

SNHU's Red-Tailed Hawks

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**Abstract:**

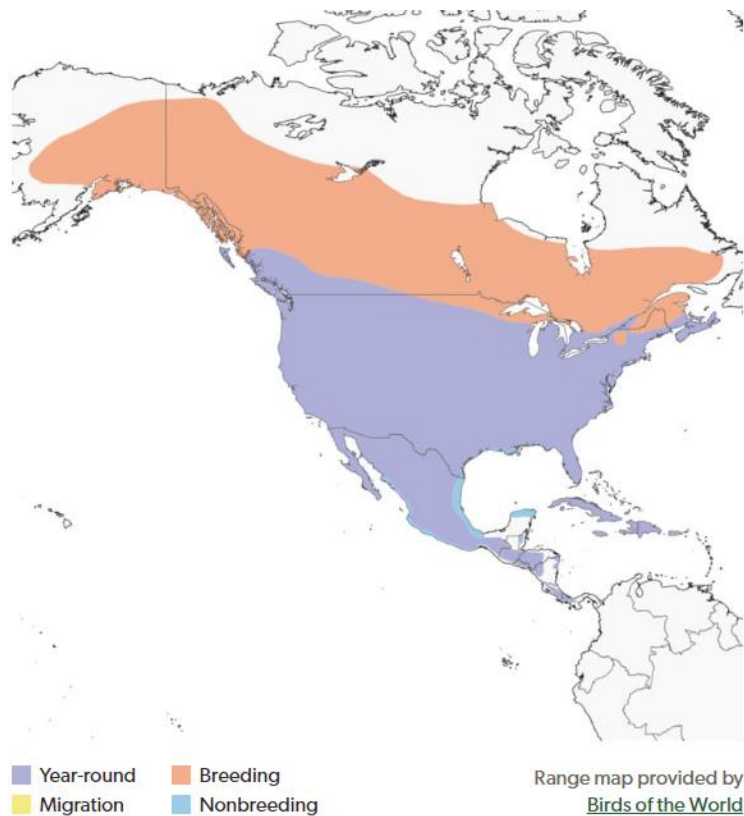
During our first year at Southern New Hampshire University (SNHU), in fall 2021, we noticed two Red-tailed hawks on campus that we named Hank and Katy. Throughout the school year, we observed frequent changes to the school environment, like trees that were cut down. The loss of forested areas caused us to worry about the safety of the hawks. We questioned the hawks' roles on campus and wanted to learn more. Our curiosity led us to initiate this research to educate other students and conserve the hawks' presence on campus. After about a year, the hawk pair bred and hatched a chick we named Finn. The introduction of a juvenile to the hawk family carried our data along into the 2nd year of research. The guiding questions of our research were (1) How does the family of Red-tailed hawks interact with the SNHU campus and community? and (2) In what area of the campus are the hawks nesting? We used a campus survey, social media, observations, and drone deployment to collect data. We found there was a mutualistic relationship between the campus and the hawks. The campus provided a habitat for the hawks while the hawks controlled animal populations through hunting. We also found that the SNHU community was knowledgeable about the hawks' presence, as shown by their involvement in the survey and social media. We did not locate an exact nesting site. However, we believe that the southern forested area of campus is the most likely location due to the protective habitat provided by the trees. We aim to continue our research through next year by engaging with the community and creating an informative plaque to display our research.

**Preliminary Research:**

The Red-tailed hawk, also known as *Buteo jamaicensis*, is a diurnal raptor found across North and Central America (Cornell Lab of Ornithology, n.d.; Dewey & Arnold, 2002; National Audubon Society, n.d.). A raptor, also called a bird of prey, refers to a carnivorous bird (The Raptor Center, n.d.). The adult Red-tailed hawk has a descending raspy screech (National Audubon Society, n.d.). They typically range from 17 to 25 inches with a 4-foot wingspan (Dewey & Arnold, 2002). These raptors are most distinguishable by their deep orangish-red tail feathers. Other notable features include chests speckled with a brown band across the belly, brown heads, and brown and white horizontal stripes across the primary and secondary flight feathers with brown tips. Males and females experience sexual dimorphism. The distinguishing characteristic of the sexes is that females are larger than males (Dewey & Arnold, 2002).

Red-tailed hawks reside in North and Central America. The hawk populations in northern areas are migratory due to the harsh winters. However, most populations in the United States and Central America are year-round. Southern New Hampshire University is in a year-round location (Cornell Lab of Ornithology, n.d.; National Audubon Society, n.d.).

Figure 1: *Red-tailed Hawk Migratory Map*



Red-tailed hawks have adapted to various environments, including deserts, woodlands, and cities. The hawks prefer to live in areas with high structures near an open plane. Structures can include crowns of trees, telephone poles, and cliffs (Dewey & Arnold, 2002). High structures provide an area for roosting or nesting. Planes, like a field or lake, are used for hunting. The Red-tailed hawk's diet mainly consists of small mammals, reptiles, fish, and birds. Mice, voles, rabbits, snakes, and songbirds are common prey. In addition, the hawks have also been known to eat carrion, especially in the winter (C. Martin, Personal Communication, September 13, 2022; Dewey & Arnold, 2002). When hunting, Red-tailed hawks observe from a high perch

and then swoop down towards the ground to catch their prey in their talons (Fitch et al., 1946; National Audubon Society, n.d.).

