

# Visitors to Red-Naped Sapsucker sap wells and the effectiveness of artificial wells.

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## Abstract

This study investigated the role of the red-naped sapsucker (*Sphyrapicus nuchalis*) as a potential keystone species within the montane and subalpine ecosystems of Colorado. Specifically, it focused on the species' creation of sap wells for their own use and the subsequent visitation by various other species, including birds, insects, and small mammals. The research built upon previous studies that identified the sapsucker's influence on local biodiversity, while adding a novel focus on nocturnal visitations and the effectiveness of artificial sap wells. This study utilizes a combination of game cameras, in-person observations, and sap quality measurements to determine whether the presence of sap wells— both natural and artificial— results in increased species visitation and supports ecosystem functionality. Key results include identifying the species that visit the sapwells, measuring visitation frequency, and comparing these data with previous research. Additionally, the study explores whether the height of sap wells correlates with visitation rates and if artificial wells attract a similar range of organisms. By contributing to the understanding of the sapsucker-driven ecosystem dynamics, this research aims to clarify the role of this woodpecker in maintaining ecological balance and potentially confirm its status as a keystone species.

## Introduction:

Within the scope of biology, a community is defined as interconnected organisms. One of the more complicated interspecific relationships is between a keystone species and their

dependents. A keystone species can be defined as: “A role...occupied by a single species, and the presence of that role may be critical to the community. Such important species are called *keystone species* because their activities determine community structure” (Krebs 1994; Paine 1969). In Paine’s 1969 experiment, the sea star *Pisaster* was manually removed to investigate its effects on the surrounding community of species. Ultimately, the mussel, *Mytilus californianus*, monopolized the space completely and out competed the surrounding organisms, resulting in an unbalanced ecosystem. The ecosystem was no longer balanced without the presence of the *Pisaster*. The *Pisaster*’s presence provides a beneficial role to several species in this ecosystem and thus can be defined as a keystone species (Miller 1999).

However, “All species play some role in their ecosystems and are thus important. Whereas some scientists consider all species equally important, others consider certain species to be more important than others, at least in helping maintain the ecosystems they are a part of” (Miller 1999). In other cases, a keystone species does not have to be a predator to fit the qualifications. “Other workers since Paine have used the term *keystone species* to refer to any species, not necessarily a predator, whose removal causes the extinction of other species” (Ehrlich and Roughgarden 1987).

A potential keystone species is the red-naped sapsucker (*Sphyrapicus nuchalis*) found within montane and subalpine ecosystems in North America. *S. nuchalis* is a medium-sized North American woodpecker, commonly identified by their black and white plumage and distinctive red head and throat markings. Sapsuckers drill rows of small, shallow holes in tree bark to access tree sap. This line-up of holes is called a sap well. Sap wells feed both *S. nuchalis*, their babies, and several other organisms in the community, thus *S. nuchalis* is considered a potential keystone species. Red-naped sapsuckers use the sap from the wells they make to dip

bugs into to feed their young. The identity of red-naped sapsuckers as a keystone species remains contentious.

Several studies have investigated the potential “keystone” role this species plays, both in sap wells (Ehrlich and Daily, 1988), and nest cavities (Ehrlich et al 1993). In their study, Ehrlich and Daily observed sapsucker wells on willows and noted visits by birds (hummingbirds, warblers, kinglets, and other woodpeckers) and insects (wasps, moths, bees, ants and flies). Because of the level of visitation and the number of visiting species, Ehrlich and Daily describe the sapsuckers as a keystone species. They later added to this research by determining the use of sapsucker nest-holes by a wide variety of other bird species.

The red-naped sapsucker utilizes several types of trees such as “... spruce (*Picea engelmannii*), aspen, and shrubby willow (*Salix* spp.). Willow sap constitutes a major portion of the sapsucker’s diet during the summer breeding season; willow sap has been observed stolen by over 40 species, including hummingbirds, warblers, chipmunks, squirrels, wasps, and butterflies (Cruz 21, 22). A study conducted at the Rocky Mountain Biological Laboratory by Veida Cruz in 2022 revisited the Ehrlich and Daily study to compare sap well visiting species, ultimately finding similar results. However, Cruz described visitations from small mammals such as deer mice and jumping mice, species that were not observed visiting wells by Ehrlich and Daily. This is potentially due to the nocturnal nature of these visitations, occurring between 0-4:00 hours when sapsuckers were not present to chase mice off “(Cruz 2022). Ehrlich and Daily did not observe wells at night. There are few studies on nocturnal well visitations.

