Food Availability and its Influence on the Sustainability of Migratory Bird Populations on the Inspiration Ridge Preserve in Homer, Alaska

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A project submitted in partial fulfillment
of the requirements for the degree of
Master of Science in Environment and Sustainability
at the University of Michigan
April 2024

Abstract

Tree swallows (*Tachycineta bicolor)* and violet-green swallows (*Tachycineta thalassina*) are migratory songbirds that travel to high latitudes to reproduce and raise young over the summer. Their migratory timeline includes migrating to North America, where they leave their wintering grounds in Central and South America in March and reach northern regions mid-late May. They will then breed and raise their young until late July and then migrate back to southern regions for the winter. Tree swallows and violet-green swallows, along with many other migratory birds, are predicted to see declines as climate change progresses due to timing mismatches between their arrival at a nest site and emergence of their prey. Anecdotal reports in Homer, Alaska suggest that climate change is already affecting swallow abundance. The Center for Alaskan Coastal Studies deployed nest boxes for use by tree and violet-green swallows on their Inspiration Ridge Preserve property outside of Homer, Alaska to aid swallow conservation efforts. Our University of Michigan School for Environment and Sustainability Master's Project group traveled to Homer, Alaska to work with CACS and monitor nest box use by tree and violet-green swallows and estimate invertebrate prey abundance and composition during summer 2023. Our work included conducting songbird, terrestrial arthropod and benthic macroinvertebrate surveys, nest box monitoring, and the development of a citizen science plan to involve youth in conservation efforts.

We found low nest box use by tree swallows on Inspiration Ridge Preserve, and no correlations between nest box use and surrounding environmental factors. Additionally, in our benthic macroinvertebrate surveys, we found that all ponds on the property scored 'excellent' or 'good' for water quality. Our terrestrial arthropod surveys found a wide range of species present, but the community was dominated by springtails (*Collembola* spp.). Finally, we found a diverse community of birds present on the Inspiration Ridge Preserve, with 39 different species represented during surveys. We recommend further monitoring of nest box use by tree swallows and further development and implementation of the citizen science guidelines outlined in this article.

Acknowledgements

We thank our advisor Dr. Allen Burton for his expertise and guidance throughout all stages of this project and without him, this project would not have succeeded.

Additionally, we thank our client, the Center for Alaskan Coastal Studies, for this amazing opportunity. We thank Executive Director Beth Trowbridge for her guidance and support, Nina Faust for our guided hikes, overall use of her property, and cookies, and Henry Reiske for his ecological knowledge. We would also like to thank Chipper for helping us navigate the terrain at the IRP.

Thank you to Alaska Maritime National Wildlife Refuge and Visitor Center Manager, Lora Haller, as well as the Alaska Songbird Institute and Executive Director, Tricia Blake, for their support and direction of our citizen science project. Without their guidance, this aspect of the project would not be possible.

Additionally, this project would not have been possible without funding support from the University of Michigan School for Environment and Sustainability and the University of Michigan Rackham Graduate School.

Finally, we would like to thank staff at the University of Michigan School for Environment and Sustainability, including Shannon Brines for his help with GIS analysis and Mark Romanowski for the funding guidance.

Land Acknowledgement

We acknowledge that most of the work conducted for this project resided at the University of Michigan, which was originally known as Michigami. This land is home to the largest freshwater system in the world and was stewarded by Niswi Ishkodewan Anishinaabeg: The Three Fire People, which include the Ojibwe, Odawa, and Boodewadomi.

The first settlements on Homer, Alaska were thought to be made by the Dena'ina people, one of the first tribes to cross the Bering Land Bridge from East Asia and Siberia to North America. The Dena'ina are known as the only tribe to settle permanently on the coast, rather than continuing a nomadic lifestyle. Their dedication to dwell permanently in the challenging environment of coastal Alaska resulted in a culture rich in trade and maritime traditions. These traditions have been passed down to the modern Ninilchik Village Tribe. Today, the Ninilchik tribe, the indigenous people of Alaska, value sustainability and environmental stewardship. (Ninilchik Traditional Council, 2021)

Kachemak Bay is a place of convergence, important to many Indigenous cultures and communities throughout time. Kachemak Bay is the traditional homeland of people belonging to two Alaska Native cultures -- the Sugpiaq and the Dena'ina. They have lived on and stewarded the land and waters of the Kachemak Bay area for millenia.

We thank and acknowledge Seldovia Village Tribe, Seldovia Native Association, Niqnalchint Qayeh Kenu (Ninilchik Village Tribe) and the Chugach communities of Paluwik (Port Graham) and Nanwalek whose heritage and culture continue to enrich our communities.

We are grateful to learn from, live on, and help to steward this special place that is their home. We recognize the ongoing harms of colonialism, and are working towards justice and to be in good relationship with the original peoples and this special place.

We are also grateful for the land, the water, the animals, the plants, the fungi, and the unseen. For the wind and the sun and the moon, for the tides and the currents. We are grateful for all this place offers and all we can learn from it.

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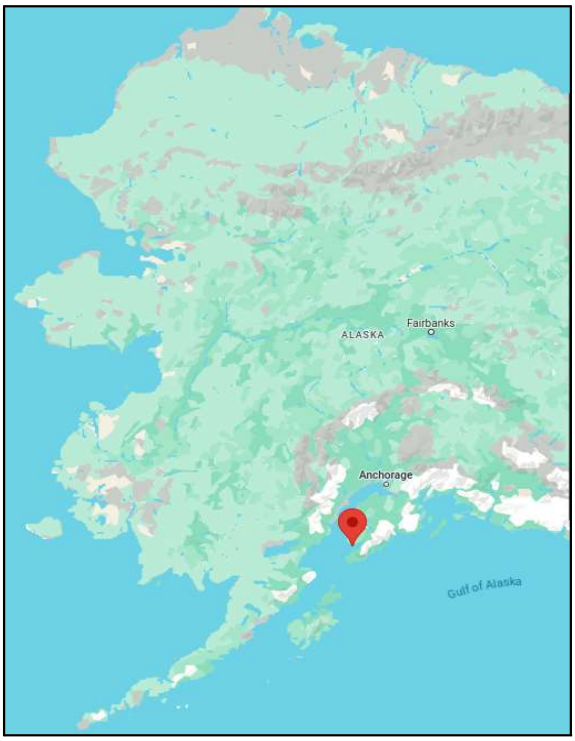
Introduction

The Center for Alaskan Coastal Studies (CACS) is a 501-c-2 non-profit organization that inspires people of all ages to connect with nature and the outdoors. CACS inspires citizens of the community to get involved in educational programs, walks, and guided programs. They are located in Homer, Alaska, in the South Central region of the state (Figure 1). Beth Trowbridge, Executive Director, is our main point of contact for this Master's project, and oversees all CACS operations.



Google Maps [Homer, AK] 2024

Figure 1. Location of Homer, Alaska

The Inspiration Ridge Preserve originated as the passion project of Nina Faust and Ed Bailey. Faust and Bailey, a biologist and a teacher with a shared love for wildlife, met in Anchorage, Alaska and wanted to dedicate their retirement to the animals and land they loved. They purchased 32 acres of bluff land upon moving to Homer, and slowly bought adjacent properties over the years to create an unfractured wildlife corridor for large and migrant animals between the Anchor River and Fritz Creek habitat to the winter habitat. Wildlife corridors allow animals to travel and roam unbothered by hunters, pollutants, and deforestation. Their social impact with neighboring landowners, boroughs, and the state of Alaska itself allowed the creation of the beautiful and critical Inspiration Ridge Preserve. See Figure 2 below for a map of Homer and Inspiration Ridge Preserve.

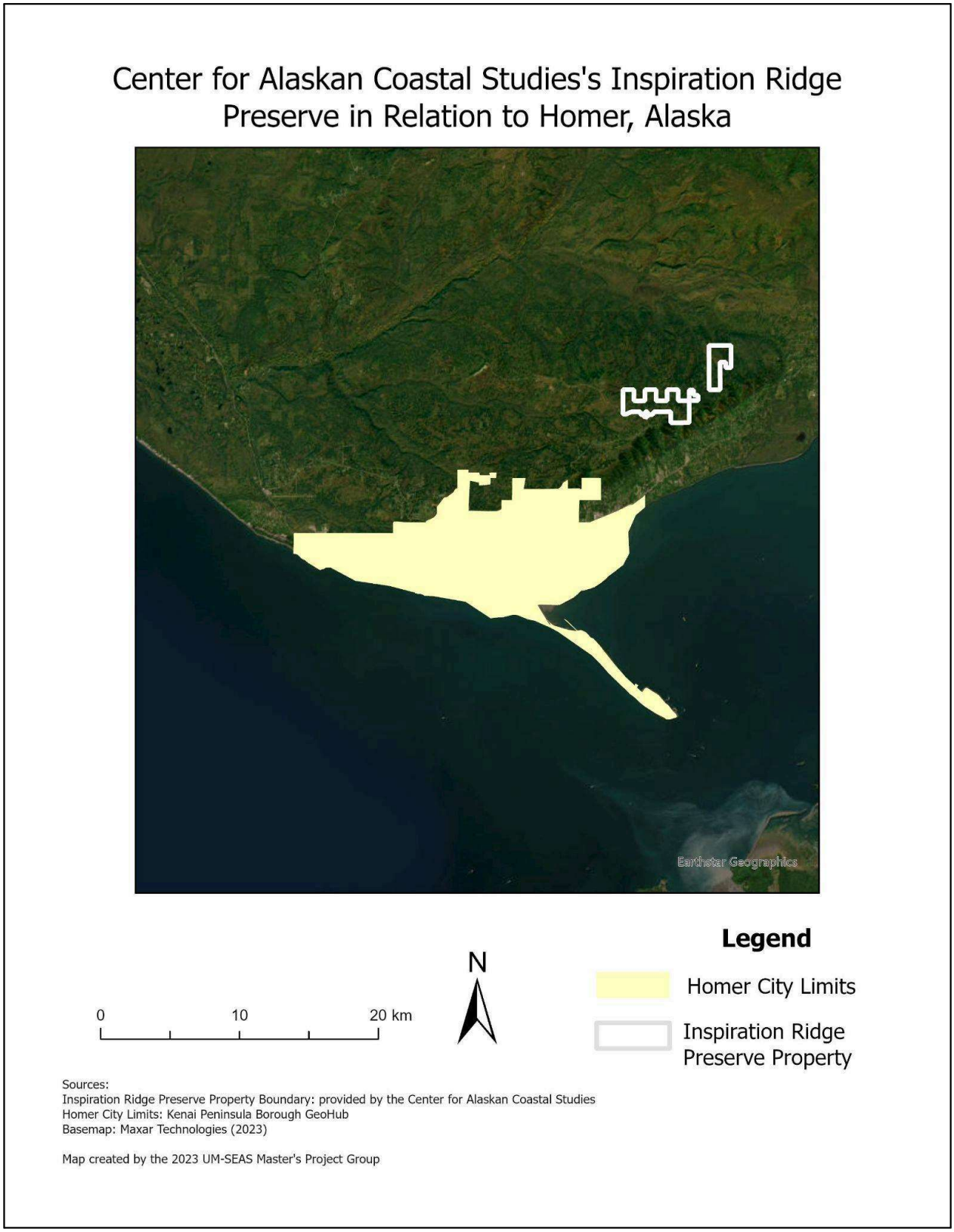


Figure 2. Map of Inspiration Ridge Preserve outside of Homer, Alaska

Corridors are extremely important in conservation work, as they link previously separated populations and foster socialization and genetic diversity, combating inbreeding depression that comes from isolation and fragmentation of land (Tewksbury et al., 2002). Corridors also provide a protected migratory path for vulnerable nomadic species with the shelter, food, and water they need during their travel. Further, many of the aforementioned animal species are too large to be adequately housed in several small, unconnected protected areas and would be subject to hunting, poaching, trapping, vehicle danger, or entanglement in fences, to name a few hazards of traveling in human-dominated areas. Wolves are a rare and beautiful boon to any river system, but are often shot on sight by shepherds and farmers (Hamilton et al., 2020). Bears' diets overlap broadly with humans (Tollefson et al., 2005) and are more inclined to root through human garbage, leading to illness, dependency, or violent encounters with humans. Moose have been known to break their legs on fences (Jakes et al., 2018) and their calves are in danger of traffic and domestic dogs. All of these animals are known to roam large properties and cannot be humanely or sustainably confined to smaller protected areas. Ed and Nina have ensured they will be able to roam freely in a project that will outlive and honor their name for decades to come.

On May 22nd, 2023, our team of five first-year UM-SEAS students flew out to Homer, Alaska in order to work with the Center for Alaskan Coastal Studies on the Inspiration Ridge Preserve. Our project composed of two main aspects. First, we researched and gathered data on how climate change has potentially impacted the migratory swallow population that utilize the Inspiration Ridge Preserve as a breeding and nesting ground. We conducted food availability surveys on the prey macroinvertebrates the swallows feed on in the critical time period during which they lay eggs and raise their chicks, including sampling benthic macroinvertebrates as well as aerial insects. We were looking for phenotypic mismatch that comes from global warming and seasonal changes, which can derail an entire ecosystem. Typically, swallows would arrive at the Inspiration Ridge at the time that their prey is bountiful, but climate change can alter how early or late organisms wake from torpor, bud, hatch, and grow. Food availability disruption during their nesting, brooding, and rearing time would be disastrous for the swallow population, so we need to be aware of the effects of the changing climate. We also conducted visual and auditory bird surveys to ascertain how many swallows we could document in comparison to other birds.

For the second half of our project, we sought to empower the citizens of Homer to take control of the health of their own ecosystem. Citizen scientists are engaged, informed residents who are willing to take on the environmental stewardship duties of their own backyards. As graduate students, we study ways on how to be informative to the public on not only global environmental stressors, but ways that they help limit their own local environmental stressors. However, since we are not local citizens of Homer, ourselves, we have to keep in mind that once we take action to inform the public, they have the education and tools needed to make their future decisions. Therefore, we created a citizen monitoring program for the swallows of Homer, AK. Our client has requested that we help create this program specifically for youth and teens, to take advantage of their natural inclination towards nature. The program will allow for a better understanding of what CACS and the people of Homer can do to mitigate the threats

the climate change poses on swallows and other migratory birds. The knowledge of the climate challenges these birds face along with the tools to address and monitor these issues will help the public foster a sense of commonality and connection with the natural environment.

