia.
	African hobby	*Falco cuvierii*	Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Republic of the Congo, Democratic Republic of the Congo, Ivory Coast,Eswatini, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Liberia, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Somalia, South Africa, Sudan, Tanzania, Togo, Uganda, Zambia, and Zimbabwe.

	Oriental hobby	*Falco severus*	eastern Himalayas and ranges southwards through Indochina to Australasia
	Australian hobby or little falcon	*Falco longipennis*	Australia
	New Zealand falcon or Ngarangi or kārearea	*Falco novaeseelandiae*	New Zealand
	Brown falcon	*Falco berigora*	Australia and New Guinea.
	Grey falcon	*Falco hypoleucos*	Australia
	Black falcon	*Falco subniger*	Australia.
	Lanner falcon	*Falco biarmicus*	Africa, southeast Europe and just into Asia

	Laggar falcon	*Falco jugger*	southeastern Iran, southeastern Afghanistan, Pakistan, through India, Nepal, Bhutan, Bangladesh and northwestern Myanmar.
	Saker falcon	*Falco cherrug*	Ethiopia, the Arabian peninsula, northern Pakistan and western China
	Gyrfalcon	*Falco rusticolus*	eastern and western Greenland, Canada, Alaska, and Norway.
	Prairie falcon	*Falco mexicanus*	western North America.
	Peregrine falcon	*Falco peregrinus*	Cosmopolitan

	Taita falcon	*Falco fasciinucha*	Kenya

19. Grades 3 - 5

Grades 3-5: Overview of Science and Engineering Practices[1]

Upper elementary is a critical time to engage students in the science and engineering practices. Students form key identities with, or against, science and engineering as they leave elementary school that can shape their relationship to science in later education, and even postsecondary and career choices later in life. Students must be given opportunities to develop the skills necessary for a meaningful progression of development in order to engage in the scientific and technical reasoning so critical to success in civic life, postsecondary education, and careers. Inclusion of science and engineering practices in standards only speaks to the types of performance students should be able to demonstrate at the end of instruction at a particular grade; the standards do not limit what educators and students should or can be engaged in through a well-rounded curriculum.

Standards for grades 3 through 5 integrate all eight science

1. Massachusetts Department of Elementary and Secondary Education (2022). *SCIENCE AND TECHNOLOGY / ENGINEERING Grades Pre-Kindergarten to 12 Massachusetts Curriculum Framework*. https://www.doe.mass.edu/frameworks/current.html

and engineering practices. Some examples of specific skills students should develop in these grades include:

1. Ask questions and predict outcomes about the changes in energy when objects collide; distinguish between scientific (testable) and non-scientific (non-testable) questions; define a simple design problem, including criteria for success and constraints on materials or time.
2. Use graphical representations to show differences in organisms' life cycles; develop a model of a wave to communicate wave features; use a particulate model of matter to explain phase changes; identify limitations of models; use a model to test cause and effect relationships.
3. Conduct an investigation to determine the nature of forces between magnets; make observations and collect data about the effects of mechanical weathering; conduct an experiment on mixing of substances; evaluate appropriate methods for collecting data; make predictions about what would happen if a variable changes.
4. Use graphs and tables of weather data to describe and predict typical weather during a season; analyze and interpret maps of Earth's physical features; use data to evaluate and refine design solutions.
5. Graph and describe the amounts and percentages of fresh and salt water in various reservoirs; measure and graph weights of substances before and after a chemical reaction.
6. Use evidence to explain how variations among individuals can provide advantages in survival and reproduction; provide evidence to explain the effect of multiple forces on the motion of an object; test and refine a simple system designed to filter impurities out of water.
7. Construct an argument that animals and plants have internal and external structures that support their survival, growth, behavior, and reproduction; distinguish among

facts, reasoned judgment based on data, and speculation in an argument.

8. Obtain and summarize information about the climate of different regions; gather information on possible solutions to a given design problem; obtain information about renewable and nonrenewable energy sources.

20. Grade 3

LAUREN WEISS AND MARGARET KRONE

Human Interactions

In grade 3, students develop and sharpen their skills at obtaining, recording and charting, and analyzing data in order to study their environment. They use these practices to study the interactions between humans and earth systems, humans and the environment, and humans and the designed world. They learn that these entities not only interact but influence behaviors, reactions, and traits of organisms. Grade 3 students analyze weather patterns and consider humans' influence and opportunity to impact weather-related events. In life science they study the interactions between and influence of the environment and human traits and characteristics. They use the engineering design process to identify a problem and design solutions that enhance humans' interactions with their surroundings and to meet their needs. Students consider the interactions and consequent reactions between objects and forces, including forces that are balanced or not. Students reason and provide evidence to support arguments for the influence of humans on nature and nature on human experience.[1] [2]

1. Massachusetts Department of Elementary and Secondary Education (2022). *SCIENCE AND TECHNOLOGY / ENGINEERING Grades Pre-Kindergarten to 12 Massachusetts Curriculum Framework*. https://www.doe.mass.edu/frameworks/current.html
2. Falcon Curriculum Common Core Standards mapping by Margaret Krone. Falcon Curriculum Lesson Plans by Lauren Weiss. © 2022 CC BY 4.0

3-LS. Life Science

LS1. From Molecules to Organisms: Structures and Processes

- **3-LS1-1.** Use simple graphical representations to show that different types of organisms have unique and diverse life cycles. Describe that all organisms have birth, growth, reproduction, and death in common but there are a variety of ways in which these happen.

Falcon Curriculum Core Categories

Anatomy and Life Cycle
Animal Behavior

Falcon Curriculum Essential Question

What is a falcon's life cycle?

Materials

For Instructors	For Students
• About Falcons • Falcon Curriculum videos • Falcon Cam livestream	• Journals • Pencils • Coloring materials

Sample Plan

This lesson should be taught in March-June when the falcon cam livestream is available. If that is not possible, you can use the prerecorded falcon cam clips.

Hand out the journals. Explain that students will be watching the life cycles of falcons through the falcon cam livestream and will use the journals to document observations.

As a class, go through the About Falcons sections and the Falcon Curriculum videos. Note important vocabulary needed to make accurate observations (nesting, pair bonding, clutch, incubation, pip, eyas, fledge, etc.). You can either hand out a glossary or have students put them in the back of their journal themselves.

Have them illustrate life cycle charts for the falcons, including egg, chick, juvenile, and adult, in the journal so they have a reference.

Give them a standard way to document each observation and do them as a class:

1. Date
2. Time (Start watching – end watching)
3. Weather
4. What happens in the nest box
    1. Adult falcons present?
        1. Can you identify if it's the male, female, or a

        floater?
    2. What behaviors are they exhibiting? (Pair bonding? Prey deliveries? Incubation? Nest defense? Preening? Loafing? Sleeping?)
2. Offspring? If so, what stage of the life cycle chart?
    1. Eggs present?
        1. When were they laid? (Check the @DuBoisFalcons Twitter account for the most accurate information about that)
        2. How many?
        3. What do they look like?
        4. Are they being incubated? (Hard incubation does not start until the second-to-last egg is laid.)
        5. Are they being enfluffeled?
        6. Do you see signs of hatching? (Approximately 28 days to hatch) Have students estimate when the eggs will hatch.
    2. Chicks present?
        1. When did they start hatching? When did they hatch?
        2. How many?
        3. What do they look like?
        4. What behaviors are they exhibiting? (Prey deliveries? Preening? Sleeping? Scooting? Walking?)
        5. Banding?
            1. Mark down the bands of each chick and whether it's a male or female.
        6. Do you see signs of getting ready to fledge? (Juvenile feathers, branching, lots of flapping exercises, etc.) Have students estimate when the chicks will fledge.
    3. Juveniles present?

1. When did they fledge?
2. What do they look like?
3. What behaviors are they exhibiting?

Follow @DuBoisFalcons for updates, and tweet if students have any questions about the nesting season. Additionally, as a class, participate in the chick naming contest. The contest is always announced on Twitter on Banding Day.

3-LS. Life Science

LS3. Heredity: Inheritance and Variation of Traits

- **3-LS3-1.** Provide evidence, including through the analysis of data, that plants and animals have traits inherited from parents and that variation of these traits exist in a group of similar organisms.
- **3-LS3-2.** Distinguish between inherited characteristics and those characteristics that result from a direct interaction with the environment. Give examples of characteristics of living organisms that are influenced by both inheritance and the environment.

Falcon Curriculum Core Categories

Anatomy and Life Cycle
Animal Behavior
Geography

Falcon Curriculum Essential Question

What traits do falcons inherit from their parents, and how do they vary? What traits are results from a direct interaction with the environment?

Materials

For Instructors	For Students
• About Falcons • Falcon Curriculum videos • Falcon Cam livestream • CalFalcons Twitter and YouTube channel • Birds of Prey with Tom Ricardi	• Journals

Sample Plan

This lesson is meant to be taught in conjunction with 3-LS1-1. As students watch the falcon cam livestream, have them observe and document what traits the chicks inherit from their parents. This will become more prominent as they get older and start to develop juvenile feathers and the signature stripes on their faces.

Take a look at the @CalFalconCam Twitter account and associated cameras and YouTube footage, paying particular attention to the 2022 season's male falcon, Alden. Alden is distinguishable because he has a limp. Discuss how this is not an inherited trait; it is the result from a direct interaction with the environment (could have been a predator, hitting something, etc.).

Have students watch one of the FalConference: Birds of Prey with Tom Ricardi videos. Tom Ricardi is a licensed raptor rehabilitator who runs Massachusetts Birds of Prey Rehabilitation Center in Conway, Massachusetts. The birds that he shows off in the videos are birds that have traits caused by direct interactions with the environment (i.e. hit by a car, etc.) and are non-releasable because of it.

3-LS. Life Science

LS4. Biological Evolution: Unity and Diversity

- **3-LS4-2.** Use evidence to construct an explanation for how the variations in characteristics among individuals within the same species may provide advantages to these individuals in their survival and reproduction.
- **3-LS4-3.** Construct an argument with evidence that in a particular environment some organisms can survive well, some survive less well, and some cannot survive.