The study Cruz referenced by Gretchen Daily and Paul Ehrlich did not mention or include nocturnal findings. There are little to no studies on which organisms visit the wells at

night. It is also unknown whether artificial wells yield sap and whether they can be an effective replacement for the *S. nuchalis* wells.

Sapsuckers often nest in cavities made near wells. Sapsuckers may act as a keystone species by providing abandoned nest cavities to other organisms; at least eight secondary cavity nesting species have been observed recycling sapsucker nests (Daily et al. 1993; NL, pers. obs.). This study focused on sapwell visitor species, frequency of visits, sap sugar content, and whether other organisms are dependent on sapwells. In order to determine if the *S. nuchalis* is a keystone species, I tested if the addition of man-made wells attracts more organisms or if areas with no sapwells had a lower count of well-visiting organisms. The addition of man-made sap wells tested if the presence of more wells increased the subsequent visitor population count.

## **Methods:**

*Participants:* Red-naped sapsuckers, any potential visitors, and the observer (me). The Red-naped sapsuckers are “Small-medium woodpecker[s]; length about 19-21 cm; mass 32-66 g. Black bib on upper breast, prominent red forehead with black band at the rear, nape red, black stripe along side of head bordered by 2 white stripes, crown and nape black, large white wing-patch, back blackish (with yellowish tinges), rump white, and underparts buffy or yellow-tinged. Throat red in male, chin and upper throat white and lower throat red in female but extent of red variable; throat-patch bordered by black. Some females with reduced or no red on forehead and reduced or no white on throat, but otherwise similar to male in plumage and size. Juveniles retain brownish plumage until Prebasic I molt (by first fall), after which variegated

brown Juvenal head and body plumage is replaced by black, white, and red coloration of adult” (Walters et al. 2002).



Figure 1: Juvenile red-naped sapsucker



Figure 2: Adult red-naped sapsucker

*Locating active wells:* The sapwells used in this experiment were found around Gothic, Colorado in the Rocky Mountain Biological Laboratory property. I located 14 wells by: using the current breeding bird survey, checking Veida Cruz’s old sites, listening for sapsucker calls and following them, and asking other scientists if they have seen any sapsuckers and/or wells nearby. I [primarily looked at willow trees for the wells. Previous studies (Shelly 2010) observed biases in well site selection in red-naped sapsucker such as “Solitary vs. Clumped Willows: Whether a willow is solitary or part of a clump may affect how many branches a sapsucker drills on and how many individual wells it drills per branch. Because clumped willows might offer more protection from predators, I expected to find both more drilled branches and more wells per branch in willows that were part of a group. I measured six clumped and four solitary willows.

Interestingly, the average number of drilled branches was almost identical between clumped and solitary shrubs, (means of 35.5 and 33.75 respectively) but clumped shrubs had an average of 2.13 times as many wells per branch. (Fig. 1)” (Shelly 2010).



Figure 3: Well on Willow Tree    Figure 4: Well on Conifer Tree    Figure 5: Well on Abies Tree

*Setting up game cameras and using them to monitor:* Once the wells were located, I set up game cameras facing the wells to record any activity. The game cameras were my primary source of data collection for analysis. They ran day and night, and I collected the SD cards several times a week to download images and categorize the visitors. The SD cards were swapped out on the spot to continue data collection. I used the Timelapse software to analyze and sort the pictures.



Figure 6: Game camera set up and wildlife interactions

*In-person observations:* Once the wells were found or created, I observed each site once a week for an hour. I sat about 10 meters away from the wells with my binoculars and a notebook, to record any species I see and what their behavior is. I noted their arrival time, time spent at the wells, and activity at the well (including feeding, maintaining, chasing, etc.). This method was adopted from previous bird observational studies (Shelly 2010). I checked on the artificial wells once a week to ensure they were still producing sap.