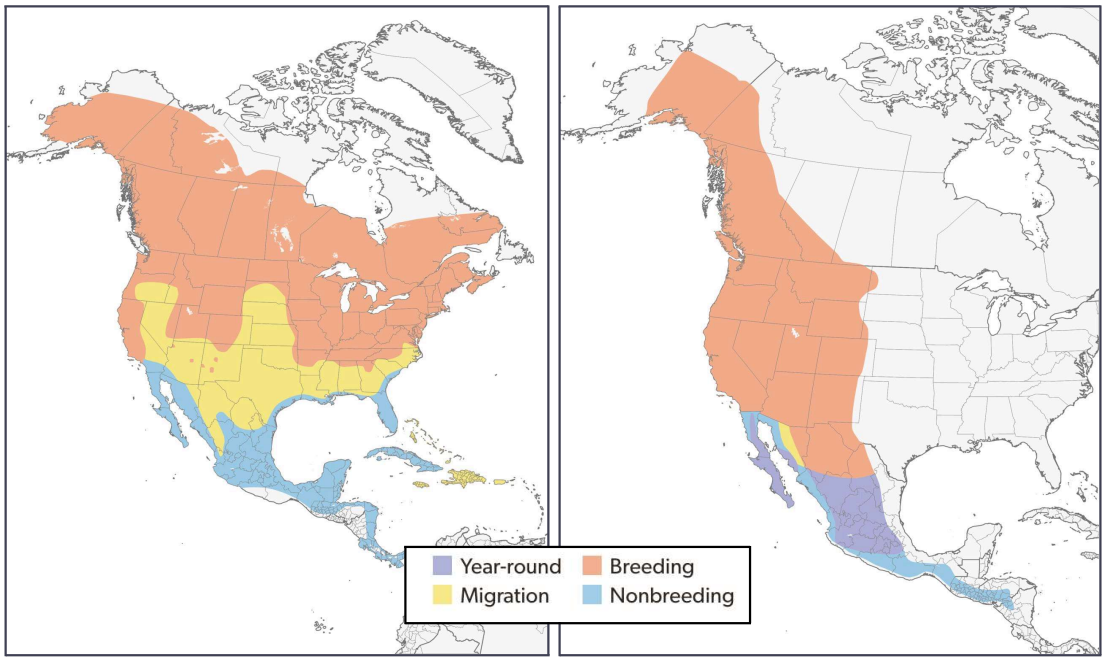
Climate change can be an overwhelming and complex issue to address, but when the public is given the tools to understand and combat what small, local climatic issues they can, the feeling of helplessness can be channeled productively into achievable action. The complexity of climate change can be simplified by addressing smaller environmental stressors. Change occurs when the solution to small impacts add up, and then generate a bigger change. Climate restoration is not only for academics, but for all citizens of this Earth.

Ecological Context and Project Scope

Ecological Context

Climate change is likely to increase stressors and population declines for migratory birds due to phenological mismatches between migration and prey emergence, altered environmental conditions, and more (Carey, 2009). One such altered environmental condition is increased fire prevalence, frequency, and intensity, which is likely to result in habitat changes throughout North America (Flannigan *et al.*, 2000). Habitat loss and decreased resource availability at high latitudes as a result of climate change will likely affect many migratory species (Robinson *et al.*, 2009).

Tree swallows (*Tachycineta bicolor*) and violet-green swallows (*Tachycineta thalassina*) are migratory songbirds that travel to high latitudes to reproduce. See Figure 3 below for migration patterns and range maps. Therefore, habitat loss could cause changes to the swallow's migrational behaviors and has the potential to negatively affect the future of the species.



Tree Swallow Range Violet-green Swallow Range

(source: Cornell Lab of Ornithology - All About Birds)

Figure 3. Range maps of tree swallows and violet-green swallows

Climate change has the potential to negatively impact tree swallow success, as Riggio *et al.* (2023) found that higher temperatures and increased precipitation negatively impacted reproductive success. Additionally, phenological mismatches between arrival at a nesting site and prey emergence may affect the reproductive success of young, as food and other resources may be spread thin. The suspected effects of phenological mismatch and climate change may be already underway, as these species were once found in abundance during the summer on Inspiration Ridge Preserve in Homer, Alaska, but locals have reported seeing fewer in recent years.

Project Scope

UM-SEAS and the Center for Alaskan Coastal Studies have worked together multiple times in the past on a variety of projects around Homer, Alaska. This 2024 UM-SEAS Master's Project group is the sixth group to work with CACS. This 2024 UM-SEAS Master's Project had multiple goals: begin a long-term dataset on swallow phenology and reproductive habits on the Center for Alaskan Coastal Studys's Inspiration Ridge Preserve; conduct food availability surveys for tree swallows on IRP by sampling aquatic, terrestrial, and aerial insects on the property; conduct auditory and visual songbird surveys on IRP to better understand the bird community present, and to create a citizen science project modeled after The Alaska Songbird Institute's Swallow Ecology Project, a citizen science program aiming to involve youth in conservation. Since our project focuses heavily on citizen science, all of the methods and equipment used are readily available to conservation organizations and the general public for

future use, in order to guarantee the survival of swallows, as a species, for generations to come.

Nest Box Sampling

I. Introduction

Tree swallows and violet green swallows are secondary cavity nesters, meaning they find cavities to lay eggs and raise young but are unable to create the cavities themselves (Rendell and Robertson, 1989). Cavities are normally found in trees, especially dead ones. Because humans frequently remove dead trees, swallows are often forced to turn to anthropogenic resources, such as artificial nest boxes. Tree swallows have been found to prefer human-built boxes over natural cavities (Robertson and Rendell, 1990; Norris *et al.,* 2018), because nest boxes can be constructed to emulate the best conditions a natural cavity could produce. The ideal design for a tree swallow has one to two entry holes 1.25 inches across. The small size allows for only smaller birds to access the nest and eliminates interspecies competition with larger birds. Two entry holes would allow the feeding parent more flexibility in feeding multiple nestlings and prevent one chick from dominating the entry hole. Nest boxes can be mounted on posts in clearings and modified with wire mesh or metal dishes to prevent rodents and reptiles from scaling the post to prey on the swallows. A tree with natural cavities is easily climbed and would play host to both competing bird species and egg predators. The proclivity for older female swallows to choose nest boxes over natural cavities implies that females learn by experience the characteristics of a safe nesting site and make their choice of mate and nesting area accordingly (Norris *et al*., 2018).

Rendell and Verbeek (1996) found that clean nest boxes, with previous nest material removed or sterilized, were preferred by tree swallows over nest boxes with remnant nests. Human maintenance can include the removal of previous-season's nesting material to remove the habitat of ectoparasites that have the ability to overwinter in leftover nesting materials and infect nestlings the following year (Rendell and Verbeek, 1996).

Many factors are known to affect nest box use and success by tree swallows. First, the height of the cavity and the size of the opening play important roles in reducing predation and competition (Rendell and Robertson, 1989; Robertson and Rendel, 1990). Both height of the nest box and the entrance into the box are important in mitigating predation and competition, with higher nest boxes being more difficult for terrestrial mammals to access, and a small nest box entrance limits both predation and competition opportunities for other species interested in occupying the box (Rendell and Robertson, 1989; Robertson and Rendel, 1990). Additionally, distance from forest was found to be impactful in nest box use and success, with tree swallows preferring nest boxes that were in the open, 30-100 meters from forest edge (Rendell and Robertson, 1990). Placing nest boxes in open fields reduces competition and predation while increasing flying insect abundance for prey. Floor area also plays an important role in tree swallow nest box selection and success, as larger floor areas were associated with larger nests that allowed larger clutch sizes (Rendell and Robertson, 1989). Finally, opening direction was found to impact nest box selection in Massachusetts, United States, where nest boxes facing South and East were preferred (Ardia *et al.*, 2006). Nest boxes facing South and East were found to have warmer internal temperatures

than North and West facing boxes in the mornings for the first half of the breeding season when swallows may arrive early to claim cavities, but these differences disappeared during the second half of the breeding season when the weather is sufficiently warm (Ardia *et al.*, 2006).

In order to discover why swallows are seen passing through the IRP but not stopping to mate, our team monitored the 32 existing nest boxes that awaited visiting swallows and drew hypotheses about occupancy based on their proximity to water, human presence, and each other. Our hypotheses are based on the swallow diet of insects who hatch from stagnant water and habitat of elevated nesting areas in open fields. If we discovered a nest box location that showed statistically higher success, we could theoretically increase the swallow stopover by replicating those conditions. We hypothesized that tree swallows prefer nest boxes that are farther from forests, roads, trails, buildings, and other nest boxes; but, prefer nest boxes that are closer to ponds for easy access to prey and water and nest boxes on low slopes.

II. Rationale

The Center for Alaskan Coastal Studies felt that nest box monitoring was an important conservation effort after anecdotal reports suggest a decrease in swallow populations in Homer, Alaska. Tree swallows, violet-green swallows, and many other migratory birds are expected to see population declines as climate change progresses. These nest box surveys are meant to be the start of a long-term dataset allowing researchers to track swallow populations and abundance through the future.

III. Study Design

The Center for Alaskan Coastal Studies deployed 32 nest boxes designed for swallows on their Inspiration Ridge Property in Homer, Alaska in the years prior to the arrival of the 2023 UM-SEAS Master's Project Group. Each nest box was 5.5 inches wide, 5.5 inches deep, and 9 inches tall made out of untreated cedar mounted at least 8 feet above the ground (Figure 4 for building plan). Mounts were typically constructed of a T-post driven into the ground, with a conduit attached above.

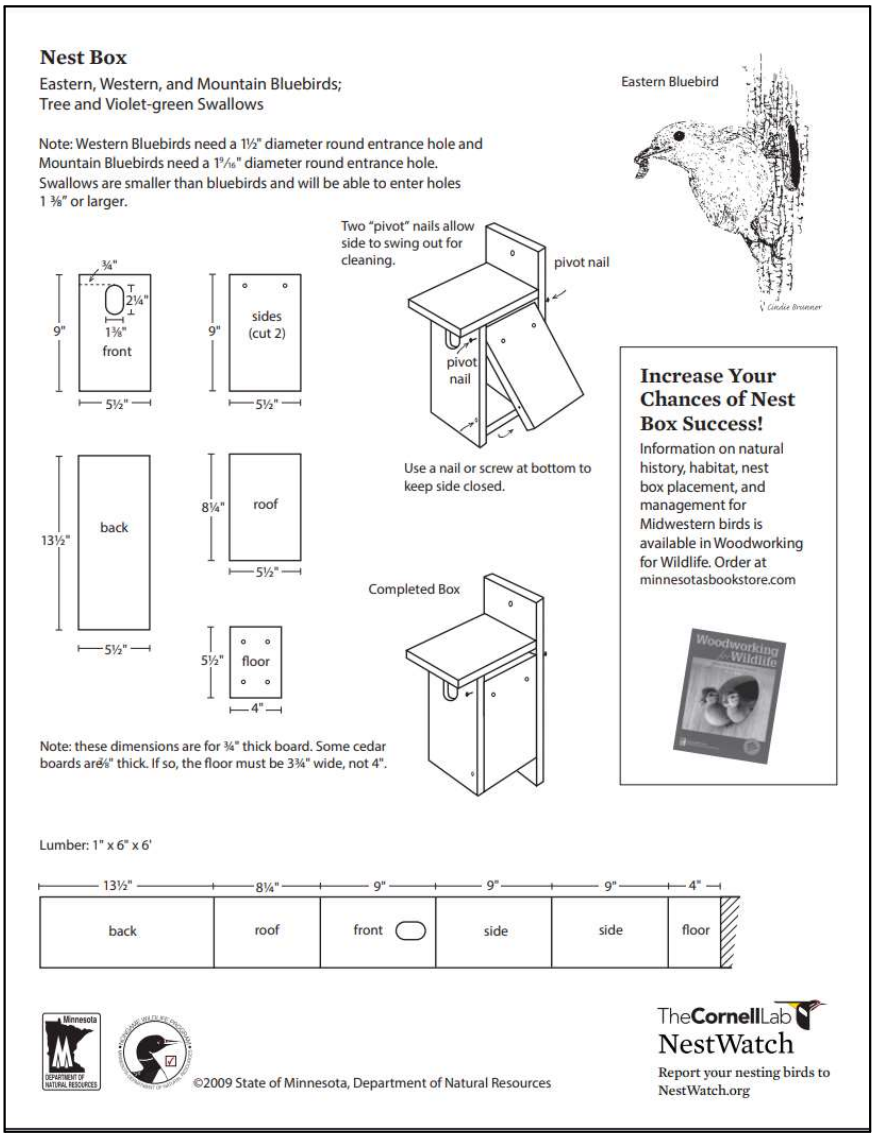


Figure 4. Building plan for nest boxes from The Cornell Lab of Ornithology

The Project Group sampled nest boxes for use at Inspiration Ridge Preserve from May 29th through June 19th. Nest boxes were sampled every 2-3 days, depending on the weather. Sampling days were adapted from previous UM-SEAS teams working with CACS and the Alaska Songbird Institute stating nest box samples should only occur on fair weather days without strong winds or rain (Armstrong *et al.*, 2022; Alaska Songbird Institute, 2023).

To sample nest boxes, a generic borescope was taped to the end of a 10 foot telescoping pole and fed into the entrance of the nest box. The borescope connected to the sampler's phone via bluetooth and displayed a live video feed onto their screen. All results were recorded in Rite-in-the-Rain notebooks and later transcribed into The Cornell Lab of Ornithology's mobile application NestWatch.

Data collection regarding nest box use began prior to approaching each nest box. Nest boxes were observed as the sampler approached each box, looking for

swallows flying in or near each nest box, and if any, how many and whether they carried nesting material. After initial observations, the sampler approached the box and fed the borescope into the entrance.

Once inside the nest box, samples were taken as quickly as possible, generally under a minute, to minimize the disturbance to the birds inside. Each nest box was measured in six ways, recorded in a Rite-in-the-Rain Notebook and transcribed into NestWatch: nest status (no nest, incomplete nest, complete nest, or damaged nest), number of eggs, number of live young, number of dead young, young status (no young present, hatching young, naked young, partially feathered young, fully feathered young, vocal young), and adult status (no adult, building nest, remained on nest, at / on then left, remained in vicinity, or feeding young). Additionally, important dates were recorded when possible, including the date of first egg laid, hatch date, and fledge date. After recording each entry, the borescope was removed and the samplers left the nest box in a different direction than they entered, to minimize trails to the nest box for predators to follow.

GIS Analysis was done in ESRI ArcGIS Pro to measure effects of multiple environmental factors on nest box use. The environmental factors in question were distance from forests, ponds, roads, trails, buildings, other nest boxes, slope, and aspect. See Figure 5 for completed map.