Falcon Curriculum Core Categories

Anatomy and Life Cycle
Animal Behavior
Geography

Falcon Curriculum Essential Question

How can variations in characteristics of peregrine falcons provide advantages in their survival and reproduction in their particular environment?

Materials

For Instructors	For Students

• About Falcons
• Falcon Curriculum: Videos
• [LEGO Birds video]
	• LEGOs: various sizes and shapes of pieces in peregrine falcon colors
	  ◦ Light gray
	  ◦ Dark gray
	  ◦ White
	  ◦ Beige
	  ◦ Brown
	  ◦ Black
	  ◦ Yellow

Sample Plan

This lesson is meant to be taught in conjunction with 3-LS1-1. Once students have learned all about peregrine falcons and their characteristics, they can then examine how those characteristics provide advantages.

Watch the LEGO Birds video on how to build different types of birds out of LEGOs. Without looking at each other's work, have students each build their own interpretation of a peregrine falcon. When everyone is finished, have students all show each other their work. There should be quite a variation in the way they look.

After viewing all the LEGO birds, as a class, discuss how all their models are of peregrine falcons, but they all look somewhat different. Discuss some of the basic characteristics of peregrine falcons that all their models should have in common: basic color, size, wing shape, beak shape, eyes, feet/talons, etc. Ask students what advantages those characteristics provide (camouflage, speed, better for hunting prey, etc.). Ask what would happen if a falcon were larger/smaller than average (may help depending on size of prey in their region), darker/lighter in color (lighter colors would be useful if the falcons lived farther north to blend in better), etc.

3-LS. Life Science

LS4. Biological Evolution: Unity and Diversity

- **3-LS4-4.** Analyze and interpret given data about changes in a habitat and describe how the changes may affect the ability of organisms that live in that habitat to survive and reproduce.
- **3-LS4-5.** Provide evidence to support a claim that the survival of a population is dependent upon reproduction.

Falcon Curriculum Core Categories

Conservation and Policy

Falcon Curriculum Essential Question

How did DDT change the peregrine falcon's habitat and affect its ability to survive and reproduce?

Materials

For Instructors	For Students

• About Falcons: Conservation
• Falcon Curriculum: Conservation, Beginner videos
	• Soft Shelled Egg Experiment Materials
	  ◦ Worksheet
	  ◦ Eggs (1/group, plus extra, in case they break)
	  ◦ Vinegar (enough for 1 cup/group)
	  ◦ Clear jars/containers
	  ◦ Measuring cups

Sample Plan

Watch the Falcon Curriculum: Conservation, Beginner videos. Talk about how humans used DDT to change the environment by getting rid of insects that ate their crops and made them sick, but DDT was bad for the environment, and when peregrine falcons ate the birds that ate the bugs that had DDT on them, it made the falcons lay eggs that couldn't hatch.

Do the Soft Shelled Egg Experiment:

1. Explain/review the Scientific Method: a process with a set of steps that scientists use to study the world around them and solve problems.
2. Put students into groups. Let them examine the egg. Have them fill out a Scientific Method sheet:
    1. Ask a question, based on observations: Scientists observed that peregrine falcon eggs affected by DDT did not hatch. Why didn't DDT-affected eggs hatch? (Observe what regular eggs that can hatch look and feel like.)
    2. Make a hypothesis (prediction): If the eggs don't have strong eggshells to protect the chicks, then the eggs won't hatch.
    3. Test the hypothesis:
        1. Examine the egg and record observations (shell is hard, etc.)
        2. Pour 1 cup vinegar into clear jar.
        3. Add the egg.
        4. Talk about what happens (bubbles will rise from the egg) and what they think might happen after it sits in the vinegar for 1 day.
        5. Leave the egg in the vinegar for 1 day.
        6. Remove the egg and record observations (shell is soft). IMPORTANT: Make sure the students are

gentle with it when they touch it, or it will break all over.

4. Analyze the data: Compare regular eggs to the ones in the vinegar. Regular eggs have hard shells sturdy enough to protect the chicks and withstand parents sitting on them to incubate them. Vinegar dissolves the calcium in the eggshells, leaving the eggs with just the soft eggshell lining.
5. Draw conclusions: DDT affected the calcium content peregrine falcons had, which made them lay eggs with soft shells that couldn't protect the chicks, so they couldn't hatch. Since the eggs couldn't hatch, the falcon population declined.
6. Communicate findings: Do a poster sharing the data.

3-PS. Physical Science

PS2. Motion and Stability: Forces and Interactions

- **3-PS2-1.** Provide evidence to explain the effect of multiple forces, including friction, on an object. Include balanced forces that do not change the motion of the object and unbalanced forces that do change the motion of the object.
- Second

Falcon Curriculum Core Categories

Animal Behavior

Falcon Curriculum Essential Question

How do birds fly?

Materials

For Instructors	For Students
• About Falcons: Flight • Falcon Curriculum: Flight videos	• Audubon for Kids Paper Airplane Birds activity[3] ◦ Paper

Sample Plan

Read About Falcons: Flight and watch the Falcon Curriculum: Flight videos. Talk specifically about the parts discussing gravity and lift. Talk about the different types of bird wings and how, while these birds all fly, they all fly differently.

Do the Audubon for Kids Paper Airplane Birds activity.

Media Attributions

- Soft Shelled Egg Experiment Results

3. ForTheBirds! Audubon for Kids, 2020. https://www.audubon.org/news/these-paper-airplanes-fly-birds

21. Grade 4

LAUREN WEISS AND MARGARET KRONE

Matter and Energy

In grade 4, students observe and interpret patterns related to the transfer of matter and energy on Earth, in physical interactions, and in organisms. Students learn about energy—its motion, transfer, and conversion—in different physical contexts. Grade 4 students interpret patterns of change over time as related to the deposition and erosion in landscape formation. They study today's landscapes to provide evidence for past processes. Students learn that animals' internal and external structures support life, growth, behavior, and reproduction. They work through the engineering design process, focusing on developing solutions by building, testing, and redesigning prototypes to fit a specific purpose. Each domain relates to the use of matter and energy over time and for specific purposes.[1] [2]

1. Massachusetts Department of Elementary and Secondary Education (2022). *SCIENCE AND TECHNOLOGY / ENGINEERING Grades Pre-Kindergarten to 12 Massachusetts Curriculum Framework*. https://www.doe.mass.edu/frameworks/current.html
2. Falcon Curriculum Common Core Standards mapping by Margaret Krone. Falcon Curriculum Lesson Plans by Lauren Weiss.

4-LS. Life Science

LS1. From Molecules to Organisms: Structures and Processes

- **4-LS1-1.** Construct an argument that animals and plants have internal and external structures that support their survival, growth, behavior, and reproduction. Animal structures can include legs, wings, fins, feathers, trunks, claws, horns, antennae, eyes, ears, nose, heart, stomach, lung, brain, and skin.

Falcon Curriculum Core Categories

Anatomy and Life Cycle
Animal Behavior

Falcon Curriculum Essential Question

How do falcons' internal and external structures that support their survival, growth, behavior, and reproduction?

Materials

For Instructors	For Students
• About Falcons • Falcon Curriculum videos • Falcon Cam livestream	• Journals • Pencils • Coloring materials

Sample Plan

This lesson should be taught in March-June when the falcon cam livestream is available. If that is not possible, you can use the prerecorded falcon cam clips.

Hand out the journals. Explain that students will be studying falcons through the falcon cam livestream and will use the journals to document observations.

As a class, go through the About Falcons sections and the Falcon Curriculum videos. Note important vocabulary needed to make accurate observations, including Life Cycle and Behaviors vocabulary. You can either hand out a glossary or have students put them in the back of their journal themselves.

Fill out the falcon worksheet and take notes on the internal and external structures covered in About Falcons and the Falcon Curriculum videos.

Give them a standard way to document each observation and do the first few as a class:

1. Date
2. Time (Start watching – end watching)
3. Weather
4. What happens in the nest box
    1. Adult falcons present?
        1. Can you identify if it’s the male, female, or a floater?

        2. What behaviors are they exhibiting, and what internal and external structures are they using? (Pair bonding? Prey deliveries? Incubation? Nest defense? Preening? Loafing? Sleeping?)
2. Offspring?
    1. Eggs present?
        1. When were they laid? (Check the @DuBoisFalcons Twitter account for the most accurate information about that)
        2. How many?
        3. What do they look like?
        4. Are they being incubated? (Hard incubation does not start until the second-to-last egg is laid.)
        5. Are they being enfluffeled?
        6. Do you see signs of hatching? (Approximately 28 days to hatch) Have students estimate when the eggs will hatch.
    2. Chicks present?
        1. When did they start hatching? When did they hatch?
        2. How many?
        3. What do they look like?
        4. What behaviors are they exhibiting, and what internal and external structures are they using? (Prey deliveries? Preening? Sleeping? Scooting? Walking?)
        5. Banding?
            1. Mark down the bands of each chick and whether it's a male or female.
        6. Do you see signs of getting ready to fledge? (Juvenile feathers, branching, lots of flapping exercises, etc.) Have students estimate when the chicks will fledge.

3. Juveniles present?
    1. When did they fledge?
    2. What do they look like?
    3. What behaviors are they exhibiting, and what internal and external structures are they using?

Follow @DuBoisFalcons for updates, and tweet if students have any questions about the nesting season. Additionally, as a class, participate in the chick naming contest. The contest is always announced on Twitter on Banding Day.

4-PS. Physical Science

PS3. Energy

- **4-PS3-1.** Use evidence to construct an explanation relating the speed of an object to the energy of that object.
- **4-PS3-3.** Ask questions and predict outcomes about the changes in energy that occur when objects collide.

Falcon Curriculum Core Categories

Anatomy and Life Cycle
Animal Behavior

Falcon Curriculum Essential Question

How do peregrine falcons fly so fast?