*Creating artificial wells and upkeep:* I chose 3 separate locations where there were no known wells to create the artificial wells. One location is near the RMBL entrance and Savoy Cabin (AW1), the East River (AW2), and by the Billy Bar Community Center (AW3). Using red-naped sapsucker-created wells as a reference, I used a razor blade to carve well-like holes into 3 willow

trees. During the artificial well creation and initial observations, I monitored sap production to ensure wells are functioning as intended.



Figure 7: Artificial Wells

*Measuring sap quality:* I collected sap during the final week of my study— testing each well once. The specific well was chosen based on which well in that system was the leakiest, to get the most data. I used a large 1.5-1.8 X 100 MM capillary tube to capture the sap and used a refractometer to calculate the sugar content. Each sap measurement was collected from all the sites on the same day, early in the morning to keep the sap fresh.

*Collecting and analyzing height of wells:* Once the wells were located, I measured the well's height (cm) from the top and bottom of the well from the ground to see if there was a correlation between height and visitations. All of the wells at each site were measured.

*Comparative Studies:* Both studies done by Gretchen Daily and Paul Ehrlich in 1988 and Veida Cruz in 2022 contain data of which species visited the wells and how often. They also discuss sap concentration. I used both studies to compare the data I collected to see if any of

the species are the same, if the frequency has differed and if the sap concentration changed.

Cruz's study had data on nocturnal visits. I used that data to compare to mine.