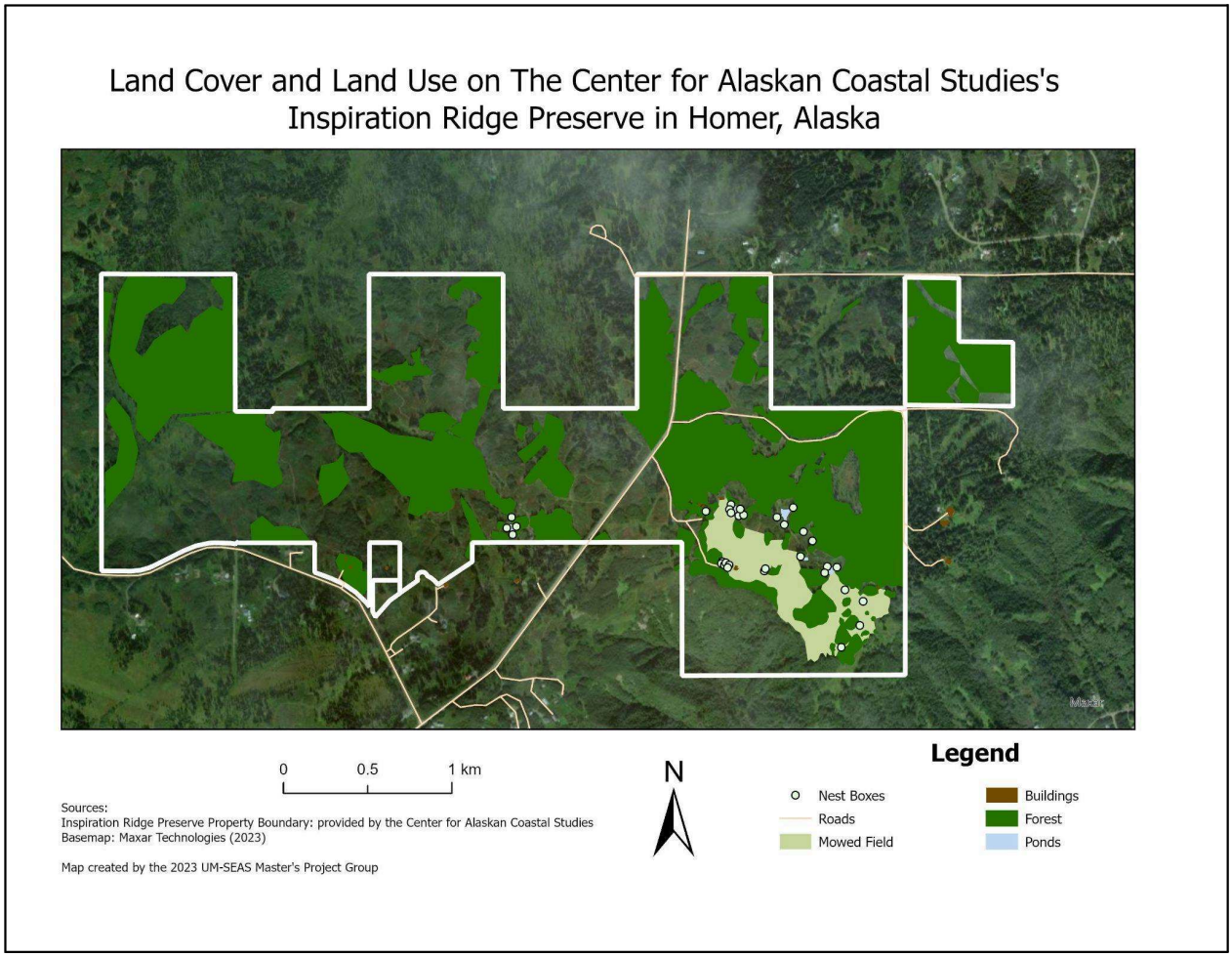


Figure 5. Nest box locations and land cover / land use on Inspiration Ridge Preserve

GPS points were first collected from The Cornell Lab of Ornithology's NestWatch using the "Coordinate Conversion" function. ArcGIS Pro's default basemap was loaded in at 2-3 meter spatial resolution, and manual classification was done using the "Create Feature Class" tool to represent forests, ponds, buildings, and roads on the Inspiration Ridge Preserve. A layer containing trails on the Inspiration Ridge Property, given by CACS, was then added to the map view. The "Near" function was then used on each coordinate for each feature class, resulting in new columns in the coordinate attribute table for distance, in meters, to the nearest polygon/line of each feature class.

A digital elevation model (DEM) of the Homer area found at the State of Alaska Division of Geological and Geophysical Surveys and imported into ArcGIS Pro. The "Percent Clip" function was used to rescale the values displaying elevation, with 250 meters above sea level being the minimum and 500 meters above sea level being the maximum elevation. The "Surface Parameters" function was used to output both slope and aspect for the entire property, and the "Extract Values to Points" function was used to append the slope and aspect values to the nest box coordinates attribute table. The final result was an attribute table for the GPS coordinates layer containing the GPS coordinates of each nest box, their distance from the nearest polygon/line of each land cover type, and elevation, aspect, and slope. These were exported into an excel spreadsheet and loaded into R Studio.

A logistic regression, with a binomial linking function, was done in R Studio to measure the correlation between nest box and land cover type, slope, and aspect. Box plots were created in R Studio to display the mean distances from each land cover type for occupied and unoccupied boxes.

IV. Results

Out of 32 boxes, 10 had completed nests (31%), 2 had eggs (6%), and 3 had hatched young (9%). The majority of the boxes with nests had adults sitting on nests during at least one visit (6/32, 19%). Two out of 10 nest boxes with completed nests were occupied by boreal chickadees, *Poecile hudsonicus*. Finally, two nest boxes occupied by tree swallows had hatched young, but likely experienced predation as the young disappeared between visits, with Steller's Jay (*Cyanocitta stelleri*) the likely predator. No violet-green swallows were observed nesting.

Because of the lack of nest box use during our time in Homer, we questioned whether there are environmental impacts influencing the use of nest boxes by swallows. We hypothesized that tree swallows prefer nest boxes that are farther from forests, roads, trails, buildings, and other nest boxes; but, prefer nest boxes that are closer to ponds for easy access to prey and water and nest boxes on low slopes.

Our combined logistic regression included nest box distance from the closest water, forests, buildings, fields, roads, trails, other nest boxes, as well as slope and aspect. There were no significant relationships between any of these factors and nest box occupation (distance to water: p=0.397; distance to woods: p=0.512; distance to buildings: p=0.957; distance to fields: p=0.988; distance to roads: p=0.267; distance to trails: p=0.199; distance to other boxes: p=0.200; slope: p=0.235; aspect: p=0.366). See

Table 1 for a comparison of mean occupied and unoccupied distances from each feature.

Table 1. Average distance in meters of occupied and unoccupied nest boxes to each land cover type on Inspiration Ridge Preserve.

Measure	Occupied Boxes	Unoccupied Boxes
Mean Distance to Water (m)	112 meters	140 meters
Mean distance to forest (m)	14 meters	10 meters
Mean distance to buildings (m)	107 meters	107 meters
Mean distance to fields (m)	220 meters	2.5 meters
Mean distance to roads (m)	187 meters	222 meters
Mean distance to trails (m)	67 meters	63 meters
Mean distance to other boxes (m)	47 meters	17 meters
Mean slope	5.3 degrees	5.1 degrees
Mean Aspect	120 degrees	100 degrees

V. Discussion and Recommendations

Our results do not support our hypothesis. Our hypothesis stated that tree swallows prefer nest boxes farther from forests, roads, trails, buildings, and other nest boxes; but, will prefer nest boxes that are closer to ponds and nest boxes on low slopes. There were no statistically significant correlations between nest box use and our measured variables.

These results contradict previous research. Rendell and Robertson (1990) found tree swallows preferred nesting in open environments between 30 and 100 meters from forest edge. Our results found no significant relationship between distance from forest and nest box occupation. The discrepancies in results could be explained by the geography of Inspiration Ridge Preserve. The South side of the Inspiration Ridge Preserve, which contained most of the nest boxes, is heavily forested. It is unlikely that there are many locations on this side of the property that could be 100 meters from the forest edge. The dominance of forest on this side of the ridge shows the average distance of occupied nest boxes from forest edge of 14 meters and unoccupied boxes an average of 10 meters. Additionally, small sample size in our study could skew results away from previous findings.

While our results disagree with Rendell and Robertson (1990), Riggio *et al.* (2023) found no relationships between habitat (grasslands, orchards, and riparian) and nest box use by tree swallows. These results are consistent with ours, where there were no significant correlations between nest box use and distances from different habitats.

There was a lack of swallow stopover in the Inspiration Ridge. Of 32 nest boxes surveyed, only 7 were confirmed to be occupied by tree swallows using visual confirmation of an adult sitting on the nest. Due to logistical constraints, we were unable to determine if latecomers occupied the remaining nest boxes after mid-June. Our team witnessed hundreds of tree swallows migrating through Homer. On site water quality and prey abundance suggested this area as being appropriate swallow habitat. The Inspiration Ridge Preserve should be an ideal haven for tree swallows, but they are largely passing it down for unknown reasons. To further expand on our research question, what other factors could be discouraging swallows from nesting at the Inspiration Ridge Preserve?

Birds who migrate longer distances, which include tree swallows and violet-green Swallows, are declining more than birds who migrate shorter distances since the 1980s. (Nebel *et al.* 2010) found that birds overwintering in South America, meaning birds who have a longer migration commute, were declining in population four times faster than those overwintering in Central America. There was no correlation with the height of the nests chosen, foraging strategy, or foraging height to population decline. Our nest boxes remained largely unoccupied in mid-June, also suggesting nesting habitats are not related to swallow declines.

Another unexplored stressor of migratory aerial insectivores is the mass decline of flying insects. An Ontario-based experiment determined higher population density of insects around low traffic roads than high traffic roads, implying traffic related death has a significant impact on insect populations (Martin *et al.* 2018). On the other hand, insect populations in rural areas can also be diminished by large-scale pesticide usage on agricultural land (Wagner, 2019). Climate change can introduce an element of phenological mismatch as insects hatch earlier due to warmer climates, and traditional migration times no longer line up with insect life cycles. Wetlands are favorite areas for migrating swallows to stop, rest, and eat insects, but over half of North American and Canadian wetlands have been lost to agriculture and urbanization since colonization (Mitsch & Hernandez, 2013). Patchy areas of low insect abundance form starvation zones for traveling birds who can eat 2,000 insects per day.

Further study is needed to determine the reason for the absence of nesting swallows. The IRP should be an ideal haven for tree and violet-green swallows, but our study suggests they are largely passing it by for unknown reasons.

Terrestrial Arthropod Survey

I. Introduction

Global declines in the abundance and population of bird species in most parts of the world are attributed to diverse factors, including habitat loss (Studds et al., 2017), increasing predation and hunting (Benítez-López et al., 2017; Evans, 2004) and extreme weather events (Cohen et al., 2021). Among all these factors, habitat loss may have become the most important threat to farmland insectivorous bird species due to insects, which is their most important food source, population decline.

Tree Swallow (*Tachycineta bicolor*) is a typical insectivores species, in some research this species is considered as a typical aerial insectivores and members of a distinct guild which forages on insects in the air column . But in the meantime, they can also prey on some arthropods that do not have the ability to fly, such as spiders (McCarty and Winkler, 1999).

II. Rationale

According to the Center for Alaskan Coastal Studies, basic data of Arthropods population such as abundance, diversity would have a strong effect on the migratory bird habitat selection, breeding strategy and breeding success rate. By monitoring the Arthropods basic data, these data are meant to be the start of a long-term dataset allowing researchers to track in future, make comparisons based on historical data and make hypotheses for further conservation policy.

III. Study Design

Arthropods were sampled by the group on sunny days above 40°F. Equipment used in arthropod collection were plastic rubbermaid 2x8 cell ice cube trays, a standard white shower curtain to catch arthropods on vegetation, and a long handled insect net to catch flying insects. The long handled insect net was only used for one sample, and then was no longer used due to both the mesh size being too large and allowing insects to escape through the mesh and there was little insect flying that time.

All samples were done by groups of between three and five participants. All samples consisted of 30 seconds of sampling per participant, followed by a counting and identification period, which lasted until all specimens were counted and recorded in Rite in the Rain Notebooks. Any specimens that we could not identify were photographed and later identified using the *Insects of South-Central Alaska* field guide (Dominique M. Collet, 2008) with iNaturalist as a basic reference. Following identification and photography, all individuals captured in this process were released after counting.

All samples using the shower curtain and ice cube trays were done by vigorously shaking vegetation with the collection receptacle held or laid under. Vegetation sampled included Bog willow (*Salix* sp.), Spruce (*Picea* sp.), Alder (*Alnus* sp.), Fireweed

(*Chamaenerion angustifolium*), and Red-berried Elder (*Sambucus racemosa*). For using the shower curtain, the curtain was laid on the ground and spread out to maximize area prior to shaking the vegetation. For samples using the ice cube tray, the tray was held with one hand directly under the vegetation to catch any falling insects, while the other hand was used to shake the vegetation.

In order to estimate the diversity of Terrestrial Arthropods, diversity, evenness and richness were calculated by given parameters/methods of Shannon and applied to the Shannon Diversity Index (Shannon, 1948).

IV. Results

Our terrestrial insect collection resulted in 18 morphotypes found, with 13 identified (to at least the family level): Milbert's Tortoiseshell (*Aglais milberti*), Unidentified Plant Bug (*Agnocoris* sp.), Unidentified Bee (Apidae sp.), unidentified true weevils (Curculionidae sp.), unidentified Leafhopper (Cicadellidae sp.), unidentified rove beetle (Staphylinidae sp.), unidentified hover fly (Syrphinae sp.), unidentified thrips (*Thrips* sp.), Psyllid Bug (*Bactericera shepherdiae*), Unidentified Springtails (*Collembola* spp.), Dwarf Spider (*Hypselistes florens*), *Pimoa altioculata* and Forest Cobweb Weaver (*Phylloneta impressa*). There were 5 morphotypes that we could not identify to at least family level that were in the flies (Diptera sp.), beetles (Coleoptera sp.), seed bugs (Lygaeoidea spp.), spiders (Araneae spp.) and worm-like creature families.

Overall, 826 arthropods samples were recorded during the whole study period. Individuals were recorded from willow (409), followed by spruce (322), alder (79), elderberry (10), grasses (3) and fireweed (3). Among all the individuals collected, the vast majority consist of springtails (*Collembola* sp.), at 691 counts. Additionally, most arthropods were found using ice cube trays (639) and sheet shake (180), only 3 individuals were recorded by aerial net.