Red-tailed hawks begin mating at three years old. Breeding occurs in the spring. Courtship behavior includes a male and female hawk soaring in circles and repeatedly diving down. A male may also pass prey to the female while flying. After the courting flight, the pair of hawks fly to a perch to preen each other and breed. Once a pair of hawks is mated, they stay together until one dies (Fitch et al., 1946; Dewey & Arnold, 2002; National Audubon Society, n.d.). For a male hawk to find a mate, he must have territory and possibly a nest (Fitch et al., 1946).

Red-tailed hawks are territorial and will roost and hunt within 1 mile of their nest. The primary use of nests is to raise chicks, but a mated hawk pair will stay within the nearby territory throughout the year (C. Martin, Personal Communication, September 13, 2022). Nesting sites vary between environments, but in a woodland setting, nests are typically built in the forks of trees from sticks, bark, and other foraged materials (Fitch et al., 1946). Nests are usually around 3 feet in length and width. The male and female hawks build the nest or touch up one from previous years (Cornell Lab of Ornithology, n.d; National Audubon Society, n.d.). Nest construction and maintenance occur in the late fall or early spring (C. Martin, Personal Communication, September 13, 2022).

Female Red-tailed hawks will typically lay 1 to 3 eggs around late spring. The eggs are white with brown blotches. The incubation period is 4 to 5 weeks. Although both parents will incubate the eggs, the female mostly does this. In the meantime, the male will hunt and deliver food to his mate. Once the eggs hatch, the female broods the chicks. Chicks leave the nest after six weeks and will remain fledglings for several more weeks (Cornell Lab of Ornithology, n.d.; Dewey & Arnold, 2002; Fitch et al., 1946; National Audubon Society, n.d.).

It can take Red-tailed hawks anywhere from 1.5 to 3 years to reach sexual maturity. Until sexual maturity, a young hawk is considered a juvenile. Juvenile hawks are smaller than adults with lighter coloring, yellow eyes, and a brown striped tail instead of orangish-red. Over several months, juveniles molt and then regrow adult plumage (*The life cycle of the Red-tailed hawk*. 2019; *Juvenile Red-tailed hawks (identification guide with pictures)*. 2022). Early juvenile habits consist of learning to fly and hunt. While learning, juveniles stay in a small area for an extended time. Older juveniles explore a wider area within the parents' territory and learn to hunt more

independently, with some parental assistance (Fitch et al., 1946). During this time, juvenile hawks let out a repeated short, high-pitched screech. This call signifies they are hungry and hunting for food. Juveniles will often eat carrion due to their lack of hunting knowledge. At around 15 to 16 weeks, the parents ignore the juvenile completely. The juvenile then roams the nearby area independently until it reaches sexual maturity (*The life cycle of the Red-tailed hawk*. 2019; *Juvenile Red-tailed hawks (identification guide with pictures)*. 2022).

Red-tailed hawks are adaptable but are prone to habitat loss. Habitat loss is connected to urbanization, which is the growth of urban areas (National Geographic Society, 2023). Expanding urban settings cause less land availability that can provide for the needs of Red-tailed hawks, like hunting grounds, prey, and nesting habitat. Habitat loss was one of the many factors that led to the endangerment of this species, along with overhunting and human interference with nests (Dewey & Arnold, 2002; National Audubon Society, n.d.). Red-tailed hawks were once listed as endangered in the 20th century, although they no longer are. Red-tailed hawks have been slowly increasing in numbers. According to the North American Bird Breeding Survey, the hawk population increased by 1.3% per year from 1966 to 2019 (Cornell Lab of Ornithology, n.d.). Since this raptor species is no longer considered endangered, there is not much stress on creating protective laws for their conservation. However, a key piece of legislation that provides protection for Red-tailed hawks is The Migratory Bird Treaty Act (Fish and Wildlife Service, 2023).

Passed in 1918, the Migratory Bird Treaty Act (MBTA) aims to protect over 1,000 species of birds from destructive human activities. The MBTA states that any actions that could cause harm to a protected species population are prohibited unless permitted by specific regulations. The actions include, but are not limited to, hunting, capturing, killing, carrying, selling, and trading. These actions protect the listed species and their feathers, eggs, and nests (The Migratory Bird Treaty Act, 1918). The MBTA is quite vague. In some legal cases, it has been used exclusively against hunting. However, in other cases, it has been used against any actions that can harm the species, such as construction and tree cutting (Rozan, 2014). The threats to Red-tailed hawks are not entirely in the past, as they still face threats of habitat loss from human interaction, which can impact nesting activity and ultimately decrease population numbers (Dewey & Arnold, 2002).

### **Research Questions & Hypotheses:**

- 1) How does the SNHU campus and community interact with the Red-tailed hawks? This can be divided into the subcategories of physical interactions and public knowledge.
- 2) In what area of the campus are the hawks nesting?

We believe we will identify a mutual interaction between the campus and the hawks. We also believe that most people will be familiar with campus hawks and have a basic understanding of the species.

We believe that the nest location will be in the southern forested region on campus. The thick forest provides adequate nesting opportunities and protection for the hawks.