## Results:

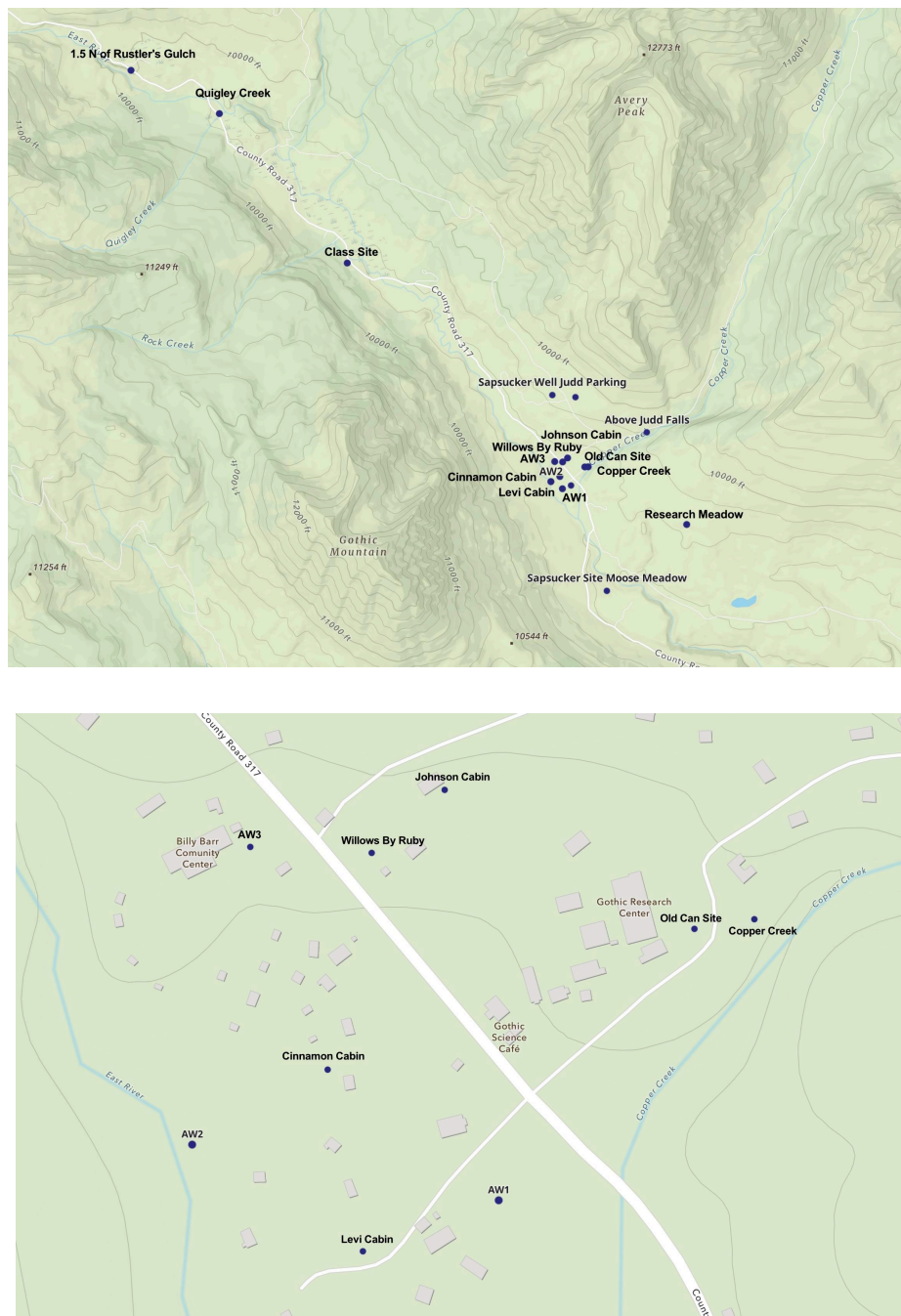


Figure 7 and 8: Map of my sites

There were a total of 18 sites: 15 were created by a red-naped sapsucker and 3 were artificial. Sites that I knew to have an active red-naped sapsucker or I saw one nearby: Sites 1, 2, 4, 5, 6, 8, 10, and AW1. Sites that I knew to have an active red-naped sapsucker or I saw one nearby: Sites 1, 2, 4, 5, 6, 8, 10, and AW1. Sites with good, juicy wells and no visible sapsucker: Sites 3 and 12. Other sites with sufficient wells and no visible sapsucker: Sites 7, 9, 11, 13 and 14.

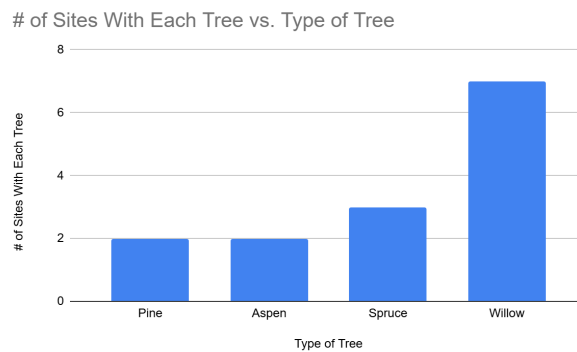


Figure 9: Types of Trees at Each Site

#### *In-person observations:*

Each site was observed twice– with the exception of wells that either had restrictions or were abandoned due to low or zero activity on the camera and in-person from one observation. Each observation was conducted either in the morning or afternoon. My study was mainly focused on observing activity directly on the well. The most frequent visitors were red-naped sapsucker, least chipmunk, rufous and broad-tailed hummingbirds, and an array of insects. The most individual species noted during an observation was 6. About half of the observations had no direct well activity. I noted down surrounding activity such as a bird landing on the site willow, or a northern flicker calling from nearby.