Materials

For Instructors	For Students
• About Falcons: Flight • About Falcons: Prey and Hunting • Falcon Curriculum: Flight videos • Falcon Curriculum: Prey and Hunting videos	• Audubon for Kids Paper Airplane Birds activity[3] ◦ Paper

Sample Plan

Read About Falcons: Flight and Prey and Hunting. Watch the Falcon Curriculum: Flight and Falcon Curriculum: Prey and Hunting videos. Talk about how the design of the falcon allows it to be the fastest animal on Earth when diving, and how it gains energy into the dive by flapping it's wings very fast and then tucking them in to become more aerodynamic. Talk about what happens when the falcon stoops on prey and collides with it.

Do the Audubon for Kids Paper Airplane Birds activity.

3. ForTheBirds! Audubon for Kids, 2020. https://www.audubon.org/news/these-paper-airplanes-fly-birds

4-ETS. Technology/Engineering

ETS1. Engineering Design

- **4.3-5-ETS1-3.** Plan and carry out tests of one or more design features of a given model or prototype in which variables are controlled and failure points are considered to identify which features need to be improved. Apply the results of tests to redesign a model or prototype.
- **4.3-5-ETS1-5(MA).** Evaluate relevant design features that must be considered in building a model or prototype of a solution to a given design problem.

Falcon Curriculum Core Categories

Anatomy and Life Cycle
Animal Behavior

Falcon Curriculum Essential Question

How can we use the aerodynamics of birds' flight to improve engineering designs?

Materials

For Instructors	For Students
• About Falcons: Flight • About Falcons: Prey and Hunting • Falcon Curriculum: Flight videos • Falcon Curriculum: Prey and Hunting videos	• Audubon for Kids Paper Airplane Birds activity[4] ◦ Paper

Sample Plan

This lesson is to be taught in conjunction with 4-PS3-1 and 4-PS3-3.

Once the students have done the Audubon for Kids Paper Airplane Birds activity, have them design their own paper airplanes. Test for flying longest, fastest, etc. Have them try the same design using different sizes, shapes, and thickness/weight of paper.

4. ForTheBirds! Audubon for Kids, 2020. https://www.audubon.org/news/these-paper-airplanes-fly-birds

22. Grade 5

LAUREN WEISS AND MARGARET KRONE

Connections and Relationships in Systems

In grade 5, students model, provide evidence to support arguments, and obtain and display data about relationships and interactions among observable components of different systems. By studying systems, grade 5 students learn that objects and organisms do not exist in isolation and that animals, plants and their environments are connected to, interact with, and are influenced by each other. They study the relationships between Earth and other nearby objects in the solar system and the impact of those relationships on patterns of events as seen from Earth. They learn about the relationship among elements of Earth's systems through the cycling of water and human practices and processes with Earth's resources. They also learn about the connections and relationships among plants and animals, and the ecosystems within which they live, to show how matter and energy are cycled through these (building on the theme of grade 4). An ability to describe, analyze, and model connections and relationships of observable components of different systems is key to understanding the natural and designed world.[1] [2]

1. Massachusetts Department of Elementary and Secondary Education (2022). *SCIENCE AND TECHNOLOGY / ENGINEERING Grades Pre-Kindergarten to 12 Massachusetts Curriculum Framework*. https://www.doe.mass.edu/frameworks/current.html
2. Falcon Curriculum Common Core Standards mapping by Margaret

5-ESS. Earth and Space Sciences

ESS3. Earth and Human Activity

- **5-ESS3-1.** Obtain and combine information about ways communities reduce human impact on the Earth's resources and environment by changing an agricultural, industrial, or community practice or process.

Falcon Curriculum Core Categories

Conservation and Policy

Falcon Curriculum Essential Question

How have humans changed their agricultural and industrial practices re: pesticides to conserve the environment/peregrine falcons?

Materials

For Instructors	For Students
• About Falcons: Conservation • Falcon Curriculum: Conservation, Beginner Videos	• Soft Shelled Egg Experiment Materials ◦ Worksheet ◦ Eggs (can use hardboiled) (1/group, plus extra, in case they break) ◦ Vinegar (enough for 1 cup/group) ◦ Clear jars/containers big enough to hold 1 egg and 1 cup of vinegar ◦ Measuring cups

Sample Plan

Read About Falcons: Conservation and watch the Falcon Curriculum: Conservation, Beginner videos. Talk about how humans had to change the agricultural and industrial practice of using DDT as a pesticide in order to conserve the environment/peregrine falcons.

Do the Soft Shelled Egg Experiment:

1. Explain/review the Scientific Method: a process with a set

of steps that scientists use to study the world around them and solve problems.

2. Put students into groups. Let them examine the egg. Have them fill out a Scientific Method sheet:

    1. Ask a question, based on observations: Scientists observed that peregrine falcon eggs affected by DDT did not hatch. Why didn't DDT-affected eggs hatch? (Observe what regular eggs that can hatch look and feel like.)
    2. Make a hypothesis (prediction): If the eggs don't have strong eggshells to protect the chicks, then the eggs won't hatch.
    3. Test the hypothesis:

        1. Examine the egg and record observations (shell is hard, etc.)
        2. Pour 1 cup vinegar into clear jar.
        3. Add the egg.
        4. Talk about what happens (bubbles will rise from the egg) and what they think might happen after it sits in the vinegar for 1 day.
        5. Leave the egg in the vinegar for 1 day.
        6. Remove the egg and and record observations (soft). IMPORTANT: if you are using a raw egg and not hardboiled, make sure the students are gentle with it when they touch it, or it will break all over.

    4. Analyze the data: Compare regular eggs to the ones in the vinegar. Regular eggs have hard shells sturdy enough to protect the chicks and withstand parents sitting on them to incubate them. Vinegar dissolves the calcium in the eggshells, leaving the eggs with just the soft eggshell lining.
    Draw conclusions: DDT affected the calcium content peregrine falcons had, which made them lay eggs with soft shells that couldn't protect the chicks, so

they couldn't hatch. Since the eggs couldn't hatch, the falcon population declined.

5. Communicate findings: Do a brief lab report or poster sharing the data.

5-LS. Life Science

LS2. Ecosystems: Interactions, Energy, and Dynamics

- **5-LS2-1.** Develop a model to describe the movement of matter among producers, consumers, decomposers, and the air, water, and soil in the environment to (a) show that plants produce sugars and plant materials, (b) show that animals can eat plants and/or other animals for food, and (c) show that some organisms, including fungi and bacteria, break down dead organisms and recycle some materials back to the air and soil.

Falcon Curriculum Core Categories

Anatomy and Life Cycle
Animal Behavior

Falcon Curriculum Essential Question

How are falcons part of the movement of matter?

Materials

For Instructors	For Students
• About Falcons: Prey and Hunting • Falcon Curriculum: Prey and Hunting videos	• Large paper • Coloring materials

Sample Plan

Read About Falcons: Prey and Hunting and watch the Falcon Curriculum: Prey and Hunting videos. Ask about the falcons' role in the movement of matter: are they producers, consumers, or decomposers? How about their prey? How about their prey's diets?

Have students make charts demonstrating the movement of matter and energy using peregrine falcons, their prey, what their prey eat, etc. Each student can pick a different prey and research its diet to add that to the chart.

5-PS. Physical Science

PS3. Energy

- **5-PS3-1.** Use a model to describe that the food animals digest (a) contains energy that was once energy from the Sun, and (b) provides energy and nutrients for life processes, including body repair, growth, motion, body warmth, and reproduction.

Falcon Curriculum Core Categories

Anatomy and Life Cycle
Animal Behavior

Falcon Curriculum Essential Question

How do falcons get energy and nutrients?

Materials

For Instructors	For Students
• About Falcons: Prey and Hunting • Falcon Curriculum: Prey and Hunting videos • Falcon Cam Livestream	• Large paper • Coloring materials

Sample Plan

This lesson is meant to be taught in conjunction with 5-LS2-1. As you discuss and chart the movement of matter, have students include a list of life processes for which the food falcons digest provides energy. Have students observe the Falcon Cam livestream to see this in action.

Media Attributions

- Soft Shelled Egg Experiment Results

23. Grades 6 - 8

Grades 6-8: Overview of Science and Engineering Practices[1]

Active engagement of middle school students with the science and engineering practices is critical: students generally make up their minds about whether they identify with science and engineering by the time they leave grade 8, and whether they will pursue these fields in high school and beyond. Students must have opportunities to develop the skills necessary for a meaningful progression of development in order to engage in scientific and technical reasoning so critical to success in civic life, postsecondary education, and careers. Inclusion of science and engineering practices in standards only speaks to the types of performances students should be able to demonstrate at the end of instruction at a particular grade; the standards do not limit what educators and students should or can be engaged in through a well-rounded curriculum.

Standards for grades 6 through 8 integrate all eight science and engineering practices. Students' understanding of and

1. Massachusetts Department of Elementary and Secondary Education (2022). *SCIENCE AND TECHNOLOGY / ENGINEERING Grades Pre-Kindergarten to 12 Massachusetts Curriculum Framework*. https://www.doe.mass.edu/frameworks/current.html

ability with each practice gets more detailed and sophisticated through middle school. For example, by the end of middle school, students can identify limitations of a particular model, including limitations of its accuracy, what features are included (or not), and limitations of what phenomena or outcomes it can predict. Students can develop models of varying levels of detail and accuracy and can identify when a situation calls for a conceptual model with little detail or a specific model with attention to accuracy, such as for making predictions of particular events.

Some examples of specific skills students should develop in these grades:

1. Define criteria and constraints of a design problem with precision.

2. Develop a model to describe cycling of matter in an ecosystem; develop a model that describes and predicts changes in particle motion and spatial arrangement during phase changes; develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena.

3. Conduct an investigation to show relationships among energy transfer, type of matter, and kinetic energy of particles; conduct an experiment to show that many materials are mixtures.

4. Examine and interpret data to describe the role human activities have played in the rise of global temperatures over time; construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships; distinguish between causal and correlational relationships in data; consider limitations of data analysis.

5. Describe, including through probability statements and proportional reasoning, the process of natural selection; use data and graphs to describe relationships among kinetic energy, mass, and speed of an object.

6. Construct an explanation using evidence for how Earth's

surface has changed over time; apply scientific reasoning to show why the data or evidence is adequate for the explanation.