### **Methodology:**

#### Survey:

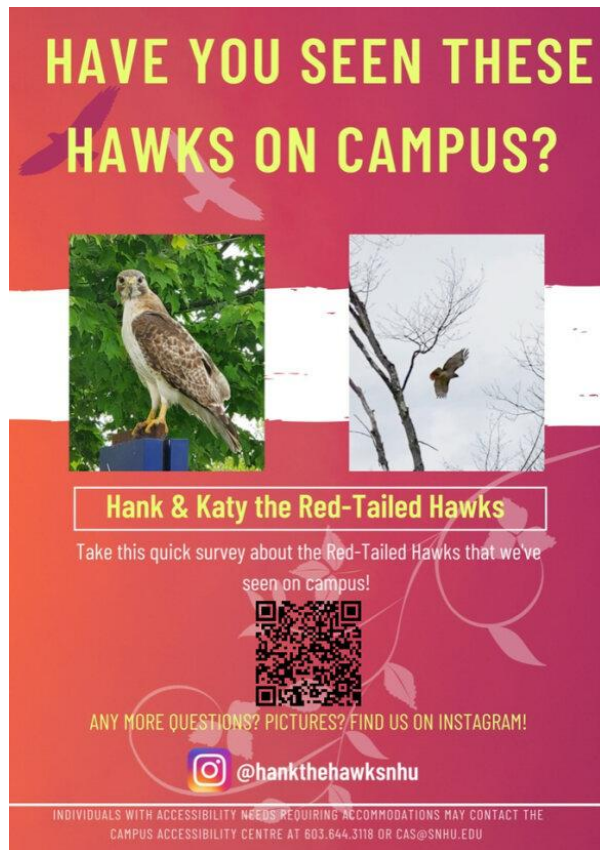
To assess the public view of the campus Red-tailed hawks, we created and deployed an anonymous Qualtrics survey. The survey was conducted from February 14 to March 10, 2023. The survey consisted of eight prompts:

1. Consent information about the use of survey data.
2. What is your role on campus?
3. How long have you been a part of the campus?
4. Do you know about the Red-tailed hawks that live on campus?
5. Have you seen a Red-tailed hawk on campus? List all interactions.
6. Insert any pictures.
7. Are there any suggestions you'd like to give us about our research?
8. Are you following us on Instagram @hankthehawksnhu?

The questions aimed to gather data about participants' interactions with the hawks, their knowledge, and their role on campus. To promote the survey, we posted a flyer around campus with a QR code linked to the Qualtrics form. Angie Makhee, a graphic design major at SNHU, created an eye-catching flyer for us (Figure 2). We posted the flyers in almost every building on campus, excluding the Dining Hall, Operations Center, Madison House, Ford House, Athletic Complex, and SETA Annex. The excluded buildings were inaccessible, had no bulletin board, or were left out of our own accord.



Figure 2: *Survey Flyer*



### Social Media:

Social media was used to recruit participants for our survey and extend research outreach. We utilized our Instagram page, @hankthehawksnhu, to connect to the community and spread information. We created posts and stories that showcased the flyer with the QR code. Media of the hawks were frequently posted to engage with the audience. The images or videos came from us or community members. Individuals could send us media through direct messaging. Media submissions from the community allowed us to record more observations about the hawks, such as locations and feeding habits.

### Observations:

Ground observations provided a large amount of data. Observations focused on data associated with the habits of the hawks, like feeding or locations. To observe the hawks, we walked around the campus or watched the environment throughout our day. Every time a hawk was seen, we logged the location, time, and hawk activity. In addition to our observations, we

also had the media from Instagram and the survey answers. The various sources allowed us to have a wider range of observations.

### Drones:

In the fall of 2023, we began drone deployment. To deploy drones, we worked with Jason Crowell and Kieran Shaklee. Jason is the Equipment Manager of Lab Operations in the SETA building, and Kieran is a student worker. The drone used was a Parrot ANAFI. The drone was equipped with a camera to record aerial footage of the forests on the southern end of campus.

Figure 3: *Parrot ANAFI Drone*



Figure 4: *Drone Camera View*



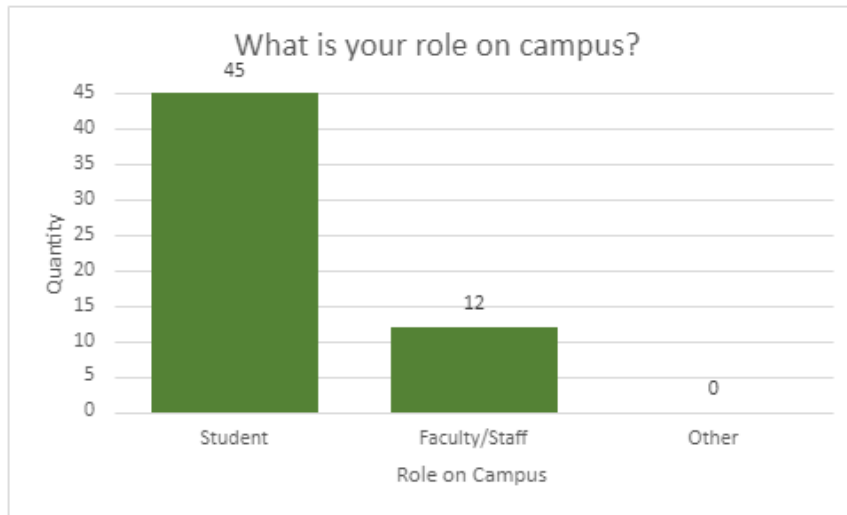
The southern forest of the campus was chosen based on the locations indicated on the Hawks' Frequent Location Map (Figures 10 and 11). We did not have drone flying licenses, so we needed to work with Jason and Kieran so they could fly the drone for us. We met before deployment to discuss details like scheduling and drone use. Before deployment, we needed to get permission from public safety to fly on campus. To get permission, Jason emailed public safety with a date, location, and purpose of drone use. There were three flying sessions. The first session was on October 13, 2023, near the Tennis Courts from 3:30-4:30 PM. The second session was on November 3, 2023, around the Operations Center from 3:30-4:30 PM. The last session was on November 17, 2023, around the Operations Center from 3:30-4:30 PM. During the sessions, the drone needed to be flown within sight. It mainly recorded footage from the edges of the forest. Data was recorded on an SD card and reviewed later.