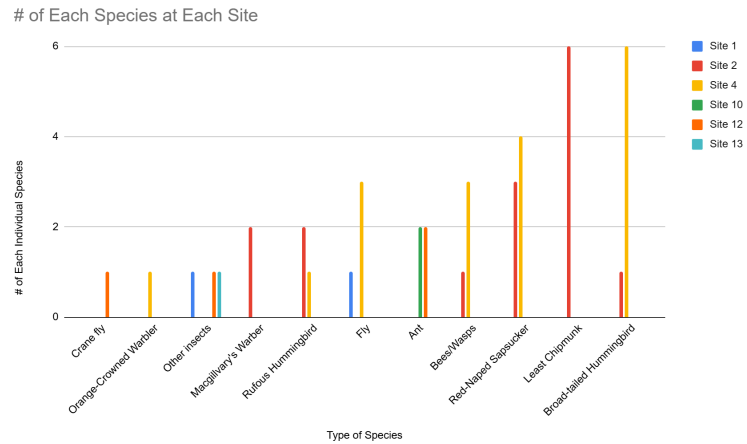


Figure 10: Species at Each Site – In-Person Observations

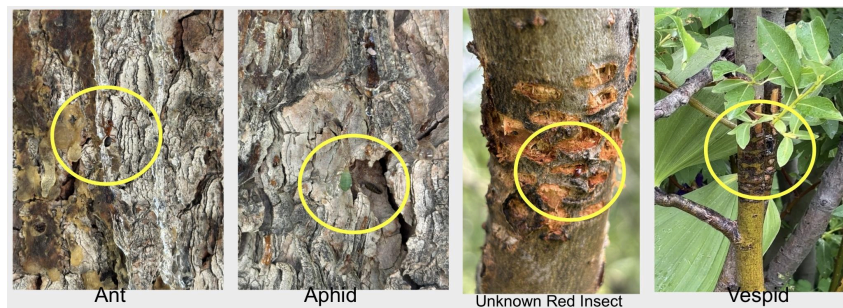


Figure 11: Insect Pictures taken during In-Person Observations

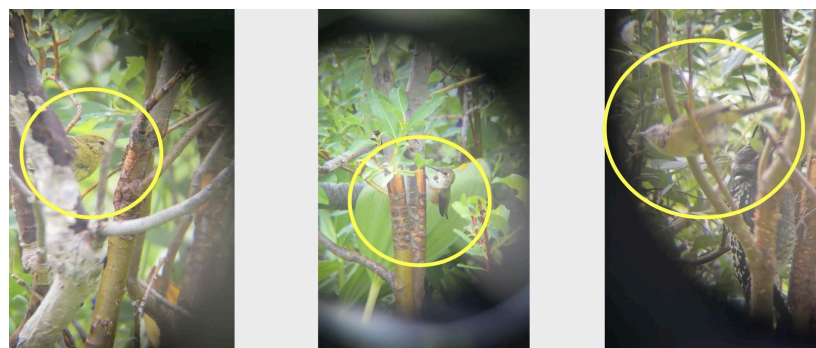


Figure 12: Insect Pictures taken during In-Person Observations

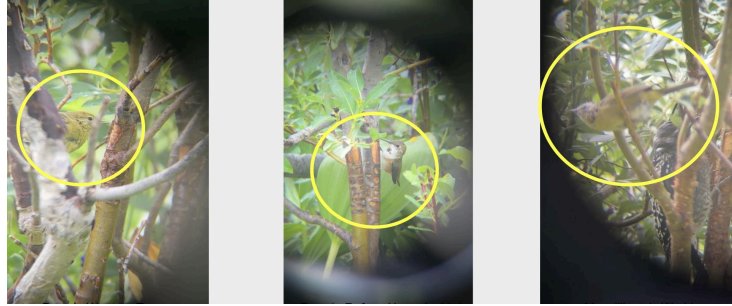


Figure 13: Bird pictures taken during In-Person Observations

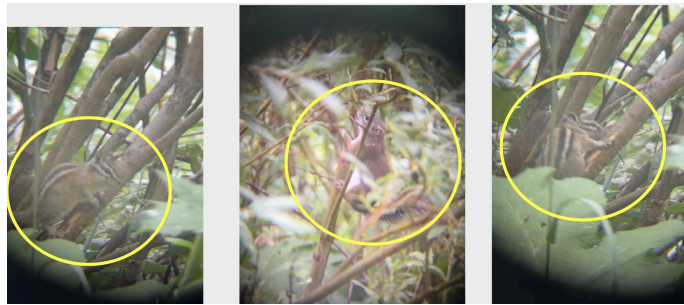


Figure 14: Mammal pictures taken during In-Person Observations

#### *Camera results:*

Instead of the intended species, a large number of the pictures were due to moving vegetation caused by wind triggering the motion activated cameras. Some footage had no animal pictures. The footage that had animal pictures consisted of all the species listed below in Figure 13. The species spanned from insects, birds, and mammals.