Construct an argument based on evidence for how environmental and genetic factors influence organism growth; respectfully provide and receive critiques about one's arguments, procedures, and models by citing relevant evidence with pertinent detail.

Synthesize and communicate information about artificial selection; obtain and communicate information on how past geologic events are analyzed to make future predictions.

While presented as distinct skill sets, the eight practices intentionally overlap and interconnect. Skills such as those outlined above should be reflected in curricula and instruction that engage students in an integrated use of the practices. See the Science and Engineering Practices Progression Matrix (Appendix I) for more information, including particular skills for students in grades 6–8.

24. Grade 6

LAUREN WEISS AND MARGARET KRONE

Structure and Function

The integration of Earth and space, life, and physical sciences with technology/engineering gives grade 6 students relevant and engaging opportunities with natural phenomena and design problems that highlight the relationship of structure and function in the world around them. Students relate structure and function through analyzing the macro- and microscopic world, such as Earth features and processes, the role of cells and anatomy in supporting living organisms, and properties of materials and waves. Students use models and provide evidence to make claims and explanations about structure-function relationships in different STE domains.[1] [2]

6.MS-LS: Life Science

1. Massachusetts Department of Elementary and Secondary Education (2022). *SCIENCE AND TECHNOLOGY / ENGINEERING Grades Pre-Kindergarten to 12 Massachusetts Curriculum Framework*. https://www.doe.mass.edu/frameworks/current.html
2. Falcon Curriculum Common Core Standards mapping by Margaret Krone. Falcon Curriculum Lesson Plans by Lauren Weiss. © 2022 CC BY 4.0

LS1. From Molecules to Organisms: Structures and Processes

- **6.MS-LS1-3.** Construct an argument supported by evidence that the body systems interact to carry out essential functions of life.

Falcon Curriculum Core Categories

Anatomy and Life Cycle

Falcon Curriculum Essential Question

How do falcons' body systems interact to carry out essential functions of life?

Materials

For Instructors	For Students
• About Falcons: Basic Information • About Falcons: Life Cycle • About Falcons: Prey and Hunting • About Falcons: Other Behaviors • About Falcons: Flight • Falcon Curriculum: Basic Info videos • Falcon Curriculum: Life Cycle videos • Falcon Curriculum: Prey and Hunting videos • Falcon Curriculum: Behaviors video • Falcon Curriculum: Flight videos • Owl Pellet Dissection Guide[3]	• Falcon parts worksheet (In progress) • Owl pellets for dissection (readily available online) • Gloves • Goggles • Facemasks (optional) • Hand sanitizer • Paper plates/trays • Dissection tools/tweezers/ wooden sticks • Water spay bottle (see guide) • Cornell Owl Pellet Bone Identification Chart[4] • Paper • Pencils

Sample Plan

Have students read the associated sections and watch the associated videos.

Talk about the different parts and systems of a falcon that enable it to carry out essential functions of life (digestion to get energy, respiratory/circulatory to fly fast, etc.). Have students identify the different parts on the worksheet.

Talk about digestion and casting pellets. Have students dissect pellets and document their findings. It is important to remind them that the material they will likely find inside the

3. Oregon Owl Pellets, 2019. https://www.oregonowlpellets.com/lesson-guide/
4. Cornell Lab K-12 Education. https://www.birds.cornell.edu/k12/bone-identification/

pellets is fragile, and so they ought to take care when doing the experiment.

25. Grade 7

LAUREN WEISS AND MARGARET KRONE

Systems and Cycles

Students in grade 7 focus on systems and cycles using their understanding of structures and functions, connections and relationships in systems, and flow of matter and energy developed in earlier grades. A focus on systems requires students to apply concepts and skills across disciplines, since most natural and designed systems and cycles are complex and interactive. They gain experience with plate tectonics, interactions of humans and Earth processes, organism systems to support and propagate life, ecosystem dynamics, motion and energy systems, and key technological systems used by society. Through grade 7, students begin a process of moving from a more concrete to an abstract perspective, since many of the systems and cycles studied are not directly observable or experienced. This also creates a foundation for exploring cause and effect relationships in more depth in grade 8.[1] [2]

1. Massachusetts Department of Elementary and Secondary Education (2022). *SCIENCE AND TECHNOLOGY / ENGINEERING Grades Pre-Kindergarten to 12 Massachusetts Curriculum Framework*. https://www.doe.mass.edu/frameworks/current.html
2. Falcon Curriculum Common Core Standards mapping by Margaret Krone. Falcon Curriculum Lesson Plans by Lauren Weiss.

7.MS-LS: Life Science

LS1. From Molecules to Organisms: Structures and Processes

- **7.MS-LS1-4.** Construct an explanation based on evidence for how characteristic animal behaviors and specialized plant structures increase the probability of successful reproduction of animals and plants.

Falcon Curriculum Core Categories

Animal Behavior

Falcon Curriculum Essential Question

What characteristic animal behaviors do peregrine falcons have to ensure successful reproduction?

Materials

For Instructors	For Students
• About Falcons • Falcon Curriculum videos • Falcon Cam livestream	• Journals • Pencils • Coloring materials

Sample Plan

This lesson should be taught in March-June when the falcon cam livestream is available. If that is not possible, you can use the prerecorded falcon cam clips.

Hand out the journals. Explain that students will be studying falcons through the falcon cam livestream and will use the journals to document observations.

Read, watch, and discuss the About Falcons sections and the Falcon Curriculum videos. Note important vocabulary needed to make accurate observations, including Life Cycle and Behaviors vocabulary.

Give them a standard way to document each observation and do the first few as a class:

1. Date
2. Time (Start watching – end watching)
3. Weather
4. What happens in the nest box
    1. Adult falcons present?
        1. Can you identify if it's the male, female, or a floater?
        2. What behaviors are they exhibiting? (Pair bonding? Prey deliveries? Incubation? Nest defense? Preening? Loafing? Sleeping?)
    2. Offspring?
        1. Eggs present?
            1. When were they laid? (Check the @DuBoisFalcons Twitter account for the most accurate information about that)
            2. How many?
            3. What do they look like?
            4. Are they being incubated? (Hard incubation does not start until the second-to-last egg is

laid.)

5. Are they being enfluffeled?
6. Do you see signs of hatching? (Approximately 28 days to hatch) Have students estimate when the eggs will hatch.

2. Chicks present?
    1. When did they start hatching? When did they hatch?
    2. How many?
    3. What do they look like?
    4. What behaviors are they exhibiting? (Prey deliveries? Preening? Sleeping? Scooting? Walking?)
    5. Banding?
        1. Mark down the bands of each chick and whether it's a male or female.
    6. Do you see signs of getting ready to fledge? (Juvenile feathers, branching, lots of flapping exercises, etc.) Have students estimate when the chicks will fledge.
3. Juveniles present?
    1. When did they fledge?
    2. What do they look like?
    3. What behaviors are they exhibiting?

Watch the Falcon Cam livestream during class, and (if possible) have students watch for homework to see if the falcons do different behaviors at different points.

When wrapping up the lesson after weeks/months of observing the Falcon Cam, have students compile a brief report on what characteristic animal behaviors do peregrine falcons have to ensure successful reproduction, using their observations as evidence.

Follow @DuBoisFalcons for updates, and tweet if students have any questions about the nesting season. Additionally, as a class, participate in the chick naming contest. The contest is always announced on Twitter on Banding Day.

7.MS-LS: Life Science

LS2. Ecosystems: Interactions, Energy, and Dynamics

- **7.MS-LS2-2.** Describe how relationships among and between organisms in an ecosystem can be competitive, predatory, parasitic, and mutually beneficial and that these interactions are found across multiple ecosystems.
- **7.MS-LS2-4.** Analyze data to provide evidence that disruptions (natural or human-made) to any physical or biological component of an ecosystem can lead to shifts in all its populations.

Falcon Curriculum Core Categories

Conservation and Policy

Falcon Curriculum Essential Question

What was the relationship like between humans and peregrine falcons prior to the decline of falconry, between then and the environmentalist movement in the 1960s, and what is it like now? How has that relationship affected peregrine falcons and their populations?

Materials

For Instructors	For Students
• About Falcons: Conservation • Falcon Curriculum: Conservation, Advanced videos • History of Falconry with Chris Davis video	• Paper • Coloring materials

Sample Plan

Read and watch About Falcons: Conservation, Falcon Curriculum: Conservation, Advanced videos, and History of Falconry with Chris Davis video. Discuss how the relationship between humans and peregrine falcons has changed constantly throughout history.

Have students make a timeline demonstrating the relationship between humans and peregrine falcons, using information from the readings and videos. Have them do additional research on some of the points mentioned in the materials, like various policies, and find additional images to add to their timelines.

7.MS-PS: Physical Science

PS3. Energy

- **7.MS-PS3-1.** Construct and interpret data and graphs to describe the relationships among kinetic energy, mass, and speed of an object.

Falcon Curriculum Core Categories

Anatomy and Life Cycle
Animal Behavior

Falcon Curriculum Essential Question

How is sexual dimorphism in peregrine falcons advantageous to males (1/3 smaller than females) as the primary hunters for the pair?

Materials

For Instructors	For Students
• About Falcons: Basic Information, Appearance, and Prey and Hunting • Falcon Curriculum: Prey and Hunting videos	• Wingshot Experiment ◦ Worksheet ◦ Sets of 3 balls with substantially different masses (1 set per group) ◦ Measuring tape ◦ Stopwatch (could use phone app) ◦ Tape ◦ Elastic (or really large rubber band) ◦ Something to stretch the elastic between (i.e. 2 chairs/desks/etc.) ◦ Books/pool noodles/etc. to set up like bumpers in a bowling alley to keep the balls from rolling all over ◦ (Optional: paper cups and cutouts of eggs and pigs)

Sample Plan

Read About Falcons: Basic Information, Appearance, and Prey and Hunting and watch the Falcon Curriculum: Prey and Hunting videos. Discuss sexual dimorphism.