## Results:

### Survey:

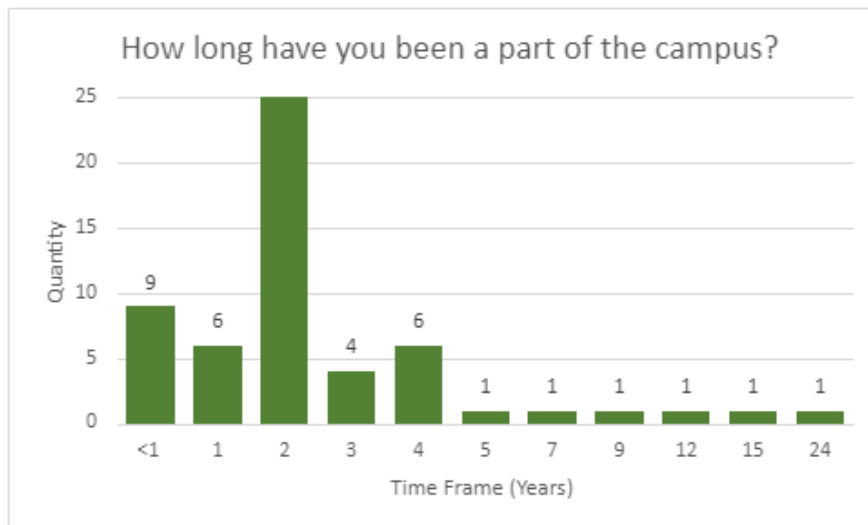
Fifty-seven participants took part in the survey. Almost every participant completed the survey in full, except for two participants, who had invalid answers for the last question. Of the participants, there was a higher percentage of students than faculty/staff.

Figure 5: *Question Two Results*



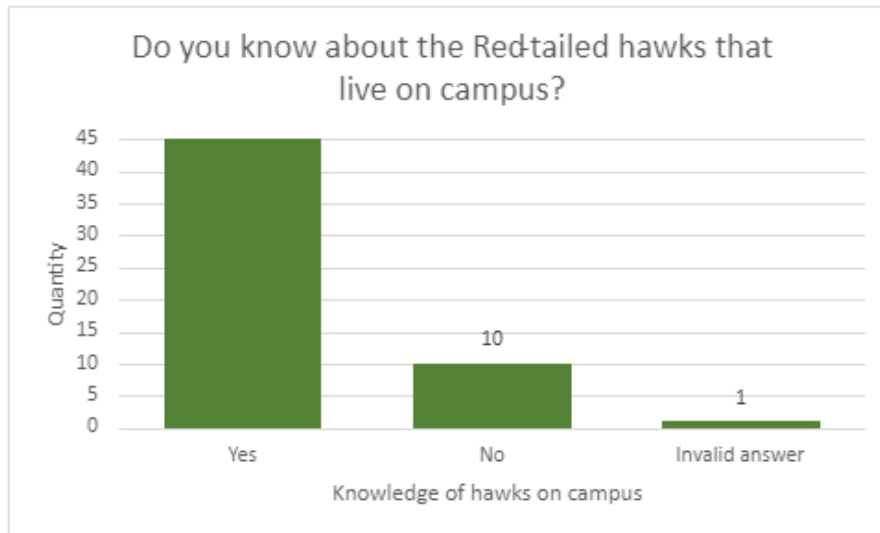
Participants recorded varying years that they were a part of the SNHU campus. Most participants have been a part of the campus for two years. There were numbers higher than four years recorded as well, but none of the exact numbers occurred more than once.

Figure 6: *Question Three Results*



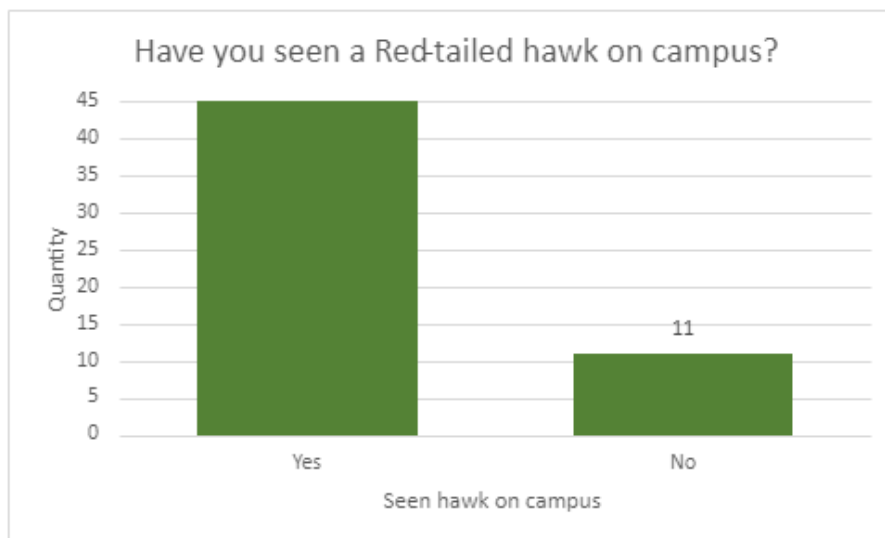
Most participants reported they were aware of the Red-tailed hawks' presence on campus. This question was open-ended, so some answers included additional notes (refer to Appendix A). One answer was invalid because the answer given did not address the question asked.