If calculated by Species level in total, Shannon Diversity Index (SDI) is 0.777, Simpson Diversity Index (1-D) is 0.30, Evenness is 0.269. The Domain species is the Springtail (83.6%). If calculated by Vegetation type in total, Shannon Diversity Index is 1.03, Simpson Diversity Index is 0.59, Evenness is 0.577. The Domain habitat that Arthropods prefer in this study is Willow. The Alder have the highest Shannon Diversity Index (1.15) and Simpson Diversity Index (0.54) if excluding the habitat that only collected a few species and individuals, while Spruce have both lowest Index (0.483 and 0.22).

Figure 6. Upper Left: Unidentified Rove Beetle/ Staphylinidae sp.; Upper Right: Unidentified Thrips/ *Thrips* sp.; Lower Left: Unidentified Seed Bugs/ Lygaeoidea sp.; Lower Right: Unidentified True Weevils/ Curculionidae sp.

V. Discussion and Recommendations

We counted 825 Terrestrial Arthropods in total during the study. The sample may not be representative due to the small sample size and our time of study. Early June may be too early in the season to see large amounts of arthropods due to the cold overnight temperatures. We highly recommend other researchers use an aerial net with a finer mesh or focus on vegetation shaking into ice cube trays or sheets, as well as sample later in the season to maximize arthropods collected.

Table 2. Identified Morphotypes List

Morphotype	Counting Number	Habitat
Milbert's Tortoiseshell (*Aglais milberti*)	1	Grassland
Unidentified Plant Bug(*Agnocoris* sp.)	2	Spruce
Unidentified Bee (Apidae sp.)	2	Grassland, Willow
Unidentified True Weevils (Curculionidae spp.)	4	Willow, Alder
Unidentified Leafhopper (Cicadellidae sp.)	25	Willow, Alder
Unidentified Rove Beetle (Staphylinidae sp.)	6	Spruce, Willow
Unidentified Typical Hover Fly (Syrphinae sp.)	1	Grassland
Unidentified Thrips (*Thrips* sp.)	2	Alder
Psyllid Bug (*Bactericera shepherdiae*)	36	Spruce, Willow
Unidentified Springtails (*Collembola* spp.)	691	Willow, Spruce, Alder, Fireweed, Elderberry
Dwarf Spider (*Hypselistes florens*)	1	Willow
Pimoa altioculata	1	Spruce
Forest Cobweb Weaver (*Phylloneta impressa*)	1	Spruce

Table 3. Unidentified Morphotypes List

Morphotype	Counting Number	Habitat
Flies (Diptera spp.)	26	Willow, Fireweed, Spruce
Beetles (Coleoptera sp.)	2	Willow, Alder
Seed Bugs (Lygaeoidea spp.)	1	Willow
Spider (Araneae spp.)	23	Willow, Spruce, Alder
Worm-like Creature	1	Alder

Benthic Macroinvertebrate Sampling

I. Introduction

Benthic macroinvertebrate surveys are conducted in many parts of the world because these aquatic arthropods can be indicators of stream and ecosystem health. Although water quality can be understood through different physical and chemical tests, using biological indicators like benthic macroinvertebrates can give us a more integrative and holistic view of stream quality (Kenney et al., 2009). Macroinvertebrates as indicators of water quality are useful because many species found in freshwater streams are sensitive to pollutants and other toxic waste (Wallace and Webster, 1996).

Benthic macroinvertebrate surveys have been conducted for decades and help answer questions about the overall health of the body of water. Since many macroinvertebrates are sensitive to disturbance, their presence or lack thereof can tell us a lot about the quality of the water. They are also essential to their ecosystems because they break down detritus and are a source of food for many other animals, including fish (Kenny et al., 2009).

Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa are especially sensitive to pollutants, so macroinvertebrates in these families are closely monitored to help us understand when an ecosystem is disturbed (Ferreira 2014). Some of the most important species to track within EPT include mayflies, stoneflies, and caddisflies. Species that are less sensitive to pollutants and can tolerate a harsher environment include gastropods, oligochaetes, and Diptera.

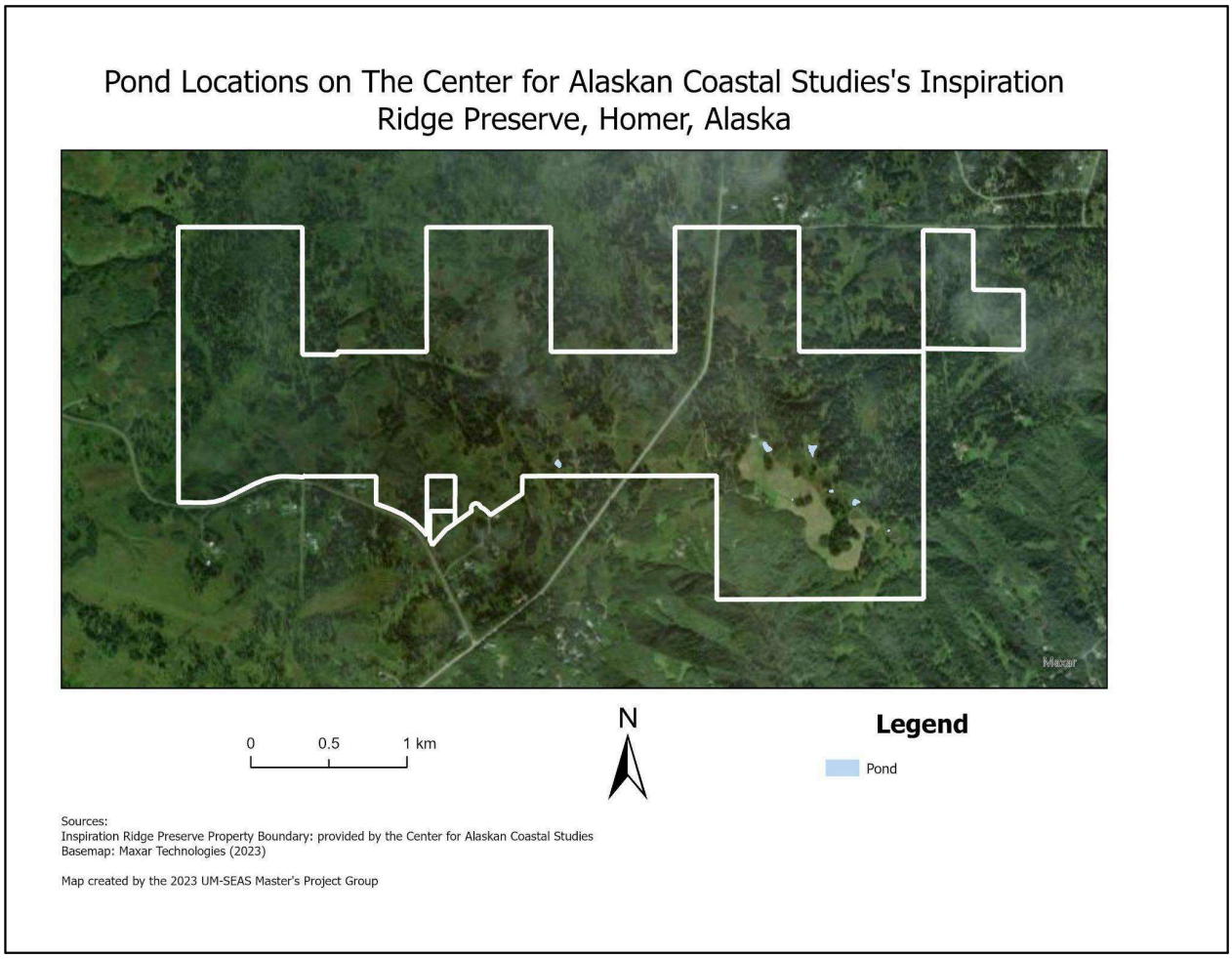


Figure 7. Pond locations on Inspiration Ridge Preserve

II. Rationale

CACS expressed that there is a need for benthic macroinvertebrate testing because it hadn't been conducted in two years. Additionally, the main focus of our project is food availability in relation to migratory songbirds, specifically tree swallows and violet-green swallows. These swallows are known for consuming aerial insects (Cornell Lab of Ornithology) and are often seen flying above bodies of water in order to catch their food. Some of the insects they consume include (but aren't limited to) caddisflies, dragonflies, damselflies, true bugs, bees, and beetles. Many of these insects will be encountered during surveys because they live in benthic ecosystems, like freshwater ponds. Benthic sampling is a beneficial way of understanding what kinds of aquatic arthropods are present on the IRP that could be potential food for swallows. Lastly, as mentioned previously, aquatic arthropods can be good indicators of water quality (Wallace and Webster 1996).

III. Study Design

There are seven ponds total located on the IRP (Figure 7). There are six ponds located on the pond side of the IRP (Crane, Snipe, Mallard, Frog, Alldredge, and Goose) and there is one (Moose) located on the ridge side of the IRP. Each pond was sampled twice. The supplies used for sampling included small aquarium nets, white paint trays, ice cube trays, silver spoons, and benthic macroinvertebrate identification cards (figure 9). We also relied on Izaak Walton's *Biological Monitoring Data Form for Stream Monitors* from League of America (Figure 8) to get a water quality score for each pond. Before sampling, each ice cube tray was filled with pond water as well as the paint trays. Organisms were sampled for two minutes at each station by 5 individuals, using "D" nets and slow, back and forth motions. This equated to a total "level of effort" sampling of 10 minutes. Samples were then picked for invertebrates for an additional 10 minutes. Since the macroinvertebrate count sheet assumes the user will be sampling for 5 minutes, the score is calculated based on that sampling effort. We had five people take samples, which equals 10 minutes of sampling time. After samples were done, we calculated the water quality scores (figure 8) and divided that score by 2, so the score would be accurate to the amount of sampling effort contributed.

MACROINVERTEBRATE COUNT

Please consult biological monitoring instructions to conduct the macroinvertebrate count. Use the table below to track numbers of each macroinvertebrate found. Once sampling and identification are complete, place a checkmark next to each type of macroinvertebrate identified and list the total number found. Add up the number of checkmarks in each category (sensitive, less sensitive, tolerant) and multiply those numbers by the indicated index value.

Sensitive (Ex: ☑ 10 Caddisflies)	**Less Sensitive** (Ex: ☑ 2 Dobsonflies)	**Tolerant** (Ex: ☑ 3 Leeches)
☐_____Caddisflies (except net spinners) ☐_____Mayflies ☐_____Stoneflies ☐_____Watersnipe flies ☐_____Riffle beetles ☐_____Water pennies ☐_____Gilled snails	☐___Dobsonflies ☐___Fishflies ☐___Crane flies ☐___Damselflies ☐___Dragonflies ☐___Alderflies ☐___Crayfish ☐___Scuds ☐___Aquatic sowbugs ☐___Clams ☐___Mussels ☐___Common net spinning Caddisflies	☐_____Aquatic worms ☐_____Black flies ☐_____Midge flies ☐_____Leeches ☐_____Lunged snails
___# of checkmarks multiplied by 3 = ___	___# of checkmarks multiplied by 2 = ___	___# of checkmarks multiplied by 1 = ___

Now add the three totals from each column for your stream's index value. Total index value = _____
Total number of macroinvertebrates in sample: _____

Compare the total index value to the following ranges to determine the water quality of the stream sample site.

WATER QUALITY RATING

_____ Excellent (>22) _____ Good (17-22) _____ Fair (11-16) _____ Poor (<11)

Share your stream monitoring data at *www.cleanwaterhub.org.* 1

Figure 8. Izaak Walton's *Biological Monitoring Data Form for Stream Monitors.*

Figure 9. All materials used for benthic macroinvertebrate sampling (ice cube tray, paint tray, spoons, ID sheet). Not pictured: “D” Nets

Figure 10. Upper Left: Paddle-tailed Darner nymph/ *Aeshna palmata*; Upper Right: Lacustrine Scud/ *Gammarus* cf. *lacustris*; Lower Left: Diving Beetle/ *Hygrotus* sp.; Lower Right: Damselfly/ *Enallagma* sp.
Photo Credit: Dongchen Lang

IV. Results

Benthic macroinvertebrate sampling resulted in 13 species identified across seven pond sites including: *Aeshna palmata* (paddle-tailed darner nymphs), *Aeshna sp*. (dragonfly nymphs), *Arrenurus sp.* (mites), *Callicorixa cf. alaskensis* (Boatmen), *Chaoboridae sp.* & *Chaoborus cf. flavicans* (midges), *Clitellates sp.* (worms), *Dytiscus dauricus*, *Hygrotus sp*., *Rhantus binotatus*, and *Gyrinus convexiusculus* (beetles), *Enallagma sp.*(damselflies), *Gammarus cf. lacustris* (scuds), *Hemiptera sp.*(water striders), *Hirudinea sp*. (leeches), *Lymnaeidae sp*. (snails), and *Ephemeroptera sp*. (mayflies). Each pond was sampled twice and water quality was calculated for each pond.

To perform data analysis, a correspondence analysis (CA) was run using the package “ca” in R. Points that are clustered or closer to each other represent variables that are more highly associated with each other. Points that are farther away from each other on the plot represent variables that are not highly associated with each other.

Additionally a correlation plot was created in R using the “corrplot” package. A Pearson’s Chi-Squared test ($p < 0.05$, df =78) was performed in order to visualize the residuals from this test in the correlation plot constructed. This test was run in R.