Do the Wingshot experiment:

1. Separate the students into groups for the experiment.
2. Have each group take an elastic and stretch it between 2 chairs/desks/etc. to make a taut slingshot 12 inches across. Put a piece of tape 5 inches behind the slingshot as the point to pull back to each time.
3. Set up books/pool noodles/etc. as bumpers to make a "track" in front of the slingshot.

4. Set up measuring tape along the track and measure out a distance of 5 feet. Put a piece of tape at that mark. (Optional: set up a small cup tower at the mark with cutouts of eggs and pigs.)
5. Figure out the different masses of the balls.
6. Put each ball individually into the slingshot, pull it back to the tape, and let it go, starting the stopwatch once it is let go and stopping the stopwatch once it reaches the 5-feet mark.
7. Repeat 3 times for each ball.

The results should demonstrate that the balls with less mass were able to travel the distance at a faster speed than the balls with more mass. This is why it is advantageous for the smaller male falcons to do the majority of the hunting.

26. Grade 8

LAUREN WEISS AND MARGARET KRONE

Cause and Effect

Grade 8 students use more robust abstract thinking skills to explain causes of complex phenomena and systems. Many causes are not immediately or physically visible to students. An understanding of cause and effect of key natural phenomena and designed processes allows students to explain patterns and make predictions about future events. In grade 8 these include, for example, causes of seasons and tides; causes of plate tectonics and weather or climate; the role of genetics in reproduction, heredity, and artificial selection; and how atoms and molecules interact to explain the substances that make up the world and how materials change. Being able to analyze phenomena for evidence of causes and processes that often cannot be seen, and being able to conceptualize and describe those, is a significant outcome for grade 8 students.[1] [2]

1. Massachusetts Department of Elementary and Secondary Education (2022). *SCIENCE AND TECHNOLOGY / ENGINEERING Grades Pre-Kindergarten to 12 Massachusetts Curriculum Framework*. https://www.doe.mass.edu/frameworks/current.html
2. Falcon Curriculum Common Core Standards mapping by Margaret Krone. Falcon Curriculum Lesson Plans by Lauren Weiss. © 2022 CC BY 4.0

8.MS-LS. Life Science

LS1. From Molecules to Organisms: Structures and Processes

- **8.MS-LS1-5.** Construct an argument based on evidence for how environmental and genetic factors influence the growth of organisms.

Falcon Curriculum Core Categories

Anatomy and Life Cycle
Geography

Falcon Curriculum Essential Question

What environmental and genetic factors influence the growth of peregrine falcons, and how?

Materials

For Instructors	For Students
• About Falcons: Life Cycle • Falcon Curriculum: Life Cycle videos	• Case Study: 72/BV

Sample Plan

Read About Falcons: Life Cycle and watch the Falcon Curriculum: Life Cycle videos. Read the Case Study of 72/BV. Identify the environmental and genetic factors that influenced her growth and her offspring's growth (i.e. her genetics seem to lend themselves to large clutches; she was raised in a relatively safe and protected environment, and was able to raise 2 4-chick clutches in a relatively safe and protected environment).

8.MS-LS. Life Science

LS4. Biological Evolution: Unity and Diversity

- **8.MS-LS4-4.** Use a model to describe the process of natural selection, in which genetic variations of some traits in a population increase some individuals' likelihood of surviving and reproducing in a changing environment. Provide evidence that natural selection occurs over many generations.
- **8.MS-LS4-5.** Synthesize and communicate information about artificial selection, or the ways in which humans have changed the inheritance of desired traits in organisms.

Falcon Curriculum Core Categories

Anatomy and Life Cycle
Geography

Falcon Curriculum Essential Question

How do genetic variations in falcon subspecies increase their likelihood of surviving and reproducing in their environments, and how have humans have changed the inheritance of desired traits in them?

Materials

For Instructors	For Students
• About Falcons: Habitat • Falcon Curriculum: Habitat videos • Tordoff & Redig 2001 PEFA genetics	• Paper (or could also do on the computer)

Sample Plan

Read and watch About Falcons: Habitat and Falcon Curriculum: Habitat videos. As a class, go through the PEFA Genetics article. Talk about the various subspecies used to restore the falcon population in North America.

Ask students to do a pretend "falcon family tree" for an admixed (hybrid) peregrine falcon released to Eastern North America. Using information provided in the article, identify traits that the bird might have inherited from its subspecies ancestors that would help it adapt to the environment.

8.MS-PS. Physical Science

PS2. Motion and Stability: Forces and Interactions

- **8.MS-PS2-1.** Develop a model that demonstrates Newton's third law involving the motion of two colliding objects.

Falcon Curriculum Core Categories

Animal Behavior

Falcon Curriculum Essential Question

How do falcons demonstrate Newton's third law?

Materials

<table>
<tr><th>For Instructors</th><th>For Students</th></tr>
<tr><td>

About Falcons: Flight
About Falcons: Prey and Hunting
Falcon Curriculum: Flight
Falcon Curriculum: Prey and Hunting videos

</td><td>

Lift-Off Experiment

Worksheet
Materials to make a balloon-powered vehicle

Simple vehicle:

Cardboard
Plastic drinking straws (regular; not extra thick)
Wooden skewers
Bottle caps (4 per student)
Rulers
Strong scissors and/or box cutters
Awls
Tape
Glue and/or clay

</td></tr>
</table>

Sample Plan

Discuss Newton's laws of motion:

1. An object at rest remains at rest, and an object in motion remains in motion at constant speed and in a straight line unless acted on by an unbalanced force.
2. The acceleration of an object depends on the mass of the object and the amount of force applied.
3. Whenever one object exerts a force on another object, the second object exerts an equal and opposite on the first. (For every action, there is an equal and opposite reaction.)

Read the "Flight" and "Prey and Hunting" sections of "About Falcons," and watch the Falcon Curriculum: Flight and Prey and

Hunting videos. Discuss how birds demonstrate Newton's laws of motion:

1. The bird is at rest until it applies force by flapping its wings to start flying.
2. Its acceleration depends on its mass and amount of force applied. With regard to peregrine falcons, this can be demonstrated by its sexual dimorphism: males are smaller than females and do the majority of hunting, because they are able to fly faster after their speedy prey.
3. When the bird's wings flap downwards and backwards, they push the air in that same direction. The air, in turn, provides an equal and opposite reaction, pushing the bird upwards and forwards. (See "lift" in "About Falcons: Flight.")

Do the Lift-Off Experiment:

1. Research models for a balloon-powered vehicle and build one.
    1. Simple vehicle:
        1. Cut out a rectangle of cardboard (3 x 6 inches).
        2. Cut 2 3-inch pieces of a straw.
        3. Tape those pieces on the bottom of the piece of cardboard.
        4. Cut off the ends of a wooden skewer; then cut 2 4-inch pieces of it.
        5. Slide the skewer pieces into the straw pieces that you taped onto the cardboard previously.
        6. Use an awl to poke holes in the centers of 4 bottle caps. You can also use cardboard if you do not have bottle caps.
        7. Put the bottle caps on the ends of the skewers. You can use glue or clay on the ends of the skewers so the bottle caps do not slide off.

8. Stick a straw about 2 inches into a balloon (not inflated) and tape the balloon tightly around the straw.
9. Tape the straw lengthwise onto the top of the cardboard. The balloon end should be on top of the cardboard and the other end of the straw should be hanging off the cardboard.

2. Use the straw to blow some air into the balloon, then pinch the straw to prevent air from escaping just yet.
3. Put the vehicle on a flat surface, and let go of the straw. The vehicle should take off!

The air that rushes out of the balloon backwards pushes the car forwards, in the opposite direction, with equal force. This simulates how birds fly.

Please note that you can also use recycled plastic bottles, small cardboard containers, or even 3D-printed vehicles for this experiment. You might even want each of your students/groups to use different materials and see which vehicle goes the farthest/fastest.

27. High School Overview

High School: Overview of Science and Engineering Practices[1]

The practices in grades 9–12 build on pre-K–8 experiences and progress to more technical and sophisticated applications to the natural and designed world we live in. The integration of science and engineering practices in high school science courses gives students dynamic and relevant opportunities to refine and communicate science understandings to be well prepared for civic life, postsecondary education, and career success.

Essential competencies for students by the end of grade 12 include reading and comprehending relevant issues in science to be informed decision-makers. Accurately using mathematics and computation as it applies to daily life and engaging in the practice of modeling to solve real-world problems enables all students to understand and analyze key scientific and tech-

1. Massachusetts Department of Elementary and Secondary Education (2022). *SCIENCE AND TECHNOLOGY / ENGINEERING Grades Pre-Kindergarten to 12 Massachusetts Curriculum Framework*. https://www.doe.mass.edu/frameworks/current.html

nical issues they will be asked to address throughout their lives. Communicating explanations coherently, with evidence from credible sources, is critical to engaging in public discourse.

Inclusion of science and engineering practices in standards only speak to the types of performances students should be able to demonstrate at the end of instruction of a particular course; the standards do not limit what educators and students should or can be engaged in through a well-rounded curriculum.

By the end of high school, students should have an understanding of and ability to apply each science and engineering practice to understand the world around them. Students should have had many opportunities to immerse themselves in the practices and to explore why they are central to the applications of science and engineering.

Some examples of these science and engineering practices include:

1. Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical, and/or environmental considerations.
2. Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
3. Plan and conduct an investigation, including deciding on the types, amount, and accuracy of data needed to produce reliable measurements, and consider limitations on the precision of the data.
4. Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific questions and engineering problems, using digital tools when feasible.

5. Use simple limit cases to test mathematical expressions, computer programs, algorithms, or simulations of a process or system to see if a model "makes sense" by comparing the outcomes with what is known about the real world.

28. High School

LAUREN WEISS AND MARGARET KRONE

HS-LS. High School Biology

The high school biology standards build from middle school and allow grade 9 or 10 students to explain additional and more complex phenomena related to genetics, the functioning of organisms, and interrelationships between organisms, populations, and the environment. The standards expect students to apply a variety of science and engineering practices to four core ideas of biology:

From molecules to organisms: structures and processes standards help students formulate an answer to the question, "How do organisms live and grow?" Students demonstrate that they can use investigations and gather evidence to support explanations of cell function and reproduction. They understand the role of proteins as essential to the work of the cell and living systems. Students can use models to explain photosynthesis, respiration, and the cycling of matter and flow of energy in living organisms. The cellular processes can be used as a model for understanding the hierarchical organization of organisms.