Figure 7: *Question Four Results*



More participants reported seeing a Red-tailed hawk on campus than not. This question was also open-ended. Some responses included additional notes on hawk sightings and activity (refer to Appendix A). Only the yes responses wrote additional notes.

Figure 8: *Question Five Results*



The inclusion of multiple open-ended questions gave varied details recorded in answers. Some participants only wrote a small amount of information, like that they saw the hawks flying around. Other participants wrote in more depth and recorded specific locations and actions of the hawks. There were over 100 open-ended answers throughout the survey regarding the hawks. Appendix A depicts a few highlights of the responses.

#### Appendix A: *Notable Survey Responses*

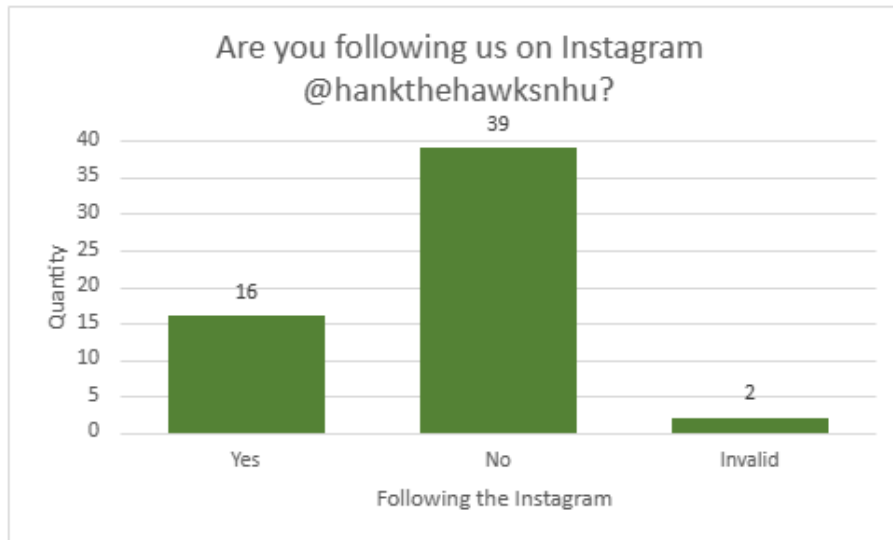
| Notable Survey Responses |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Number                   | Response                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 1.                       | "I see them while practicing while at the stadium."                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 2.                       | "I lived in Kingston last year and they have always flown past my window in the morning overlooking the river. Also, one of the hawks caught a mouse right in front of me walking to class one morning."                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 3.                       | "I saw them flying around on thermals."                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 4.                       | "In between the Student Center and Robert Frost, caught a smaller bird and ate it."                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 5.                       | "Yes. Flying over campus into trees."                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 6.                       | "Yes, saw him sitting on a flagpole once he stole my hat the other time."                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 7.                       | "Yes! My office faces the green lawn area next to the ACC building. I regularly see the hawk (s) perched on the lamp posts between ACC and the Dining Center. It will swoop down to the grass from time to time."                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 8.                       | "Regularly lands on lamp posts on the Dining Center side of ACC. At least 3 times, I've seen it eating a small rodent while on top of the lamp post. I've also seen it swooping low and/or landing on the grass right next to ACC (presumably going after prey)."                                                                                                                                                                                                                                                                                                                                                                                                     |
| 9.                       | "Yes, was out walking by webster, saw them circling overhead together for a few minutes."                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 10.                      | "Morning: On front of Frost building across from Student Center, perched in tree by Frost near North River Rd, perched in tree in front of Gustafson, by Lincoln on ground, parking lots behind Kingston on light pole, in Pine tree by SNHU arch over North River Road. Afternoon: Perched in tree by Student Center dumpster, soaring over Belknap alone and as a pair, soaring over Webster, soaring over parking lot by CETA 3, perched in tree by new Tennis court parking lot, soaring over CETA Annex, perched in tree by Hampton, perched on multiple light poles by Hampton & Windsor, perched in tree by Operations building, soaring over Penmen stadium." |

#### Social media:

Our social media account on Instagram has amounted to around 230 followers. The follower counts significantly rose during the survey period. According to the survey results, only a portion of participants followed the Instagram page. In addition, when new posts were made a

few more profiles would follow. There were 30 direct messages (DMs) from profiles, both following and not following the page. The DM's content ranged from hawk media (photos/videos), questions, and responses to Instagram story posts.