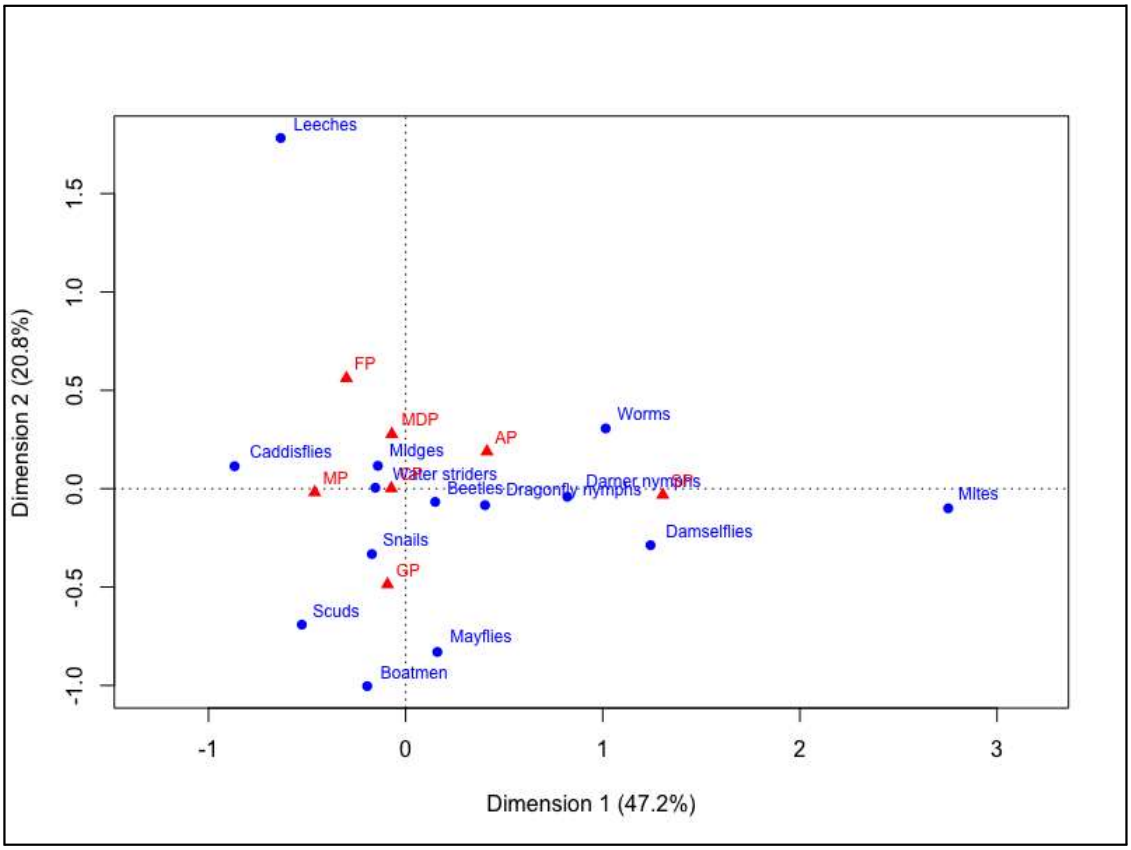


Figure 11. Correspondence Analysis biplot with benthic macroinvertebrates species in blue and pond site in red.

Correspondence analysis (CA) was conducted to compare the seven different ponds at the IRP and benthic macroinvertebrate abundance (figure 11). The main purpose of the CA was to be able to correlate macroinvertebrate abundance and the different ponds at the IRP. The first two axes of the CA explained 68% of the total variance in the dataset (figure 11). Frog Pond, Mallard Pond, Crane Pond, Alldredge Pond, and Moose Pond were all closely associated with each other. Midges were highly associated with Crane Pond and Mallard Pond. Additionally, beetles were highly associated with Crane Pond. Snails were associated with Goose Pond. The main outliers were leeches and mites, with no clear association with any pond. This is likely due to the small sample size (n=4). Damselflies and Darner Nymphs were highly associated with Snipe Pond.

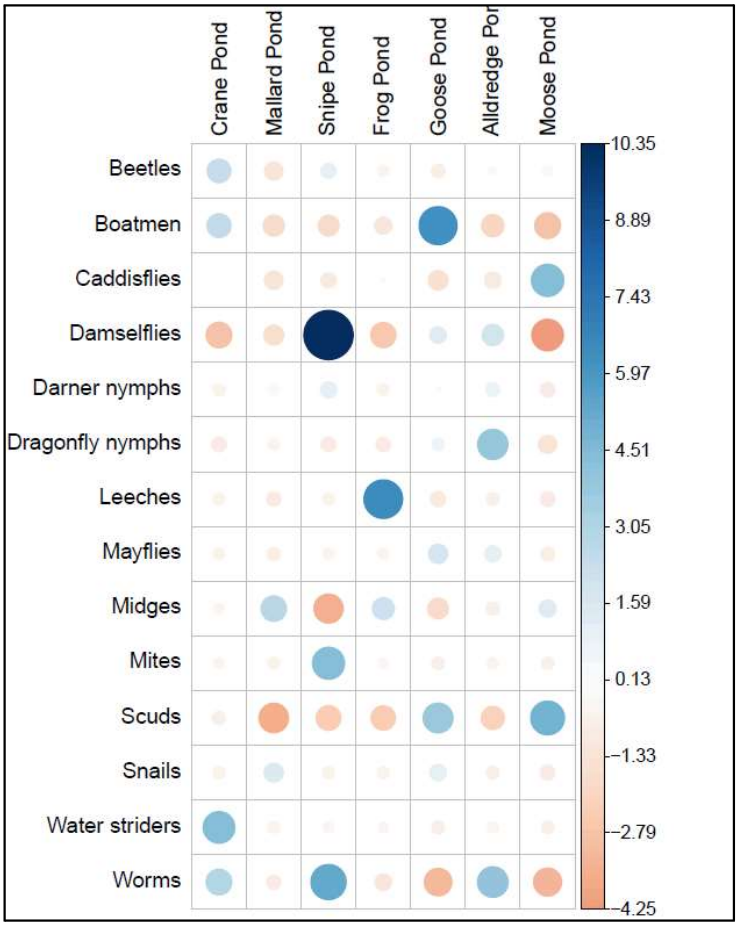


Figure 12. Correlation plot showcasing the significance between species and pond location.

A correlation plot was created to understand the relationship between variables that are highly associated (Figure 12). Based on this plot, circles that are blue are more highly associated with their row and column. In addition, the size of the circle indicates the strength of the variables being compared. For instance, damselflies have the largest circle and the darkest circle when compared to Snipe Pond. This indicates that there is a high association between these two variables. Furthermore, leeches have a strong association with Frog Pond and Boatmen have a strong association with Goose Pond. Worms have a somewhat high association with Snipe Pond and Scuds with Moose Pond.

Table 4. Water quality scores based on Izaak Walton League of America *Biological Monitoring Data Form for Stream Monitors.*

Sample	Pond	Score
1	Crane	20, Excellent
2	Crane	54, Excellent
1	Mallard	33.5, Excellent
2	Mallard	78, Excellent
1	Frog	20.5, Good
2	Frog	27.5, Excellent
1	Goose	63.5, Excellent
2	Goose	104.5, Excellent
1	Snipe	24.5, Excellent
2	Snipe	40, Excellent
1	Alldredge	42.5, Excellent
2	Alldredge	38.5, Excellent
1	Moose	37, Excellent
2	Moose	104.5, Excellent

A table was generated to showcase water quality scores for each of the six ponds at the IRP. These water quality scores were determined by Izaak Walton's *Biological Monitoring Data Form for Stream Monitors* (Figure 8). Arthropods categorized as Sensitive (caddisflies, mayflies, stoneflies, etc.) are weighed at a heavier scale, with the total count for each species identified multiplied by three. Species in the Less Sensitive category (damselflies, scuds, etc.) totals are multiplied by two. Lastly, species in the Tolerant category (aquatic worms, midges, etc.) are not multiplied and their totals are added to the overall count. Based on these results all ponds, aside from Frog Pond, had a score >22 which equates to an Excellent water quality rating. Frog Pond scored the lowest overall out of all the ponds sampled. Goose Pond and Moose Pond both scored 104.5 for at least one of the samples, which was the highest score that we recorded.

V. Discussion and Recommendations

We recommend that CACS resamples these ponds every 1-2 years. With the exception of one sample, every pond scored an Excellent water quality rating based on the Izaak Walton League of America *Biological Monitoring Data Form for Stream Monitors* (Figure 8). We encourage CACS and anyone who is curious about water quality and benthic macroinvertebrate diversity to use this data form to conduct their own surveys. Izaak Walton League of America also has an app and other resources for biological stream monitoring that can be useful for citizen scientists. Additionally, we recommend that correlation analysis be conducted for future benthic macroinvertebrate surveys. We hope that future groups can use our dataset(s) to contribute to the overall diversity and knowledge of macroinvertebrates at the IRP. In the past, research groups have used the following metrics to test water quality: dissolved oxygen, temperature, pH, and conductivity. This did not get tested during our time at the IRP, so we recommend that future groups do these tests in order to compare to data collected in the past.

Bird Surveys

I. Introduction

The surveying and monitoring of bird species occurs worldwide as a method for indicating and analyzing the health of the ecosystem. With increasing global temperatures, it's important to monitor the changes in the dynamics of local populations, considering that there are many species-specific features when testing for the effects of climate change (Jiguet et al., 2010). Bird species are used as bioindicators, meaning that their presence or absence in the ecosystem can help signal environmental stressors (abiotic or biotic), and natural changes (Parmar et al., 2016). Since it is impractical to measure all species, indicators are built on the monitoring of well-known taxa (birds); and it is the indicators' jobs to communicate current knowledge and scientific criteria to researchers. By monitoring indicator species, it allows for researchers to depict urgent needs for devising strategic climate and conservation policies (Fraixedas et al., 2020). Birds being used as indicators allows for the measuring of increasing or decreasing biodiversity. Changes in biodiversity can halt the functionality of the ecosystem as a whole (Fraixedas et al., 2020).

The Inspiration Ridge Preserve is home to both year-round and migratory bird species. Surveying the bird species that are present at IRP will allow for CACS to monitor changes in bird abundance and diversity. The data collected will be knowledgeable for the community of Homer, because it will help indicate the changes that are potentially occurring due to climate change. Also, it's important to familiarize with the migratory species and acknowledge the resources present for those species. If there's a difference in species phenology and the resources present, it may threaten the survival and reproductive success for that species (Jiguet et al., 2010).

Data collected by CACS will allow them to monitor changes in biodiversity in the IRP, which can also be relevant to the changes in biodiversity of the whole city of Homer. With the impacts of climate change and increasing urban development, it's important to monitor how the presence of species are changing as well. Most bird species arrive in Alaska in the early spring to breed, but climate change has been impacting the changes in temperature and precipitation. Also, climate change can cause wildlife disturbances such as drought, wildfires, flooding, etc., which could lead to hazardous conditions for wildlife.

Bird surveys can provide valuable information that can be used when addressing the issues of climate change. The surveys can help monitor the distribution of species across the IRP, and can also help overall represent the bird populations in Homer, AK.

II. Rationale

Bird Surveys were conducted on clear days, when rain or fog was not present. They were completed every other day, twice on the same day. One survey took place at 7:00am and the other survey would take place in the afternoon, approximately between 3-4:00pm. The surveys were taken using background knowledge on bird identification,

and supplemented with the use of The Cornell Lab of Ornithology's Merlin Identification Application.

All surveys were completed near the six ponds located on the side of the IRP (Crane, Snipe, Mallard, Frog, Goose, and Alldredge). The surveys were done in groups of three members from the SEAS team. One group member would refer to background knowledge on the bird identification in order to identify the different species, and then the other two members would use the Merlin Identification Application to guarantee the species spotted/heard. All surveys were completed in 7 minutes. When the group members approached the pond, there was a 2 minute time period for settling in. The 2 minute time period in the beginning was implied before surveying in order to limit noises/disruptions from group members, which could affect which bird species might be initially seen/heard. Once group members the 2 minute time period for settling in was over, then there were 5 minutes allowed for the process of spotting nearby birds and recording observations. Observations were recorded by one group member on an observation sheet/template given to us by CACS, and the two other group members recorded data in lab notebooks. The date, weather, and location was also recorded in those lab notebooks.

Surveys were conducted on days when weather conditions were optimal for spotting the different species present. We did not conduct surveys on days when precipitation and foggy conditions were present. These conditions would limit our ability to accurately depict what species can be seen at the IRP. Therefore, we surveyed on days with clear weather conditions in order to optimize our chances of a more accurate survey.

III. Study Design

The sites for bird surveys were established by Nina Faust, and they were determined by reference to the location of the six ponds (Crane, Snipe, Mallard, Frog, Goose, and Alldredge), that were located on the side of the IRP. Conducting the surveys near the ponds would allow for more efficient ways to educate visitors of the IRP, and allow for easier ways to conduct bird surveys in the future. Also, surveys were conducted near the ponds, to limit the chance of counting the same individual bird twice at the different surveying locations, since the location of the ponds are far enough away from each other, that chance would be less apparent.

IV. Results

For bird surveys, we gathered data on six different days. Some days we gathered data in the morning and in the evening (limited by weather conditions). The dates, times, and total number of birds spotted are listed below:

Table 5: Total number of birds seen during collection each sampling period.

Date of Collection	Time of Collection	Total # of birds seen
05/28/2023	7:20-8:18	79
05/30/2023	16:00-16:51	39
06/06/2023	7:22-8:12	132
06/08/2023	17:05-17:51	66
06/13/2023	7:40-8:12	41
06/14/2023	7:33-7:45	36

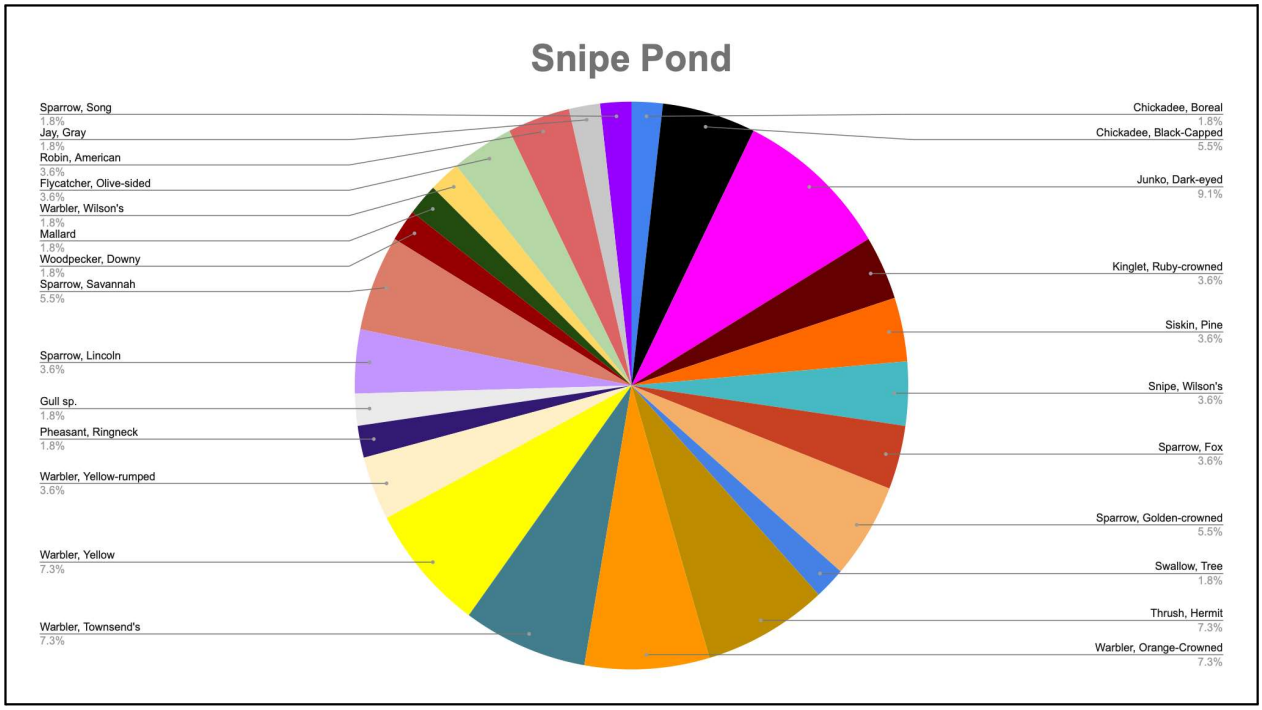


Figure 13: Number and relative abundance of bird species seen throughout bird surveys at Snipe Pond.