Standards focused on **ecosystems: interactions, energy, and dynamics** help students formulate an answer to the question, "How and why do organisms interact with their environment, and what are the effects of these interactions?" Students can use mathematical reasoning to demonstrate understanding of fundamental concepts of carrying capacity, factors affecting biodiversity and populations, and the cycling of matter and flow of energy among organisms in an ecosystem. These models support students' conceptual understanding of systems and their ability to develop design solutions to reduce the impact of human activities on the environment and maintain biodiversity.

Heredity: inheritance and variation of traits standards help students formulate answers to the questions: "How are characteristics of one generation passed to the next? How can individuals of the same species and even siblings have different characteristics?" Students are able to ask questions, make and defend a claim, and use concepts of probability to explain the genetic variation in a population. Students demonstrate understanding of why individuals of the same species vary in how they look and function. Students can explain the mechanisms of genetic inheritance and describe the environmental and genetic causes of gene mutation and the alteration of gene expression.

Standards for **biological evolution: unity and diversity** help students formulate an answer to the question, "What evidence shows that different species are related?" Students construct explanations for the processes of natural selection and evolution and communicate how multiple lines of evidence support these explanations. Students can evaluate evidence of the conditions that may result in new species and understand the role of genetic variation in natural selection. Additionally, students can apply concepts of probability to explain trends in populations as those trends relate to advantageous heritable traits in a specific environment.

The high school biology standards place particular emphasis on **science and engineering practices** of developing and using models; constructing explanations; engaging in argumentation from evidence; and obtaining, evaluating, and communicating information. Students are expected to use multiple types of models, including mathematical models, to make predictions and develop explanations, analyze and identify flaws in the model, and communicate ideas that accurately represent or simulate the biological system. Students are asked to construct and revise explanations and claims based on valid and reliable evidence and apply scientific reasoning to evaluate complex real-world problems such as the effects of human activity on biodiversity and ecosystem health. Students must be able to find and interpret scientific literature to compare, integrate, and evaluate sources and communicate phenomena related to genetics, the functioning of organisms, and interrelationships between organisms, populations, and the environment. The application of these practices across the core ideas gives students a rich grounding in biology.[1] [2]

HS-LS. High School Biology
LS2. Ecosystems, Interactions, Energy, and Dynamics • **HS-LS2-7.** Analyze direct and indirect effects of human activities on biodiversity and ecosystem health, specifically habitat fragmentation, introduction of non-native or invasive species, overhar-

1. Massachusetts Department of Elementary and Secondary Education (2022). *SCIENCE AND TECHNOLOGY / ENGINEERING Grades Pre-Kindergarten to 12 Massachusetts Curriculum Framework*. https://www.doe.mass.edu/frameworks/current.html
2. Falcon Curriculum Common Core Standards mapping by Margaret Krone. Falcon Curriculum Lesson Plans by Lauren Weiss. © 2022 CC BY 4.0

vesting, pollution, and climate change. Evaluate and refine a solution for reducing the impacts of human activities on biodiversity and ecosystem health.

Falcon Curriculum Core Categories

Conservation and Policy

Falcon Curriculum Essential Question

How have human activities affected the peregrine falcon population, both negatively (DDT) and positively (conservation)?

Materials

For Instructors	For Students
• About Falcons: Conservation • Falcon Curriculum: Conservation, Advanced videos • History of Falconry with Chris Davis video • *Silent Spring* by Rachel Carson • Dr. White-Stevens Will Defend Use of Pesticides. *The Long-Islander*., February 07, 1963, Page 24, Image 24	• Additional research • Paper or access to word processing

Sample Plan

Go through selections of *Silent Spring* as a class (specifically, the early chapters). Carson doesn't specifically mention peregrines in the book; have students extrapolate from the readings as to what they think the connections are between the use of pesticides and peregrine falcons. Also read the 1963 pro-pesticides coverage from *The Long-Islander* and discuss.

Read and watch About Falcons: Conservation, Falcon Curriculum: Conservation, Advanced videos, and History of Falconry with Chris Davis video to confirm/expand upon the students' extrapolations.

Have students pretend to be early environmentalist advocates during the early 1960s and make trifold pamphlets to convince people to regulate pesticide use using information from the readings and additional research as needed.

High School Introductory Physics

The high school introductory physics standards build from middle school and allow grade 9 or 10 students to explain additional and more complex phenomena central to the physical world. The standards expect students to apply a variety of science and engineering practices to three core ideas of physics:

Standards on **motion and stability: forces and interactions** support students' understanding of ideas related to why some objects move in certain ways, why objects change their motion, and why some materials are attracted to each other while others are not. This core idea helps students answer the question, "How can one explain and predict interactions between objects and within systems of objects?" Students are able to demonstrate their understanding by applying scientific and engineering ideas related to Newton's second law, total momentum, conservation, system analysis, and gravitational and electrostatic forces.

A focus on **energy** develops students' understanding of energy at both the macroscopic and atomic scales that can be accounted for as either motions of particles or energy stored in fields. This core idea helps students answer the question, "How is energy transferred and conserved?" Energy is understood as a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system; the total change of energy in any system is always equal to the total energy transferred into or out of the system. Students apply their understanding to explain situations that involve conservation of energy, energy transfer, and tracing the relationship between energy and forces.

Standards on **waves and their applications in technologies for information transfer** support students' understanding of the physical principles used in a wide variety of existing and emerging technologies. As such, this core idea helps students answer the question, "How are waves used to transfer energy and send and store information?" Students are able to apply understanding of how wave properties and the interactions of electromagnetic radiation with matter can transfer information across long distances, store information, and investigate nature on many scales. They develop and use models of electromagnetic radiation, as either a wave of changing electric and magnetic fields or as particles. Students understand that combining waves of different frequencies can make a wide variety of patterns and thereby encode and transmit information. They can demonstrate their understanding by explaining how the principles of wave behavior and wave interactions with matter are used in technological devices to transmit and capture information and energy.

Across the set of high school introductory physics standards, particular emphasis is placed on **science and engineering practices** of developing and using models, analyzing and interpreting data, using mathematics, and engaging in argument from evidence. Students are expected to use mathematical and graphical representations and models to quantitatively and qualitatively describe, evaluate, and make predictions of a variety of phenomena such as motion, energy, and waves. Students should be able to use multiple types of models and compare their merits and limitations and level of detail and accuracy, and use them as a basis for explanations or arguments about underlying concepts or processes. The standards call for students to critique competing ideas and evaluate design solutions using data and evidence relevant to high school science. Analyzing and interpreting data gathered during investigations or experiments, such as of magnetic fields and electric current, wave properties, or motion, also contributes to students' development of explanations and arguments using relevant, quantitative evidence. Applying these practices across the core ideas gives students a rich grounding in introductory physics.[3] [4]

HS-PHY. High School Introductory Physics

3. Massachusetts Department of Elementary and Secondary Education (2022). *SCIENCE AND TECHNOLOGY / ENGINEERING Grades Pre-Kindergarten to 12 Massachusetts Curriculum Framework*. https://www.doe.mass.edu/frameworks/current.html
4. Falcon Curriculum Common Core Standards mapping by Margaret Krone. Falcon Curriculum Lesson Plans by Lauren Weiss.

PS2. Motion and Stability: Forces and Interactions

- **HS-PS2-1.** Analyze data to support the claim that Newton's second law of motion is a mathematical model describing change in motion (the acceleration) of objects when acted on by a net force.

Falcon Curriculum Core Categories

Animal Behavior

Falcon Curriculum Essential Question

How does Newton's second law of motion relate to peregrine falcons in the context of sexual dimorphism?

Materials

For Instructors	For Students
• About Falcons: Basic Information and Prey and Hunting • Falcon Curriculum: Prey and Hunting videos • STEMonstrations: Newton's Second Law of Motion video	• "Wingshot" Experiment ◦ Worksheet ◦ Sets of 3 balls with substantially different masses (1 set per group) ◦ Measuring tape ◦ Stopwatch (could use phone app) ◦ Tape ◦ Elastic ◦ Something to stretch the elastic between (i.e. 2 chairs/desks/etc.) ◦ Books/pool noodles/etc. to set up like bumpers in a bowling alley to keep the balls from rolling all over ◦ (Optional: paper cups and cutouts of eggs and pigs)

Sample Plan

Read and watch About Falcons: Basic Information and Prey and Hunting and Falcon Curriculum: Prey and Hunting videos. Discuss sexual dimorphism: how male falcons are smaller than female falcons, and how their sizes assist them in their roles of hunting and nesting, respectively.

Explain/review Newton's second law of motion: The acceleration of an object depends on the mass of the object and the amount of force applied. Watch the STEMonstrations: Newton's Second Law of Motion video.

Do the "Wingshot" experiment:

1. Separate students into groups.
2. Have each group take an elastic and stretch it between 2

chairs/desks/etc. to make a taut slingshot 12 inches across. Put a piece of tape 5 inches behind the slingshot as the point to pull back to each time.

3. Set up books/pool noodles/etc. as bumpers to make a “track” in front of the slingshot.
4. Set up measuring tape along the track and measure out a distance of 5 feet. Put a piece of tape at that mark. (Optional: set up a small cup tower at the mark with cutouts of eggs and pigs.)
5. Figure out the different masses of the balls.
6. Put each ball individually into the slingshot, pull it back to the tape, and let it go, starting the stopwatch once it is let go and stopping the stopwatch once it reaches the 5-feet mark.
7. Repeat 3 times for each ball.
8. Part 2: See what happens when the distance to which you pull back on the elastic is less/more.

The results should demonstrate that the balls with less mass were able to travel the distance at a faster speed than the balls with more mass. This is why it is advantageous for the smaller male falcons to do the majority of the hunting. The results from the second part should also demonstrate that the amount of force will also affect the object’s acceleration.