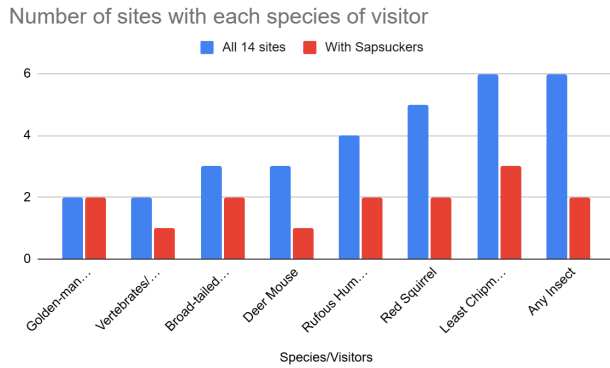


Figure 15: Comparison of how many sites each species was found

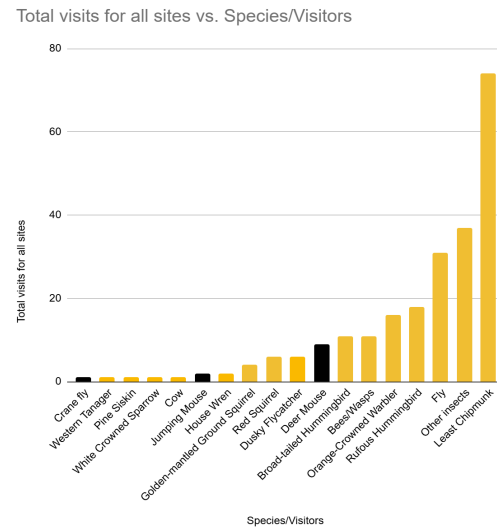


Figure 16: The total number of each species seen



Figure 17: Insects seen on game camera footage



Figure 18: Birds seen on game camera footage



Figure 19: Red squirrel seen on game camera footage

*Artificial wells:*

It was difficult to replicate the same results for an artificial well as compared to what the red-naped sapsucker could do. The artificial wells produced little to no sap, and dried out very quickly. Artificial wells 2 and 3 had no visitations. On camera, Artificial well 1 had two different insects using the well. However, on July 30th, I noticed that there were real red-naped sapsucker marks at the top of Artificial well 1. There were now several new wells on the same willow, and a nearby willow. A camera was set up on the new well to be monitored.



Figure 20: Maintenance done by red-naped sapsucker on artificial well 1



Figure 21: Red squirrel seen feeding from new well on willow near AW1

#### *Testing the Sugar Content:*

The sap collection process was abandoned due to low sap volume or the concentration being outside of the range of the handheld refractometer.

#### *Measuring Well Height:*

The heights ranged from 0.5 m to 2.80 m.

| Site Number | Well Height (m)                    |
|-------------|------------------------------------|
| 1           | 1.20                               |
| 2           | 0.500, 0.750, 1.25, 1.4, 1.5, 1.75 |
| 3           | 1.20                               |
| 4           | 0.950, 0.980, 1.00, 1.20           |
| 5           | 1.10, 1.40, 1.80                   |
| 6           | 1.60, 1.63, 2.10, 2.40, 2.40       |
| 7           | 2.20                               |
| 8           | 1.20, 1.40, 1.45, 1.50             |
| 9           | 1.15                               |

|     |                              |
|-----|------------------------------|
| 10  | 2.80                         |
| 11  | 1.65, 1.70, 1.75, 1.85, 1.90 |
| 12  | 1.35                         |
| 13  | 1.07, 1.20, 1.34             |
| 14  | 1.45                         |
| AW1 | 0.951                        |
| AW2 | 1.00                         |
| AW3 | 1.18                         |

Figure 22: Collective well heights from all sites

| Tree Species | Average Well Height (m) |
|--------------|-------------------------|
| aspen        | 2.16                    |
| pine         | 1.40                    |
| spruce       | 1.54                    |
| willow       | 1.32                    |

Figure 23: Average well height based on species

## Discussion:

### *In-person observations:*

In some sites, it was difficult to sit very far away due to foliage. This may have kept some animals from visiting. There were sites that were more fruitful than others. There were times when I visited and saw nothing, but the camera caught visitations later in the day. Time of day, weather and my presence could have affected in-person observation success.

### *Camera Discussion:*

It was highly successful for catching animals when I was not around to do the in-person observations. The camera captured many unwanted subjects such as wind blown trees, cars or

hikers. The red-naped sapsuckers often made their wells close to the road and trails. This could also just be due to the areas where I was looking. The footage was rather difficult and tedious to sort through. The SD card would fill up after two days for some cameras, and not for others. The SD cards would have needed to be switched out more frequently for the most optimal data collection. There were little to no nocturnal sightings. The animals either did not trigger the camera or did not come. If I made the camera easier to trigger, there may have been more sightings but the wind would have triggered the camera even more.