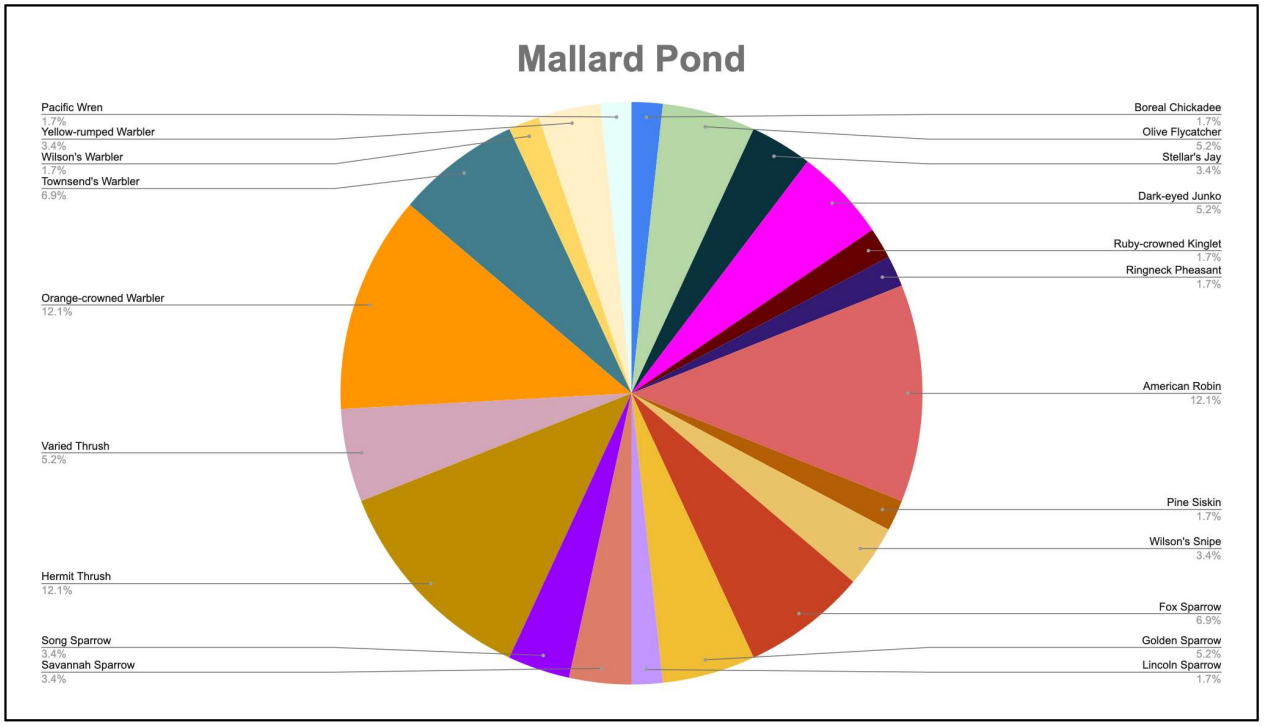


Figure 14: Number and relative abundance of bird species seen throughout bird surveys at Mallard Pond.

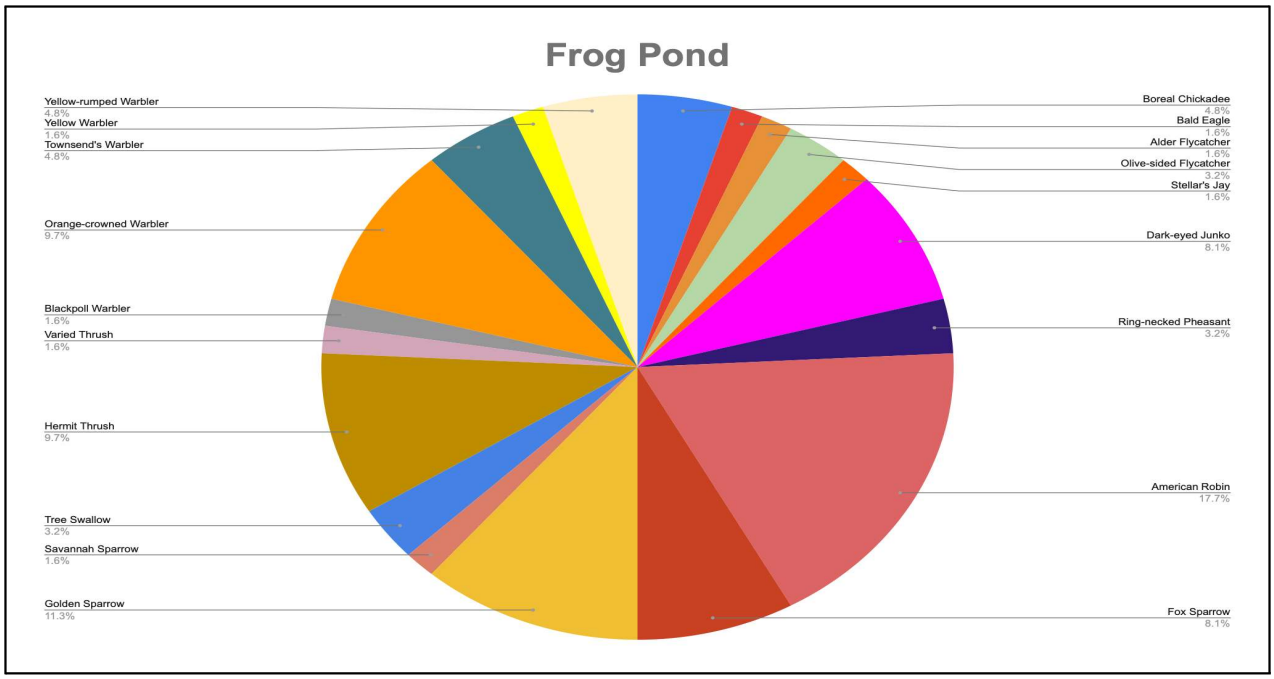


Figure 15: Number and relative abundance of bird species seen throughout bird surveys at Frog Pond.

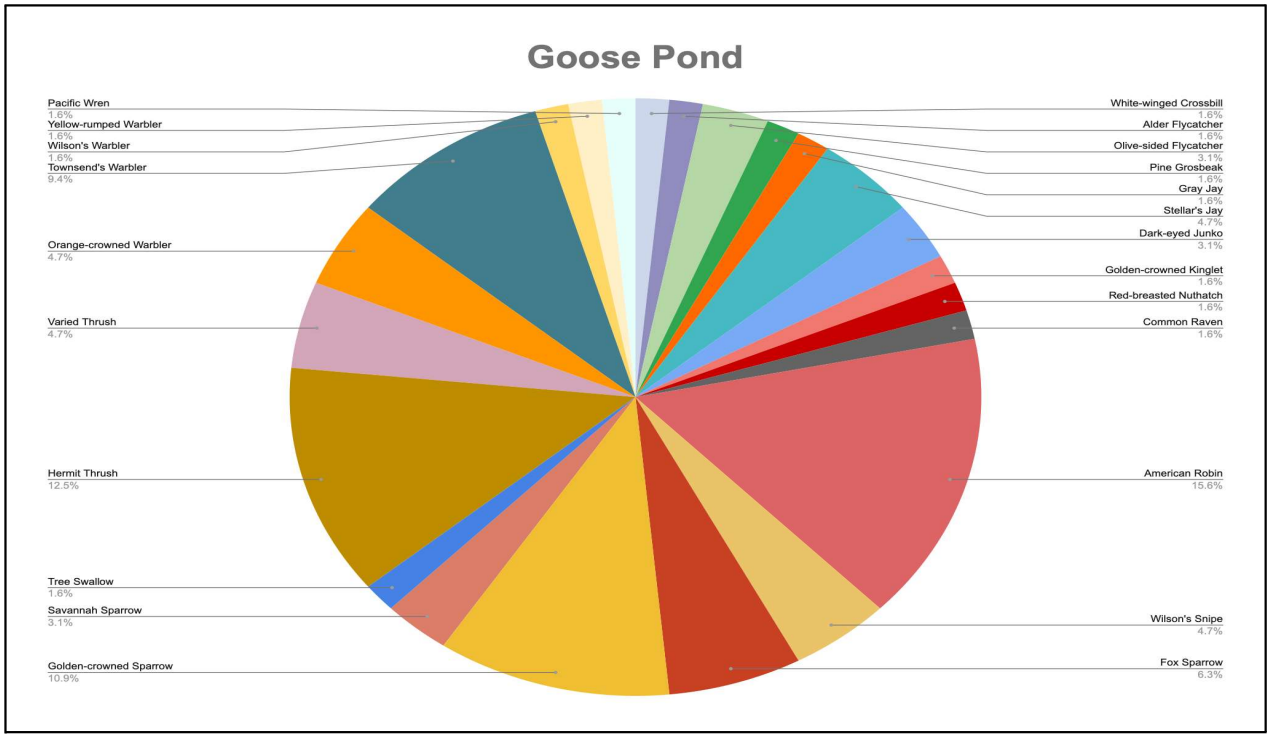


Figure 16: Number and relative abundance of bird species seen throughout bird surveys at Goose Pond.

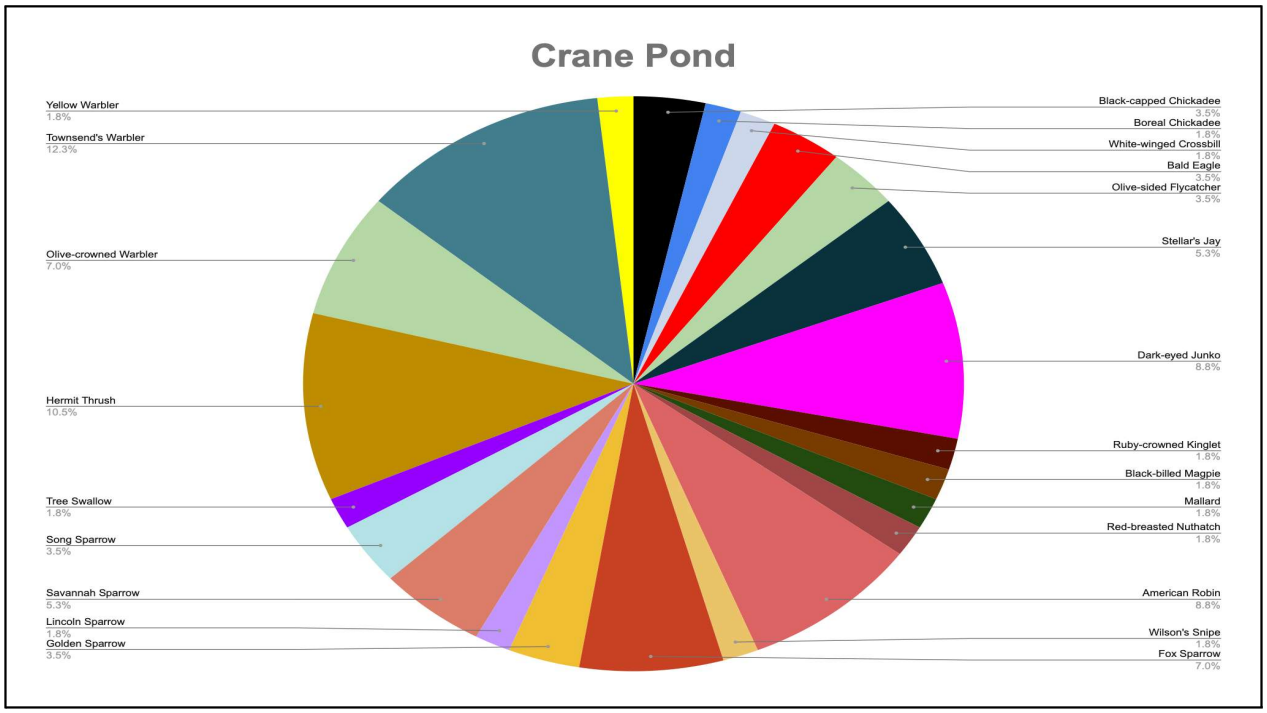


Figure 17: Number and relative abundance of bird species seen throughout bird surveys at Crane Pond.