Figure 9: *Question Eight Results*



Observations:

Most observations recorded were brief. The entries recorded slowed in the early winter months, December and January. Observations increased again in the late winter months, February. Late summer and early fall months also recorded a fair number of entries.

Appendix B: *Group Observation Log*

| Group Observation Log |        |                  |                                                                                                            |
|-----------------------|--------|------------------|------------------------------------------------------------------------------------------------------------|
| Date                  | Time   | Location         | Activity                                                                                                   |
| 9/7/2022              | 4:10pm | Gustafson Center | Hawk perched in tree outside Gustafson.<br>Jumping around branches.                                        |
| 9/19/2022             | 5:50pm | Green Space      | Hawk perched on lamp post on Green Space.<br>Actively surveying ground. Looked to be male. Cloudy weather. |
| 9/29/2022             | 9:20am | Green Space      | Hawk soaring high over green space. Windy day.                                                             |

|            |         |                        |                                                                                                                                                          |
|------------|---------|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 9/30/2022  | 5:50pm  | Library                | Hawk perched in tree between Library & Nock. Swooped down to ground after a bit.                                                                         |
| 10/6/2022  | 6:20pm  | Green Space            | Male hawk perched on lamp post next to stop sign crossing from Green Space to Hospitality. Turning head around. Walked close to lamp without flying away |
| 11/17/2022 | 3:30pm  | Gustafson Center       | Male hawk perched in tree. Swooped to ground.                                                                                                            |
| 12/2/2022  | 3:00pm  | Gustafson Center       | Hawk perched in tree. Got close to hawk.                                                                                                                 |
| 8/23/2023  | 5:30pm  | Green Space            | Heard juvenile calls.                                                                                                                                    |
| 8/28/2023  | 5:30pm  | Kingston & Green Space | Juvenile called outside Kingston, in trees. Followed hawk to tree outside Esports Arena. Many repeated hunger calls.                                     |
| 8/30/2023  | 12:30pm | Near Hospitality       | Hawk flew from lamp post to tree, possibly juvenile.                                                                                                     |
| 8/31/2023  | 3:00pm  | Near Operations        | Flew in front of car on road to Ops. Flew to grass & caught mouse. Perched on guard rail to eat. Flew into tree after.                                   |
| 10/13/2023 | 5:00pm  | Operations Center      | Juvenile perched on lamp post eating rabbit. Got close & took pictures, hawk didn't mind. Flew away into trees after a while.                            |

|            |         |                   |                                                                                                      |
|------------|---------|-------------------|------------------------------------------------------------------------------------------------------|
| 11/18/2023 | 10:10am | Kingston          | Hawk flying from Kingston towards practice field.                                                    |
| 11/30/2023 | 12:50pm | Dining Hall       | Juvenile flying near Dhall.                                                                          |
| 1/11/2024  | 12:55pm | Green Space       | Hawk soaring high above Green Space.                                                                 |
| 1/23/2024  | 3:30pm  | Gustafson Center  | Juvenile flying over Gustafson. Perched on tree, then flew away.                                     |
| 1/29/2024  | 4:20pm  | Library           | Hawk perched on tree over main road.                                                                 |
| 2/1/2024   | 4:10pm  | Athletic Complex  | Flying above athletics                                                                               |
| 2/2/2024   | 10:45am | Robert Frost      | Walking on path outside front of frost & hawk flew about 5-10 feet above my head. Headed to Belknap. |
| 2/6/2024   | 10:45am | Lot 17            | Two hawks flying together over parking lot. Headed over to Webster.                                  |
| 2/7/2024   | 3:35pm  | Hospitality       | Flew behind Hospitality.                                                                             |
| 2/15/2024  | 10:55am | Library           | Hawk soaring above Library green. Flew super low.                                                    |
| 2/22/2024  | 4:15pm  | Operations Center | Hawk flew over Ops & surrounding trees. Cloudy day.                                                  |
| 2/23/2024  | 5:00pm  | Operations Center | Hawk flew from tree over Ops.                                                                        |

Once we gathered our observations, we compiled the data from Instagram and the survey. Then, we took the combined data and marked the frequent hawk locations on a campus map using ArcGIS (Figure 10 and 11).



Figure 10: *Hawk Frequented Locations Map*

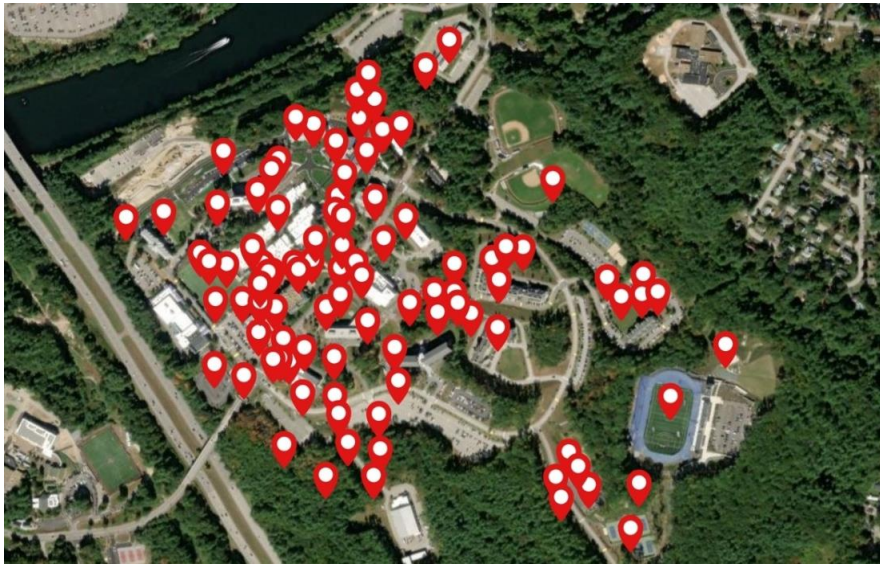


Figure 11: *Hawk Frequented Locations Map*



Drones:

There were 40 minutes of video footage recorded by the drone. The footage covered the edges of the forest and the clearings adjacent to the trees. There are eleven videos of various lengths. The shortest video was 0:31 in duration, and the longest video was 5:17 in duration. After reviewing the footage, there were no noticeable nesting sites found. However, the footage provided an overview of the vast size of the forest.

Figure 12: *Ariel drone view*



Figure 13: *Ariel drone view*



Figure 14: *Ariel drone view*

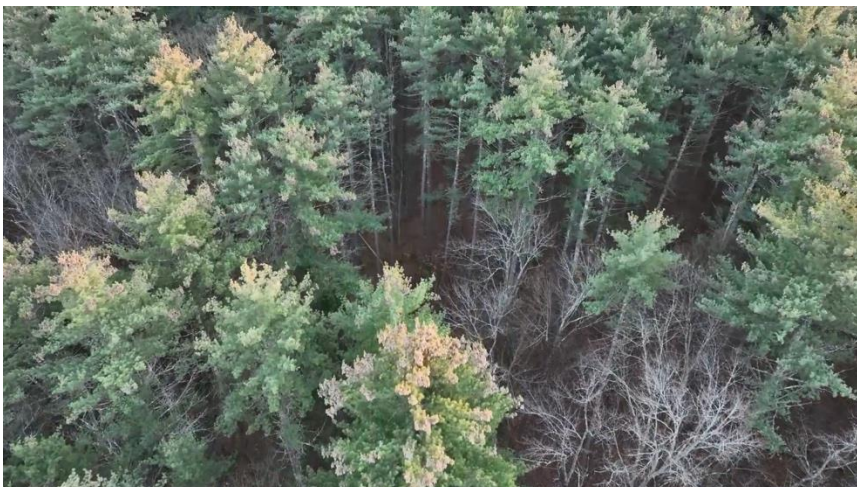




Figure 15: *Ariel drone view*



## **Discussion:**

### Review of Results:

The survey attracted numerous participants, mainly consisting of students and faculty. We believe there were more student participants due to our connections to classmates. We also told faculty and staff about our survey; however, we spoke to fewer faculty/staff than students. In addition, there was most likely a higher amount of 2<sup>nd</sup>-year campus members due to us being in our 2<sup>nd</sup> year of college during the survey period; so, we engaged with many other 2<sup>nd</sup> year students in our classes.

Social media was a useful tool to advertise our research. Social media engagement went together with the survey. Creating posts that advertised the survey brought in more participants, and the survey brought in more followers. The media that was DMed to us showed us additional hawk behavior that we would not have seen otherwise. For example, a video of a hawk eating a mouse on the Green Space. Many people spoke to us about the hawk Instagram in casual conversations. From these verbal interactions, we conclude that the Instagram account helped spread information about our research.

Ground observations were one of the most resourceful data sets collected. The data recorded gave us an idea of where the hawks were most active. Based on the Frequent Locations Map (Figures 10 and 11). We concluded that the hawks were most active towards the west side of campus. The hawks may prefer the open layout of the west side due to the open green spaces

and occasional high trees providing the ideal hunting environment. There may also have been increased sighting reports on the west side due to more frequented locations than on the east side.

From the observations, we also learned of the progression of the hawk family. At first, we observed one hawk that we believed to be male. Then, we noticed two different hawks that were male and female. The male and female hawk engaged in a courtship flight. Soon after, we began to collect data on juvenile hawk sightings. These observations showed that the hawks actively used the campus as their territory and most likely nested nearby since the juvenile frequented the campus at an early age.

The drone deployment was not a largely successful addition to our research (refer to the implications section for more detail). However, we learned that the best time to deploy drones was late fall. During the first flying session, many leaves remained on the trees that obstructed the view. We waited a few weeks for the leaves to fall, then resumed the flying sessions. After the trees were bare, it was much easier to spot nests.

#### Implications:

Our ground observations provided adequate data, but we could have improved them. Our observation periods were brief, typically between classes, which limited the number of occasions we saw the hawks. We did not have many observations in late fall to early winter or on bad weather days. These differing observations could have strengthened our data set.

The area of our research that experienced the most errors was drone deployment. When we first communicated with Jason and Kieran, we were not completely clear about our research goals. If there had been better communication, we could have filmed the trees more efficiently. In addition, we should have provided more explanation and visual aid of what we were looking for, like showing pictures of Red-tailed hawk nests. The drone also had multiple visual limits. The camera quality for faraway objects appeared blurry, which limited our view. The drone needed to stay within eyesight so we could not fly too far into the forest. Most clips recorded partial forest and human structures, like roads or parking lots (refer to Figure 15).