#### *Artificial wells:*

The artificial wells did not work for the most part. In order for better success, the artificial wells would have benefited from more consistent upkeep. I did not tend to them as much as I could have. The location or choice of tree could have been a factor. Artificial 1 was utilized by a red-naped sapsucker. There was no well on the tree when I made the artificial well. However, a red-naped sapsucker chose the same tree and the one next to it to make their own well. This either means that I chose a good location and tree, or the sapsucker thought my premade well was an optimal starting point to use.

#### *Testing the Sugar Content:*

The sap collection was unsuccessful. The willows were too dry to collect sap from, due to the increase of warmer days and drought conditions in the 2025 summer here in Gothic, Colorado. The sap collected from the Spruce and Fir trees was too thick, and was possibly too high of a percentage to work with the refractometer I was using.

### *Well height:*

Each group of wells on one tree were around the same consistent height. This could be due to the red-naped sapsucker trying to keep a better eye and to better protect the wells, or red-naped sapsuckers have an affinity for keeping things uniform (such as the size, shape and spacing of the wells). Well height might also correlate with an effort to keep away possible saprobbers. If the wells are too close to the ground, it will be easier for animals such as Least Chipmunks to sneak in and out. If the wells are too high up, the sap might not travel up as far or have as rich of nutrients. There were often multiple wells on willow trees and only a single group of wells on the other species of tree.

### *Comparative studies:*

Compared to Veida Cruz, she did not see any orange-crowned warblers, red squirrels, or rufous hummingbirds. I saw one orange-crowned warbler, a few red squirrels at different locations, and a few rufous hummingbirds. I did not get many nocturnal sightings. The two species I observed were a jumping mouse and a deer mouse. These two species were also recorded by Cruz in 2022. Compared to Gretchen Daily and Paul Ehrlich, I saw less orange-crowned warblers. We both reported rufous and broad-tailed hummingbirds. They did not see a northern flicker. We both saw chipmunks, red squirrels, black and white vespids, and flies.

| Species/Visitors      | S. Graham | V. Cruz | G. Daily & P. Erlich |
|-----------------------|-----------|---------|----------------------|
| Crane fly             | Y         | N       | N                    |
| Western Tanager       | Y         | N       | N                    |
| Pine Siskin           | Y         | N       | N                    |
| White Crowned Sparrow | Y         | N       | N                    |
| Cow                   | Y         | N       | N                    |

|                                |   |   |   |
|--------------------------------|---|---|---|
| House Wren                     | Y | N | N |
| Golden-mantled Ground Squirrel | Y | N | N |
| Dusky Flycatcher               | Y | N | N |
| Deer Mouse                     | Y | Y | N |
| Jumping Mouse                  | Y | Y | N |
| Rufous Hummingbird             | Y | N | Y |
| Orange-Crowned Warbler         | Y | N | Y |
| Red Squirrel                   | Y | N | Y |
| Butterfly                      | N | Y | Y |
| Broad-tailed Hummingbird       | Y | Y | Y |
| Bees/Wasps                     | Y | Y | Y |
| Fly                            | Y | Y | Y |
| Least Chipmunk                 | Y | Y | Y |

Figure 23: Comparison between this study, Veida Cruz 2022, and Gretchen Daily & Paul Ehrlich 1988

*Future directions:*

Further study can be conducted on whether well height or sap sugar content influence visitations, or the choice of tree. If artificial wells can help with conservation (considering the sapsucker used Artificial Well 1).

Things I would change next time: camera issues, more artificial well maintenance, and more observations that vary throughout the day. Visitations could have been affected by different factors: weather, nearby flowers and my presence. Due to the weather, the trees could have been producing less sap– especially if they are not near a source of water. If there are too many flowers close to the well site, possible saprobbers could be utilizing the flowers instead of the wells for a source of sugar. During in-person observations, my presence could have kept any

visitors from coming to the wells. My goal was to sit 5-10 m away from the well site. However, the foliage surrounding the tree often made it difficult to observe from that far away.

### **Conclusion:**

Many different species of saprobbers frequented the wells. However, many wells had little to no visitations. None of the species were consistently seen at every well site. The artificial wells provided insufficient evidence of activity. Activity mostly consisted of insects. A red-naped sapsucker did utilize one of my wells to create their own. Nevertheless, this may have been a one-off and is not enough to constitute the level of importance of the red-naped sapsucker. Overall, this data indicates that the red-naped sapsucker may not be a keystone species. Rather, the saprobbers that frequent these wells are opportunistic feeders.

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