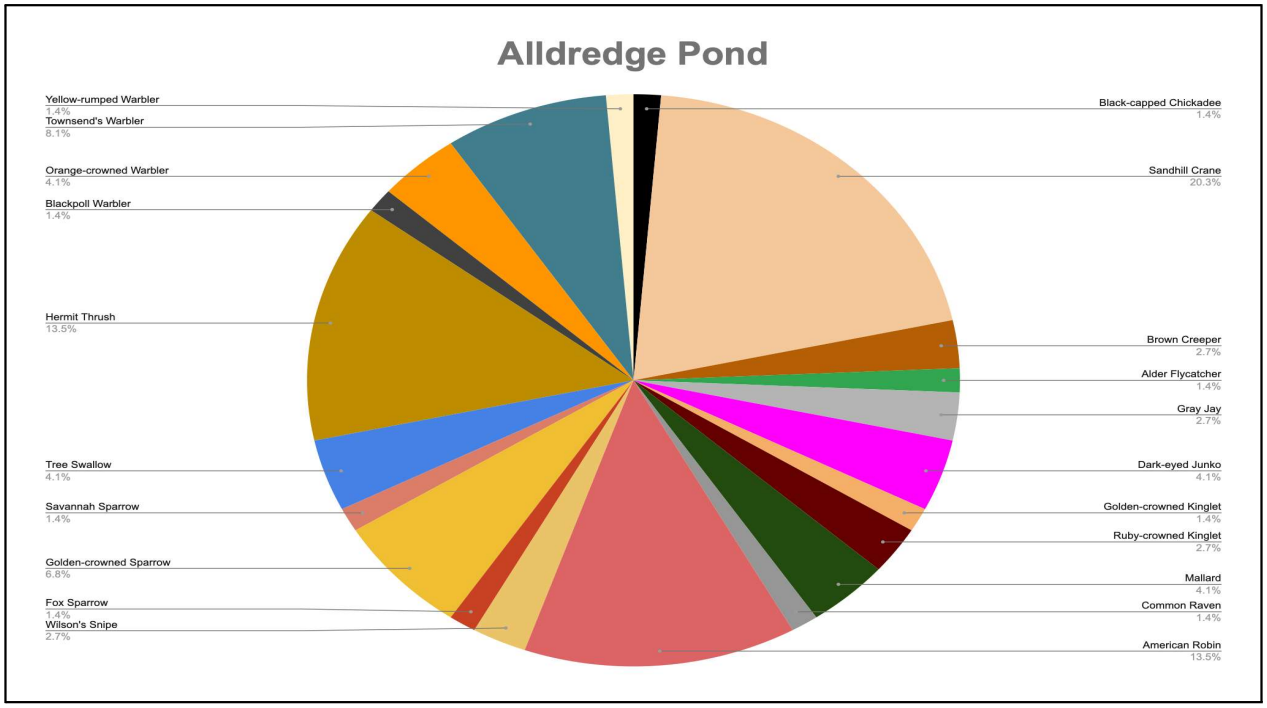


Figure 18: Number and relative abundance of bird species seen throughout bird surveys at Alldredge Pond.

Figure 19: Some Species we observed during bird survey. Left: Steller's Jay (*Cyanocitta stelleri*), Right: Spruce Grouse (*Canachites canadensis*).

After conducting bird surveys, we counted a total number of 390 individual birds and 39 different bird species. The bird species that had the highest number seen were American Robins, Hermit Thrushes, Golden Sparrows, and Townsend's Warblers.

V. Discussion and Recommendations

The results for our data can be interpreted in a variety of ways. We ended up surveying a diversity of birds at the six ponds that were sampled. However, based on results, there isn't consistency in the abundance of species that were seen.

Nevertheless, there is overlap in the types of species that were seen, but this can be due to the ponds being a close proximity to each other, and potentially seeing overlap in the bird species present. Also, there wasn't consistency in the times that we surveyed, based on weather conditions, or the presence of a nearby moose.

We recommend that CACS conducts bird surveys every spring at the IRP, in order to sample the migratory bird species that can be seen. Also, it's important to understand which bird species are present throughout the IRP at different times of the year; therefore, bird surveys should be conducted every season in order to familiarize with what species inhabit the area. When surveys are completed, one should be completed in the morning and one in the afternoon. We believe that surveys should be completed before a group of visitors arrives at the IRP, because human disturbances could potentially lead to changes in the number of birds being observed.

We recommend that all six ponds are surveyed at the IRP, and that results should be recorded for the total number of birds seen and the diversity of the birds present. By completing this, comparisons can be made each year amongst the sites. After conducting the surveys throughout multiple years, this can allow for CACS to determine long-term trends of bird populations in Homer, AK., and how they are changing with other human and environmental impacts over time.

Citizen Science/Public Outreach

I. Introduction

The Center of Alaskan Coastal Studies and the Alaska Maritime National Wildlife Refuge Center Visitor Center (AMNWR) often work together to accomplish many different efforts within the conservation world. CACS has expressed that they want to get the community more involved in songbird conservation, and eventually want to create a citizen science program for children and young adults. With the help of both of these organizations, we were able to create a short (~30 min) program, involving a presentation, hands-on activity, and nest-box walk through for visitors of the AMNWR Visitor Center to participate in.

Lora Haller, Visitor Center manager of AMNWR, was our main point of contact for this project. The first step we took during this process was to plan out what we wanted the community to learn and how we were going to demonstrate that. Lora and Beth decided that it would be best if we created swallow nest boxes to reside on the AMNWR Visitor Center property. Our goals were not only to see if the nest boxes got used by swallows, but also to create a visual for visitors so they could learn how to create their own nest boxes, and maintain them in their own backyards. By informing visitors about ways that they can make their own nest boxes, can help educate the community about the importance of swallows and how we can ensure the future of the species for generations to come.

II. Rationale

CACS has expressed their interest in creating a citizen science program that focuses on Tree Swallows and Violet-Green Swallows. The Alaska Songbird Institute is a big source of inspiration for them and they also have a Swallow Ecology Project that CACS hopes to emulate in the future. Although this project at the AMNWR Visitor Center only lasted a few weeks, it served as a great opportunity to start getting the public involved in swallow conservation, even by taking action in their own backyards. Now with the knowledge gained from this project, the public will have the tools needed to continue the conservational efforts of swallows, and guarantee

III. Study Design

The 2023 UM-SEAS Master's Project Group built and deployed 9 nest boxes on the AMNWR Visitor Center property. Nest boxes were made of untreated cedar. See Figure 4 above for building instructions.

Nest boxes were attached to eight foot tall t-posts. Two boxes were placed near their upper pond that borders the staff parking lot, one box was placed near their storage barn on the edge of museum property, and the remaining six were scattered through their wetland, three on either side of their walking path. See Figure 19 below for a map of nest box placements.

Nest boxes were sampled every 2-3 days, depending on the weather. Sampling occurred from May 29, 2023 through June 19, 2023. Sampling days were adapted from previous UM-SEAS teams working with CACS and The Alaska Songbird Institute stating nest box samples should only occur on fair weather days without strong winds or rain (Armstrong *et al.*, 2022; Alaska Songbird Institute, 2023). To sample nest boxes, a generic borescope was taped to the end of a 10 foot telescoping pole and fed into the entrance of the nest box. The borescope connected to the sampler's phone via bluetooth and displayed a live video feed onto their screen. All results were recorded in Rite-in-the-Rain notebooks and later transcribed into The Cornell Lab of Ornithology's mobile application NestWatch.

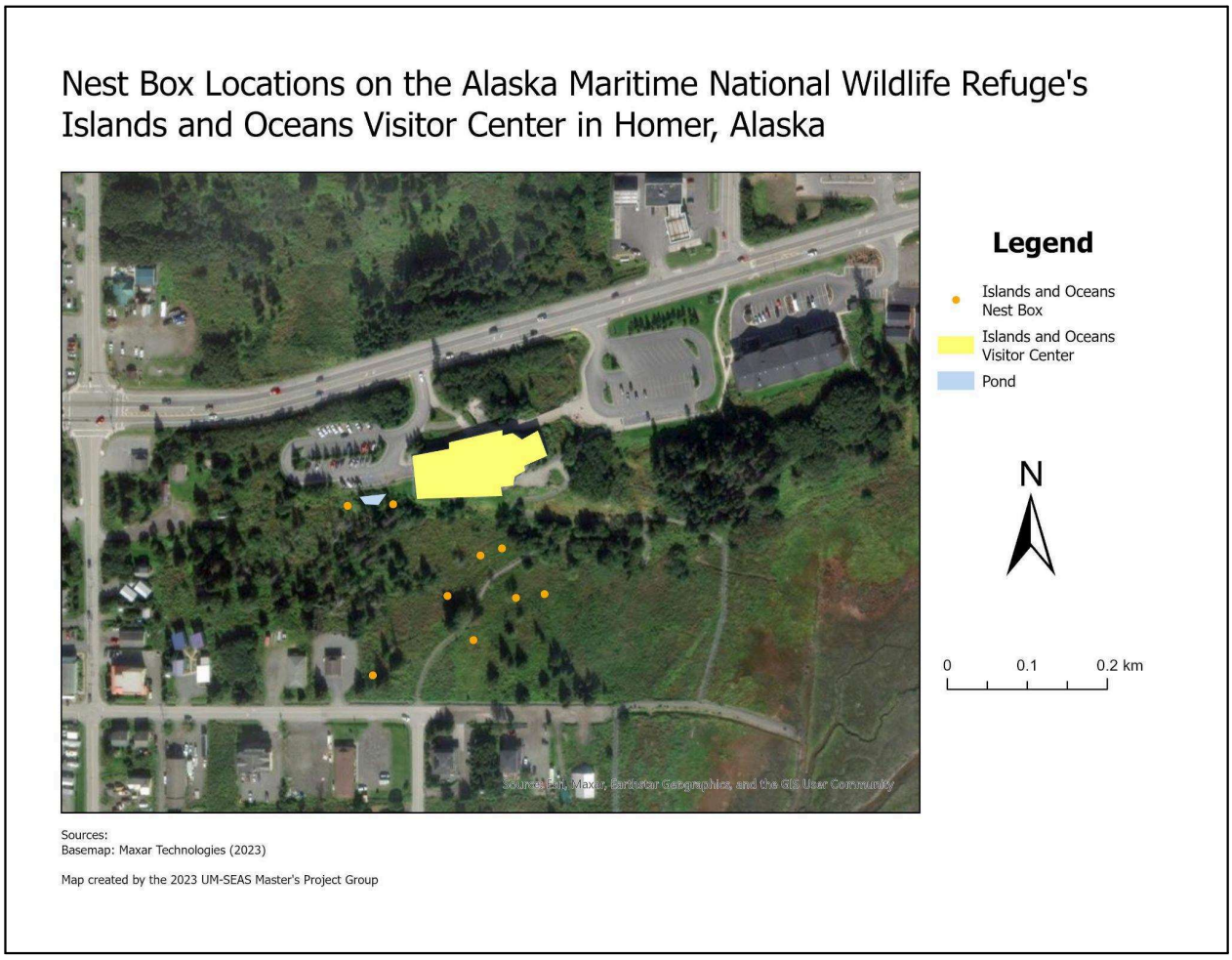


Figure 20: Nest box locations at the AMNWR Visitor Center

IV. Results

The nest boxes that we built at the AMNWR Visitor Center did not result in any success for swallow usage. We consistently checked weeks after placing them throughout the property, and every time we checked there were no signs of swallows present.

Even though no swallows ended up using our nest boxes at the AMNWR Visitor Center, we used this opportunity as a chance to teach the public about the importance of swallows in the ecosystem, and how building nest boxes can help their populations flourish. We presented to museum visitors and staff at the AMNWR Visitor Center on June 8, 2023 about the value of swallows in Homer. The presentation was about 10-15 min long, then was followed by a visual representation outside of the building of how swallows eat flying insects, and then ended with a guiding tour where we would show visitors how to monitor the nest boxes for swallows. The presentations started at every half hour, and we presented through a 3 hour time period. We prepared a powerpoint for the presentation, and for the visual representation, we had a machine that would shoot out bubbles, and we had the children try to catch the bubbles with either their hands spread out or close together. We told the children that by cupping your hands close together to catch the bubbles, it makes it harder to catch a large amount of bubbles, than by having your hands spread out so that you can catch more in less movements. We compared this analogy to how swallows have a small beak, and are able to catch less insects than a bird with a larger beak; therefore, swallows have to put more energy into catching their prey than some other birds.

V. Recommendations

After working with the AMNWR Visitor Center on the nest box project and presentation, we have generated a few recommendations to make the process run more smoothly in the future. The first recommendation that we have is that the nest boxes need to be higher off the ground than the ones that we placed at the AMNWR Visitor Center. We were given poles that were not nearly as tall as the ones that were located at the IRP; therefore, we believe that the nest boxes were too closely located near the ground for swallows to prefer those nesting sites. This mistake should be incorporated into future presentations/projects of CACS or AMNWR, and compared to successful nest boxes that were placed higher off the ground, so that the public can visualize the height they chose when making/placing their own nest boxes in their backyards.

CACS Swallow Ecology Project Manual

The following manual is intended to be used as a standalone source of information for CACS' future Tree Swallow citizen science program. This manual was adapted from the Alaska Songbird Institute's Swallow Ecology Program, and CACS hopes to jumpstart a program of their own in the near future.

CENTER FOR ALASKAN COASTAL STUDIES
SWALLOW ECOLOGY PROJECT MANUAL

Center for Alaskan Coastal Studies
708 Smoky Bay Way
Homer, AK 99603
https://www.akcoastalstudies.org/
1st Edition (2024)
photo credit: Dongchen Lang

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Acknowledgements

Special thanks to Tricia Blake and the Alaska Songbird Institute for allowing us to adapt this manual based on their own swallow ecology project.

Thank you to Lora Haller, Visitor Center Manager, and staff of the Alaska Maritime International Wildlife Refuge. This project would not be the same without their help.

Thank you to the Cornell Lab of Ornithology and *Golondrinas de la Americas* for kick starting the first swallow ecology project. Without their initial research, this project would likely look very different.

Purpose of this Manual

The purpose of this manual is to

1. Provide a guidebook that CACS staff and volunteers can use for nest box monitoring projects;
2. Provide continuity and consistency in data collection;
3. Provide a resource for new staff and volunteers; and
4. Gather educational and scientific information relevant to the project

Project Rationale

Tree Swallows (*Tachycineta bicolor)* and Violet-green Swallows (*Tachycineta thalassina)* are neotropical migratory songbirds that roam throughout North America. Alaska marks the northernmost region where swallows breed, so studying them in this region is ideal for understanding differences in life history in arctic and subarctic regions as well as changing conditions due to climate change and other environmental factors.

Swallows belong to a group of birds known as aerial insectivores—along with swifts, flycatchers, and nightjars—that are currently undergoing significant population decreases. This group, not necessarily closely related but all sharing the use of similar resources in their ecological niche, has seen an estimated loss of 160 million birds, or 32%, since the 1970s.[1] Birds that undertake extensive migratory journeys are especially vulnerable, showing sharper declines compared to those that have shorter migration routes.[2] Several factors contribute to the reduction of these bird populations, including habitat loss due to industrial, agricultural, forestry, and urban developments. Moreover, the extensive use of pesticides, like neonicotinoids, poses a severe threat by reducing the number of insects available for food. These chemicals are notably destructive as they remain in the ecosystem, contaminating plants, groundwater, and soil, while having a high degree of toxicity to birds even at low levels. Climate change and shifts in ecological seasons are also responsible, disrupting the timing of events such as vegetation bloom, insect emergence, and migration, leading to a mismatch between the birds and their food sources.