Our first flying session was on October 13, 2023. Almost none of the trees had dropped their leaves, so we could not see into the forest from above. Due to this, we waited about a month until we conducted the second flight session. We also encountered issues with the way that the drone was capturing footage. Jason and Kieran focused the drone on singular trees for an extended time rather than multiple trees for a short time, most likely due to the lack of initial

communication. Once we noticed this issue, we communicated with Jason and Kieran to record multiple trees for a shorter time with the drone.

The second flight session was on November 3, 2023. The leaves had fallen from the trees, increasing the visibility. After this flight, we learned the SD card was full from previous use, so we did not record footage of the drone's flight.

### **Conclusions:**

The SNHU campus and community interacted with the Red-tailed hawks in a mutualistic relationship. Our hypothesis was correct. The college campus benefited the hawks by providing hunting, roosting, and possibly nesting grounds. The hawks benefited the campus by hunting small rodents, like mice, that lived on campus. By eating mice, the population was controlled. In addition, community members have seen hawks eating small mammals, like rabbits or squirrels, which shows that aside from mice, there were other food sources provided by the campus environment.

Based on the survey and interactions with community members, community hawk interactions were positive and somewhat knowledgeable. Our hypothesis was partially correct. Most individuals were familiar with the hawks but had slightly more than basic knowledge. We initially believed that community members would know about the hawks on campus and not much more. Individuals in the survey and social media were excited to share their pictures of the hawks with us. Most people knew information about the hawks like what species they were, where they liked to stay around campus, and their typical activities. The community engagement showed that the community was knowledgeable of the hawks' presence on campus.

We did not find an exact location of the hawks' nesting location. We learned that Red-tailed hawks hunt around one mile from their roosting or nesting site, so it was challenging to pinpoint a specific nesting location based on campus sightings. In addition, nests may not be reused every year, so the nesting site could change often and be anywhere within the 1-mile territory. We hypothesized that the nesting site would be in the southern forest of campus. We cannot confirm this hypothesis to be true. However, we still believe that it is the most likely location. The south end of campus is suitable for a nest because it provides many tall trees from the forest and a distance from human activity. We also recorded many hawk sightings near that region of the campus.

**Future Goals:**

We plan to continue our research on the Red-tailed hawks through next year. Our future research will likely consist of monitoring the hawks through personal and community observations. We will continue to post on our Instagram page to educate the SNHU community about the hawks. The page experiences a lot of interactions from followers and other users, so it is important to maintain our account to continue engaging with the community.

We want to create an informative plaque about the hawks' presence on campus. We are proud of our research and want to leave behind our data for the current and future SNHU community. To learn more about implementing a plaque on campus, we spoke to Mike Weinstein, the Director of the Office of Sustainability, who was familiar with the process. First, we need a sponsor or a grant to cover costs. Creating and installing a plaque could cost over a thousand dollars. A possible sponsor may be the Office of Sustainability due to our research aligning with their goals. We also need to design a mockup plaque that includes pictures, research information, and citations (if necessary). We would need to collaborate with the SNHU creative team so that our plaque matches the school branding. The plaque's location would be somewhere the hawks are active and with adequate foot traffic. One possible place might be the SNHU Arboretum. We hope that by displaying our findings, we can continue to involve the community in preserving the hawks' habitat on the campus.

**Intellectual Merit:**

Our research purpose was to gather data about the Red-tailed hawks on campus to ensure the safety of the hawks and their environment. While performing the research, we aimed to educate the public about the hawks and their presence on campus. Although Red-tailed hawks are no longer on the endangered species list, they should still have protection as a bird of prey with expanding numbers. These hawks are an essential part of the campus environment because they regulate small organisms like mice and rabbits. Our findings were used to inform the SNHU community of the importance of the hawks. We helped people better understand the mutualistic relationship between the campus and the hawks. If more individuals are knowledgeable about how the Red-tailed hawks benefit the campus environment, then there will be more voices to advocate for the protection of the hawks' habitat.

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### Appendix C: *IRB Consent Form*

Southern New Hampshire University Institutional Review Board Informed Consent Form for Red-tailed hawk survey. You are being invited to participate in a research project conducted by Jonathan Morse, Emily Salyards, and Makenzie Naska, undergraduate students at Southern New Hampshire University.

You are invited to participate in a research study about the Red-tailed hawks on campus.

You will be asked to answer survey questions that will take about five minutes of your time. Questions like, have you seen the hawks on campus, if you have seen them, where, your role on SNHU campus, any extra info you may have of the hawk etc.

There are no potential risks with this study. We expect the project to benefit you in these ways: learn about the hawks on campus and support fellow students' independent study. You will not receive any compensation for your participation.

If you have decided to participate in this project, please understand that your participation is voluntary and that you have the right to withdraw your consent or discontinue participation at any time with no penalty.

In addition, your individual privacy will be maintained in all publications or presentations resulting from this study. There will be no record of who takes the survey, and we will not ask for any personal information from you at any point during the survey. If you have any questions regarding this project, you may contact the researcher at [jonathan.morse1@snhu.edu](mailto:jonathan.morse1@snhu.edu).

If you have questions regarding your rights as research participant or any concerns regarding this project, you may report them – confidentially, if you wish – to the University Campus Institutional Review Board Chairperson at [IRB@snhu.edu](mailto:IRB@snhu.edu) or COCE Institutional Review Board Chairperson at [COCEIRB@snhu.edu](mailto:COCEIRB@snhu.edu).