High School Technology/Engineering

The high school technology/engineering standards build from middle school and allow grade 9 or 10 students to explain major technological systems used in society and to engage in more sophisticated design problems. The standards expect students to apply a variety of science and engineering practices to four core ideas of technology/engineering:

Engineering design standards support students' understanding of how engineering design is applied to complex societal challenges as well as developing their skills in defining design problems and developing solutions.

A focus on **materials, tools, and manufacturing** supports students in understanding how manufacturing makes use of and can change material properties to create useful products. They consider different manufacturing processes, including where computer-aided systems can be useful, and how those processes can affect material properties.

Standards about **technological systems** help students to learn how complex design systems work, particularly those they use every day. Such systems include communications systems, structural systems, and transportation systems. Through the study of these critical infrastructure systems, students understand how the components they interact with every day depend on the design and functioning of the larger system. They also can abstract the concept of a system, identifying inputs and outputs of subsystems and their interrelationships.

Energy and power technologies standards support students in understanding how humans manipulate and use energy to accomplish physical tasks that would otherwise be impossible or difficult. These technologies include open and closed pneumatic and hydraulic systems.

The high school technology/engineering standards place particular emphasis on **science and engineering practices** of developing and using models; analyzing and interpreting data; using mathematics; designing solutions; and obtaining, evaluating, and communicating information. Relevant examples give students a valuable context to learn about and model a technological system, use a model to explain differences in systems or illustrate how a system works. This leads to a more detailed understanding of the role that engineering design, materials, tools, and manufacturing have in the natural and designed world. The standards expect students to research and analyze specific design solutions that give them an opportunity to determine optimal conditions for performance of materials, influences of cost, constraints, criteria, and possible environmental impacts. Use of mathematics is a key skill in designing prototypes to scale, using prototypes or simulations that model multiple interactions in a complex problem and calculating change to a system that includes a number of variables. Students communicate and evaluate solutions to real-world problems, propose or refine solutions, and examine the social and cultural impacts a product, material, manufacturing process, or technology could have in our world. The application of these practices across the core ideas gives students a rich grounding in technology/engineering.[5] [6]

HS-ETS. High School Technology/Engineering

ETS1. Engineering Design

- **HS-ETS1-1.** Analyze a major global challenge to specify a design problem that can be improved. Determine necessary qualitative and quantitative

5. Massachusetts Department of Elementary and Secondary Education (2022). *SCIENCE AND TECHNOLOGY / ENGINEERING Grades Pre-Kindergarten to 12 Massachusetts Curriculum Framework*. https://www.doe.mass.edu/frameworks/current.html
6. Falcon Curriculum Common Core Standards mapping by Margaret Krone. Falcon Curriculum Lesson Plans by Lauren Weiss. © 2022 CC BY 4.0

criteria and constraints for solutions, including any requirements set by society.

Falcon Curriculum Core Categories

Anatomy and Life Cycle
Animal Behavior

Falcon Curriculum Essential Question

How can studying peregrine falcons (and nature in general) inspire design solutions to complex, real-world problems?

Materials

For Instructors	For Students
• About Falcons • Stanford Article	• Paper • Pencils

Sample Plan

Read the About Falcons sections and the Stanford article about SNAG. Discuss the potential uses mentioned in the article and try to come up with additional ones. Put students into groups and have them brainstorm potential other design problems that could be improved by studying falcons.

PART III

RESOURCES

29. Videos

Falcon Curriculum Videos

Introductory Videos[1]

This series of introductory videos is designed to compliment the "About Falcons" section of the Pressbook and includes visuals and animation to demonstrate the concepts in the text.

- Basic Info, Part 1
- Basic Info, Part 2
- Life Cycle, Part 1
- Life Cycle, Part 2
- Behaviors
- Habitat, Part 1
- Habitat, Part 2
- Flight, Part 1
- Flight, Part 2
- Prey and Hunting, Part 1
- Prey and Hunting, Part 2
- Conservation, Beginner, Part 1
- Conservation, Beginner, Part 2
- Conservation, Advanced, Part 1
- Conservation, Advanced, Part 2

Special Guests

These videos were filmed in collaboration with Chris Davis, New England Falconry, and Tom Ricardi, Massachusetts Birds of Prey Rehabilitation Center, respectively.

A Short History of Falconry with Chris Davis, New England Falconry

FalConference 2021 Panel 3: "Birds of Prey Program"

UMass Amherst Libraries Falcon Cam

The UMass Amherst Falcon Cam livestream is available during the spring nesting season on the Libraries' YouTube Channel. The following videos are recordings from the 2021 falcon season, including Banding Day.

UMass Amherst Libraries Falcon Cam 5/31/21 to 6/7/21
UMass Amherst Libraries Falcon Cam 6/8/21 to 6/14/21
UMass Amherst Libraries Falcon Cam 6/15/21 to 6/21/21
UMass Amherst Libraries Falcon cam 7/7/21 to 7/14/21
Falcon Banding Day 2021 Video

Additional Falcon Cams

There are many falcon and wildlife cams available throughout the year for livestreaming. These two are from our "pen pals."

Cal Falcons at UC Berkeley
UMass Lowell Hawk Watch

Additional Videos

The following videos are other videos referenced throughout the curriculum.

Bob Schriber: "The Bird Guys: Chasin Grins"

Bruce Yolton: YouTube Channel

Crafts with Toddler: "3 Easy Birds Crafts for Kids"

LEGO: Build Small Creator Birds

NASA Johnson: "STEMonstrations: Newton's 2nd Law of Motion"

30. Images

Basic Info

Appearance

Habitat

Local Information: Massachusetts

Life Cycle

Prey and Hunting

Prey

Other Behaviors

Flight

Types of Wings

High-Speed Wings (Peregrine Falcon)
Hovering Wings (Hummingbird)
Passive Soaring Wings (Bald Eagle)

Conservation

Article: "Dr. White-Stevens Will Defend Use of Pesticides," *The Long Islander*, Feb. 7, 1963
Cade, Tom
Cade, Tom with Captive-Bred Peregrine Falcon
Captive-Bred Falcon Chicks
Captive-Bred Peregrine Falcon with Chicks
Carson, Rachel
DDT
DDT ad from Penn Salt Chemicals in Time Magazine on June 30th, 1947.
Douglas C-47s spraying DDT insecticide over Manila, April 1945
Ford tri-motor spraying DDT for the Western spruce bud-worm control project. Powder River control unit, Oregon. 1955
Hack Site: Cliffside
Hack Site: Cliffside, Putting in Peregrine Falcons
Hack Site: Manhattan Building
Half-page ad in the Daily Olympian, prior to western hemlock looper control projects, 1963.
Insecticide with DDT
Meng, Heinz
Muller, Paul Hermann
Peregrine Falcon Eggs in Incubator
Peregrine Falcon Eggshells 1
Peregrine Falcon Eggshells 2
The Peregrine Fund
Silent Spring by Rachel Carson

Local Information: Massachusetts

French, Dr. Tom at Nest Box on W. E. B. Du Bois Library, UMass Amherst
Fuller, Dave at Nest Box on W. E. B. Du Bois Library, UMass Amherst
Griffin, Dr. Curtice at Nest Box on W. E. B. Du Bois Library, UMass Amherst
Massachusetts: Historic Photographs of Peregrine Falcons on Mount Tom
Massachusetts: Mount Tom
Massachusetts: Pioneer Valley
Peregrine Falcon Eggshell

Falconry

History of Falconry Timeline Part 1
History of Falconry Timeline Part 2

Subspecies

Anatum
Babylonicus
Brookei
Calidus
Cassini
Cassini (Pallid Variant)
Ernesti
Furuitii (Currently, there are no known photographs of living *furuitii*)
Japonensis

Macropus
Madens (No image currently available)
Minor
Nesiotes
Pealei
Pelegrinoides
Peregrinator
Peregrinus
Peregrinus (View of Back)
Radama
Submelanogenys
Tundrius

31. Auditory Recordings

The following YouTube videos are provided courtesy of Cal Falcons, UC Berkeley. Their nest box cameras have audio capability and captured the various sounds peregrine falcons make.

Antagonistic Interaction Between Established Female and Floater Male (Around 4:00)

Chicks Cawing for Food

Courtship Display

Nest Defense

Prey Delivery to Mate

32. Activity Sheets

Audubon for Kids Paper Airplane Birds[1]

Banding Scavenger Hunt Falcons

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12
- 13

Banding Scavenger Hunt[2]

Bird Yoga[3]

Case Study: 72/BV[4]

"Falcon genomics in the context of conservation, speciation, and human culture"[5]

1. Audubon. For the Birds. "These Paper Airplanes Fly Like Birds. https://www.audubon.org/news/these-paper-airplanes-fly-birds
2. Weiss, Lauren. CC-BY.
3. Weiss, Lauren and Chloe Deeley. CC-BY.
4. Weiss, Lauren. CC-BY.
5. Wilcox, Justin J.S., Stéphane Boissinot, and Youssef Idaghdour. "Falcon genomics in the context of conservation, speciation, and human culture."

Lift-Off Experiment[6]
Owl Pellet Bone Identification Guide[7]
Peregrine Falcon Anatomy[8]
Peregrine Falcon Coloring Sheet 1[9]
Peregrine Falcon Coloring Sheet 2[10]
Peregrine Falcon Sun and Moon Coloring Sheet[11]
"Role of Genetic Background in the Success of Reintroduced Peregrine Falcons"[12]
Soft Shelled Egg Experiment[13]
Wingshot Experiment: High School[14]
Wingshot Experiment: Middle School[15]

6. Weiss, Lauren. CC-BY.
7. Cornell Lab of Ornithology. https://www.birds.cornell.edu/k12/bone-identification/
8. Weiss, Lauren. CC-BY.
9. Deeley, Chloe. CC-BY.
10. Deeley, Chloe. CC-BY.
11. Deeley, Chloe. CC-BY.
12. Tordoff, Harrison B. and Patrick T. Redig. "Role of Genetic Background in the Success of Reintroduced Peregrine Falcons."
13. Weiss, Lauren. CC-BY.
14. Weiss, Lauren. CC-BY.
15. Weiss, Lauren. CC-BY.

33. Glossary

Accipitriformes: (axe-SIP-ih-trih-forms) N. An order of birds including hawks, eagles, and Old World vultures.

Active Soaring Wings: (ACK-tihv SOHR-ing WINGS) N. Long and narrow wings so birds can soar for a long time. See Soar.

Aerodynamic: (AIR-oh-dye-NAHM-ick) Adj. Streamlined with less drag so it can go faster. See Drag.

Band: (BAND) V. To put specially colored, numbered and lettered metal bands around a chick's legs to help wildlife experts and other birdwatchers identify the chicks as they grow and eventually leave the nest.

Biomagnification: (BYE-oh-MAHG-niff-ih-CAY-shun) N. When the amount of a toxic substance gets more and more concentrated in organisms at each step up the food chain.

Birds of Prey: N. See Raptors.

Branch: (BRANCH) V. (For chicks) To explore the environment around their nest, often climbing around on top of objects.

Brood Patch: (BROOD PATCH) N. An area on falcons' bellies that loses feathers after egg-laying and develops additional blood vessels close to the surface so that the patch is nice and warm in direct contact with the eggs.

Cache: (CASH) N. A store of prey items saved for later. V. To store prey items for later.

Cade, Tom: N. A falconer, field biologist, Cornell professor, and the founder of The Peregrine Fund.

Cariamiformes: (carry-AM-ih-forms) N. An order of birds including seriemas.

Carson, Rachel: N. An American marine biologist, writer, and conservationist famous for *Silent Spring*, which began the environmentalist movement.

Cast Pellets: (CAST PELL-uhts) V. To regurgitate pellets to keep the digestive tract clean. See Pellet.

Cathartiformes: (cuh-THAR-tih-forms) N. An order of birds including New World vultures.

Cere: (SEER) N. Prominent yellow fleshy base of the falcon's bill.

Conservation: (cahn-sihr-VAY-shun) N. The act of protecting nature so it will be around in the future.

Crop: (CRAHP) N. An organ that aids in breaking down and storing food for digestion.

Courtship Display: (CORT-ship diss-PLAY) N. A series of behaviors to attract a mate, including head bows (they bow their heads low to each other), aerial displays, scraping of the ground, and beaking (playfully nipping at each other).

DDT: N. Dichloro-diphenyl-trichloroethane (DYE-clohr-oh-DYE-fehn-uhl-TRY-clohr-oh-EH-thayn). A synthetic chemical discovered to be a successful insecticide, but very harmful to humans and the environment.

Diurnal: (dye-URN-uhl) Adj. Active during the day.

Down: (DOWN) N. Fine feathers underneath a bird's exterior feathers that help keep it warm. Young chicks only have down until they grow their regular feathers.

Drag: (DRAHG) N. A force that slows down the movement of an object when it passes through a liquid or a gas.

Egg Tooth: (EGG TOOTH) N. A temporary sharp tooth-like projection on the beak of a chick used to break the shell during hatching.

Elliptical Wings: (ee-LIHP-tick-uhl WINGS) N. Wings that are rounded/oval-shaped. They are good for flying fast for short amounts of time, but can't keep up that high speed for too long. Elliptical wings also allow for fast takeoffs and tight maneuvering.

Endangered: (ehn-DAYN-juhrd) Adj. (For a species) At risk for extinction.

Enfluffel: (en-FLUFF-uhl) V. To pull, push, roll, and rotate the eggs around underneath them so that they develop properly.

Environmentalism: (ehn-vye-rahn-MEN-tuhl-iz-uhm) N. Support for the environment and laws and other actions that protect it.

Extinct: (eck-STINKT) Adj. (For a species) Completely gone and can no longer be found.

Extirpate: (ECK-stuhr-payt) V. To wipe out.

Eyas/Eyass: (EYE-uhs) N. Peregrine falcon chick. Also called hatchling or nestling when it hatches.

Eyrie: (EYE-ree) N. A peregrine falcon's nest site.

Falconiformes: (fal-CON-ih-forms) N. An order of birds including falcons.

Falconry: (FAHL-con-ree) N. The ancient practice of training birds of prey to hunt and fly for you.

Feak: (FEEK) V. To rub the beak against other surfaces to clean or wipe it and maintain beak shape.

Fledge: (FLEJ) V. (For chicks) To fly (for the first time).

Fledgling: (FLEJ-ling) N. Chick that has fledged.

Floater: (FLOH-tuhr) N. A falcon that doesn't have its own territory or mate.

Gastrolith: (GAS-troh-lith) N. Small pieces of gravel/rocks/sand that birds eat and store in their gizzard. Stones held within the gizzard break down the food the birds eat before it gets to the stomach. Also called "gizzard stones."

Gravity: (GRAH-vih-tee) N. A force that pulls things towards each other.

Hack: (HACK) V. To put unfledged falcon chicks in a special structure where they are fed and protected with minimal human contact until they fledge and fly away.

Hallux: (HAL-ucks) N. The toe facing backwards.

Hard Incubation: (HARD ink-yoo-BAY-shun) N. Constant incubation. See Incubation.

Hatchling: (HATCH-ling) N. See Eyas.

High-Speed Wings: (HYE-SPEED WINGS) Wings that are long, thin, and pointed (but not as long as active soaring wings). They allow a bird to fly very fast and keep up the high speed for a while.

Hovering Wings: (HUH-vuhr-ing WINGS) N. Wings that are very small and quick.

Incubation: (ink-yoo-BAY-shun) N. Sitting on the eggs to keep them warm so they can develop and hatch.

Insecticide: (ihn-SECK-tuh-syde) N. A substance used to kill insects.

Keel: (KEEL) N. An extension of the sternum (breastbone) that acts like an anchor for a bird's wing muscles.

Lift: (LIHFT) N. An upward force where air moves faster over the top of a bird's wing and slower under the bottom of the wing. This means that air pressure is lower over the top of the wing. Since air automatically goes to places with lower pressure (like when you deflate a balloon and the air comes out of it fast), the air moves from over the top of the wing to underneath it, which pushes the bird up.

Loaf: (LOHF) V. (For birds) To display relaxed behaviors not specifically related to feeding, breeding, or predator evasion.

Lower Mandible: (LOH-uhr MAN-dih-bull) N. Lower beak. In peregrine falcons, it is shorter, and the hook tip of the maxilla goes right over it.

Malar Stripes: (MAY-lar STRIPES) N. Dark-colored stripes down the faces of peregrine falcons that act like athletes' eye black to reduce glare from the sun.

Mantle: (MANT-uhl) V. To spread wings over prey to protect it from rivals, including siblings.

Maxilla: (macks-ZILL-uh) N. Upper beak. In peregrine falcons, it is curved and hook-tipped.

Mid-Air Prey Exchange: (MID-AIR PRAY ECKS-change) N. Quick feat where one falcon flies underneath the other that is carrying prey, turns upside down, and grabs the prey from the carrier with its talons.

Migrate: (MY-grayt) V. To move seasonally from one location to another.

Molt: (MOHLT) V. To lose old feathers and grow new ones to replace them.

Nest: (NEST) V. To find a mate and territory and raise chicks.

Nestling: (NEST-ling) N. See Eyas.

Nictitating Membrane: (NICK-tih-tay-ting MEM-brane) N. A third eyelid that protects and moistens the eye. It is translucent (clear) so the falcon can still see when it's closed.

Nocturnal: (knock-TURN-uhl) Adj. Active at night.

Pair Bonding: (PAIR BON-ding) N. A continuation of courtship display activities throughout nesting to strengthen the connection between the mates.

Passive Soaring Wings: (PASS-ihv SOHR-ing WINGS) N. Wings with long primary feathers that spread out so hot air can get through and help the birds fly higher.

Pellet: (PELL-uht) N. Collection of indigestible material gathered in the stomach of birds that occasionally need to be disposed of.

Peregrine Falcon: (PAIR-uh-grin FAL-cuhn) (*Falco peregrinus*) N. A bird of prey belonging to the Falconiform order with a gray back, hook-tipped beak, yellow feet and legs, and malar stripes or "sideburns" on its face.

Pip: (PIHP) N. The first hole in the egg made by the chick when it starts to hatch.

Preen: (PREEN) V. Cleaning arranging, and oiling their feathers to keep them in good condition.

Raptor: N. Birds that evolved from a common ancestor (a bird that lived on land and ate vertebrates, or animals with backbones), and many of that ancestor's descendants continue to have a raptorial lifestyle (meaning they also eat vertebrates). Also referred to as birds of prey.

Scrape: (SCRAYP) N. A peregrine falcon's nest.

Sexual Dimorphism: (SECK-shoo-uhl dye-MORE-fizz-um) N. A difference in size or physical appearance between males and females of a species.

Soar: (SOHR) V. To fly without flapping wings.

Stoop: (STOOP) N. A controlled dive done by falcons. V. To drop straight down in a controlled dive.

Strigiformes: (STRI-jih-forms) N. An order of birds including owls.

Subspecies: (SUHB-spee-sheez) N. A classification rank below species used to describe populations of a species that live in different areas and have different physical characteristics, but are still able to interbreed.

Talons: (TAL-uhns) N. Sharp curved claws.

Tarsus: (TAR-suhs) N. Part of a falcon's leg between backwards "knee" and ankle." (Pl. Tarsi)

Territory: (TAIR-uh-tore-ee) N. With regard to peregrine falcons, it is a large area around the nest site.

Thermoregulate: (THUHR-moh-REG-yoo-late) V. To control one's own body temperature.

Tiercels: (TEER-suhls) N. Male peregrine falcons. From the old word for "third," since they are approximately one-third smaller than females.

Tomial Teeth: (TOE-me-uhl TEETH) N. Sharp points that fit into corresponding notches on the lower mandible when the falcon closes its beak.

Unihemispheric Slow-Wave Sleep (USWS): (YOO-nee-HEM-uhs-FEER-ick SLOW-WAYV SLEEP) N. When a bird sleeps with half of their brain alert and half of it asleep, so actually sleeping with one eye open. This lets them get the rest they need while also staying alert in case a predator approaches.

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