History

The installation and observation of Tree Swallow nesting boxes at the Creamer's Field Migratory Waterfowl Refuge began in 1994. Five years later, in 1999, the Alaska Bird Observatory started a comprehensive project focusing on the breeding and survival of Tree

Swallows in the high latitude environments. This initiative seamlessly integrated research and educational opportunities from its inception, allowing students and researchers to work side by side. The first year saw monitoring of 12 nests, and eventually, the project expanded to include partnerships with the University of Alaska, Fairbanks, and the Wild Rose Farm just outside of Fairbanks. Formal youth mentorship programs were introduced in 2007, with a structured high school internship program kicking off in 2012. However, the project's development often hinged on student engagement and the capacity of the organization, which led to irregular and sometimes incomplete data collection in the early stages.

When the Alaska Bird Observatory shut down in 2012, the Alaska Songbird Institute took over the monitoring of the Tree Swallow sites at Creamer's Field and the University of Alaska, Fairbanks in 2013. They began a more disciplined approach to data collection that involved capturing and banding breeding adult swallows, adopting standardized data collection protocols in line with *Golondrinas de las Americas* (http://golondrinas.cornell.edu/), and establishing a consolidated database for the sites in Fairbanks while also preserving historical data. That year, the Alaska Department of Fish & Game installed boxes for Violet-green Swallows at the Creamer's Field site, although these weren't used and were later modified between 2018 and 2019.

In 2016, the Alaska Songbird Institute spearheaded the establishment of the Alaska Swallow Monitoring Network. This comprehensive, joint venture aimed at harmonizing field methods and compiling data was designed to assess the impact of widespread ecological changes on the population of aerial insectivores across Alaska (https://aksongbird.org/alaska-swallow-monitoring-network). Various communities across the state, including Fairbanks, Ester, and Juneau, among others, participated in this initiative.

Currently, the Alaska Songbird Institute collaborates with 15 to 20 students through its youth mentoring and high school internship programs to oversee approximately 150 nesting boxes at Creamer's Field and the University of Alaska, Fairbanks. They follow the nesting process from its inception to the fledging of the birds. The breeding adults are caught and banded in the earlier stages of nesting, and the young are banded when they are about 11 days old. The information gathered contributes to a growing body of data on key population dynamics and nesting timelines under varying environmental conditions, while simultaneously serving as a valuable scientific educational tool for young people and teenagers.

With this in mind, CACS hopes to recreate swallow ecology projects just like these. There is a strong need for programs like this in the Homer community and with this manual, CACS can start to create their own programs based on this manual and inspiration from the Alaska Songbird Institute.

Objectives

- To create an extensive dataset documenting key events like laying, hatching, and fledging dates, as well as occupancy, success rates, and productivity of *Tachycineta* swallows, particularly Tree Swallows, in Interior Alaska.
- To track crucial life history traits that could drive local Tree Swallow population declines, including the size of clutches, number of reproductive tries, survival and return ratios, and the rates of hatching, fledgling, and juvenile recruitment.
- To investigate the loyalty of swallows to their nesting sites and partners by banding breeding adults and their offspring.
- To observe environmental indicators tied to bird habitat quality and susceptibility to climate shifts, for instance, the availability of aerial insects near nesting areas throughout the breeding period.
- To contribute findings to broader-scale research projects and collaborative scientific endeavors.
- To offer local students and families immersive and impactful exposure to scientific research within their own community.
- To facilitate conservation-oriented volunteering and educational opportunities, predominantly targeting young people and teenagers.
- To enhance public understanding and awareness regarding the lives and conservation of aerial insectivores in Interior Alaska.

Annual Research Priorities

The following tasks are ranked by their significance so CACS can start to gain a long-term dataset:

1. **Document the use of nesting boxes and measure breeding outcomes at each location**. Calculate percent occupancy by dividing the number of nests with activity by the total number of boxes provided. Determine nesting success by the ratio of nests that successfully produced at least one fledgling to the total number of nests where eggs were laid.

2. **Keep a detailed timeline of nesting events.** For every nest in use, note the dates when eggs are laid, chicks hatch, and fledglings leave the nest. Refer to the detailed protocols for more information.

3. **Ensure all breeding females are captured for banding, and, where possible, also band the males.** For specific instructions, consult the provided protocols.

4. **Place bands on all chicks in the nest.** The protocols offer in-depth guidance on this process.

5. **Band all adult birds involved in breeding activities.** Protocol documents will provide further details on this procedure.

6. **Monitor** the levels of flying insects in the vicinity of the nesting areas to gauge possible shifts in food supply during the breeding season.

Age in days from left to right:
0; 6; 10; and 20 (with an adult
on top of the pole)
Photo credit: Alaska Songbird Institute

Educational Philosophy

CACS' own Swallow Ecology Project presents a distinctive chance for children, teenagers, and members of the community to partake in authentic scientific exploration. This initiative is structured so that learning and working happen collaboratively among individuals of various educational levels, including younger students, teenagers, college students, and professional scientists. Participants are immersed in the hands-on tasks associated with field biology, going beyond mere observation to direct involvement. As they move through the program, many students advance to internship positions at the high

school and college levels. While the program predominantly serves younger demographics, adult volunteers within the community can also contribute to the upkeep of the site, monitoring of nests, banding, and mentoring roles.

The information we gather is vital to the preservation of bird species, but just as imperative is our role in fostering a connection between individuals, particularly young people and teenagers, with wild birds and their natural environments. We aim to enhance their comprehension of the changing state of our planet and the importance of research in the service of environmental stewardship. Employing such community-centered educational tactics proves significantly effective as it allows the broader environmental challenges more relatable and manageable, which can be particularly impactful in the realm of science and ecological education.[4]

Youth Mentor Program: This program is meant to serve 10-15 students in the 10-16 age range. This program is focused on the individual level and responsibilities vary depending on maturity level. Youth are expected to dedicate a minimum of four hours per week for the entire breeding season, though many often contribute more time. Volunteers are responsible for keeping personal field notebooks and typically do not interact with the nests or birds without guidance. Through this experience, they are gaining skills in documenting their observations and collecting data. While most of the students will get the opportunity to handle both mature birds and chicks, the decision to allow this rests with the group leader. The safety of the birds is the highest priority, so leaders must assess each student's overall behavior, maturity, and dedication before permitting them to handle the wildlife.

High School Internship Program: This program is meant to serve ~5 students in the 14-18 age range. Interns are required to contribute at least 85 hours per season and may be eligible for a stipend of approximately $500 upon fulfilling their internship obligations. It is the interns' responsibility to coordinate with the project leader to establish and adhere to a work schedule. They also set personal objectives for their learning experience and work towards achieving them. Interns are tasked with keeping detailed field journals and undergo extensive training in uniform data collection methods and the handling of wild birds. With proper training, some high school interns may progress to monitoring nests on their own, and they often acquire fundamental skills in banding both adult birds and chicks. However, banding should always be conducted under the supervision of an experienced bander. Interns additionally support the project by assisting with data entry and verification. Those who return for subsequent internships may have the chance to undertake individual research or educational initiatives. There is much more opportunity for leadership development within this specific program.

Scheduling for interns is maintained with Google Calendar and project leads post field times for students to sign up for based on their own availability.

Golondrinas de las Americas:

Golondrinas de las Americas was a collaborative group of scientists spanning from Alaska to Argentina focused on conducting research on swallows belonging to the *Tachycineta* genus. This project ran from 2007-2012 and was led by Dr. David Winkler at Cornell University. It is important to acknowledge the origins of this project because it lays the foundation for swallow ecology projects just like this one. This project established standard protocols that we and many other organizations use today.

This project follows protocols established by the *Golondrinas* program with a few exceptions:

1) The *Golondrinas* protocols keep track of nest construction and inventory the feathers found in nests throughout the breeding season. However, the sites in Homer serve as transit points for large numbers of Sandhill Cranes and a variety of waterfowl, leading to a substantial excess of feathers for nest building. Consequently, our studies have traditionally excluded these particular nest measurements due to their abundance.

2) The data sheets we use for banding adult birds incorporate additional metrics such as the length of the wing and assessments of feather molt and wear. This is done to ensure alignment with longstanding data records and to maintain consistency with other projects under the Avian Science Initiative (ASI).

3) Positioned at the very northern edge of the Tree Swallow's habitat range, our swallows are typically larger and experience a more condensed breeding timeline. Additionally, our nestlings grow more rapidly than those in more temperate regions. As a result, we've modified our protocols over time to accommodate these regional distinctions. For instance, we band chicks on their twelfth day, and to avoid the risk of causing early fledging, we usually refrain from disturbing them after banding. The data we collect on the nestlings also encompass a range of additional physical measurements, which have been slightly altered throughout the course of our research.

4) The most notable distinction in our data collection practices involves fat scoring. To streamline our processes and ensure compatibility with other data sets, we have adopted the fat scoring system used by the Alaska Bird Observatory, which is a straightforward scale from 0 to 7 that estimates overall body fat. In contrast, the *Golondrinas* protocol evaluates fat at nine separate body points using four distinct scales, and these methods are detailed comprehensively in the *Golondrinas* handbook, still accessible on their website.

Tree Swallow Ecology and Life History[5]

Migration: tree swallows are neotropical migrants that breed across North America and migrate to the southern parts of the U.S., Mexico, and Central America for the winter season. They can typically be spotted in open areas and the borders of woodlands, often in proximity to bodies of water.

Diet/Foraging Behavior: Tree Swallows primarily feed on flying insects. Their diet includes mosquitoes, numerous species of true flies from the Diptera group, dragonflies and damselflies from the Odonata order, mayflies from the Ephemeroptera category, and caddisflies belonging to the Trichoptera group. Observations in Alaska have shown that these swallows consume a diverse array of insects, including moths, bees, and beetles. Compared to other insect-eating birds, Tree Swallows seem to exhibit more dietary flexibility, resorting to berries or plant matter when insects are scarce. While they typically hunt at heights over 100 meters, during poor weather conditions, they have been seen foraging closer to the ground in fields, feeding on spiders and land-based insects. Some tree swallows have also been known to consume air-breathing, freshwater snails.



(From left to right)
Juveniles are entirely brown on the top and white below. Sometimes a gape is visible (soft stretchy/yellow tissue at the base of a bird's mouth). **Females** are green-ish blue above and can get as blue as males, but for the first 2 years, females are usually brown with spots of iridescent green/blue, with white on the bottom. **Males** are iridescent blue above and white below.

Nesting Behavior/Breeding Behavior: Tree Swallows nest in cavities and frequently occupy spaces carved out by woodpeckers. They easily adapt to and take advantage of artificial structures and nest boxes created by humans. Their tolerance to human activity makes them perfect subjects for nest box research. Consequently, they are extensively researched across their habitat range. Tree Swallows display a notable loyalty to their nesting sites, and it is a regular occurrence to discover tagged adult birds returning to their previous nesting boxes, or to ones nearby, in the following breeding seasons.

Tree Swallows engage in intricate mating displays in the air. Males may compete for both potential partners and nesting sites. While not typically polygynous, instances where one male mates with multiple females occur. Although it is not the norm, it is also common for us to observe nest boxes with an additional adult bird present. This bird is often a female, or occasionally, an adult whose gender cannot be determined with certainty. It's important to observe these interactions closely and document them thoroughly in your field notebook!

Nests are made from grass stems and are lined with feathers. Feathers are likely used for insulation and the grass stems provide structure. The nest's dimensions and quality are often indicative of the bird's age and nesting experience. The typical number of eggs in a clutch ranges from 4 to 7, though there have been occasions where as many as 9 or as few as 3 have been found. When there is a plentiful supply of food, both the clutch size and the chances of survival for the young increase. The timing of nesting, the number of eggs laid, and the survival rate of the nestlings also coincide with the age and experience of the adult birds. More mature birds usually begin nesting sooner and produce larger clutches compared to their younger counterparts, to increase their chances of having successful offspring.

Both males and females will **incubate**, but females usually do this more often. Incubation can last anywhere from 13-16 days and eggs hatch asynchronously (usually over a 24 hour period). Their young fledge after 16-24 days.

Swallow Project Timeline

April

- When conditions allow, start conducting site surveys.
- Any repairs for nest boxes should be conducted now
- Take note of posts that need to be replaced when the ground thaws
- **Last week of April:** start noting first arrivals
- Violet-green Swallows start arriving as early as April 24th and Tree Swallows arrive around May 1st

May

- **First week of May:** swallows start finding nest boxes to inhabit
- **Second week of May:** nest building begins, note the day that a nest begins and is completed in your field notebook, check nests every three days during nest building
- **Third/Fourth week of May:** many birds still completing nests, keep checking boxes and continue to check them every 3rd day
- follow nest monitoring protocol when females begin laying, first eggs can show up nas early as May 14th
- proceed with caution and reduce amount of disturbance during this period, parents can be prone to abandonment in the early nesting process
- Do not trap birds at this time
- Females tend to sit tight on nests during this period, if a bird does not get off the nest when you open the box, get an experienced staff member to ID the sex and read a band if there is a band present

June

- **Last week of May/First week of June:** should be okay to check only the boxes with active nests, but timing differs year to year so always keep a watchful eye
- if you still notice active nest building, keep checking every box for a few more days until you notice nest building has completely ended
- run a full check of all boxes for new nests during this last week of May and again during the first week of June
- **First/Second week of June:** eggs will start to hatch around this time, so this a very busy time for trapping adults and banding
- calculate expected hatch dates for each nest and check boxes daily at the beginning of day 14, but note that incubation periods can last longer in cold/rainy weather
- hatch dates as early as June 2nd but typically hatch around June 14th
- Make sure to confirm how many eggs hatched
- **Third week of June:** clutches will finish hatching this week.
- It is easiest to catch adults during this time frame, between hatch and nestling day 5

- You will likely see both adults entering the box frequently since this is an intense time for feeding
- Chicks can start to get banded during this period
- This is a short time frame, so chicks need to be banded quickly. In interior Alaska, day 11 is the best time to band chicks.
- ***Do not band chicks past 12 days old without consulting the project lead, never open a box when the chicks are past 14 days old***
- This week is also a good time to check all nest boxes and catch any late nests that may have sprung up
- **Fourth week of June/first week of July:** most clutches will have reached day 11 and chicks should be banded by the end of June
- Fledge checks will start at nestling day 16. Check all boxes using the *Fledge Check Protocol*. Do this carefully since premature fledgling can cause mortality.

July

- **Second week in July:** season is slowing down and most chicks will have fledged at this point. Clean out old nest boxes using the *Nest Clearing Protocol.* Note any anomalies like the presence of snail shells or evidence of unusual food sources. Record any chick fatalities.
- **Third/Fourth Week in July:** almost all nests will have fledged by now. Make sure that all nests are removed from boxes, data is entered and proofed according to the ASI procedures and any repairs that the boxes need are completed.

**It is important to note that although this is a timeline of a typical year, variation can occur due to weather, phenology, human disturbance, etc.*

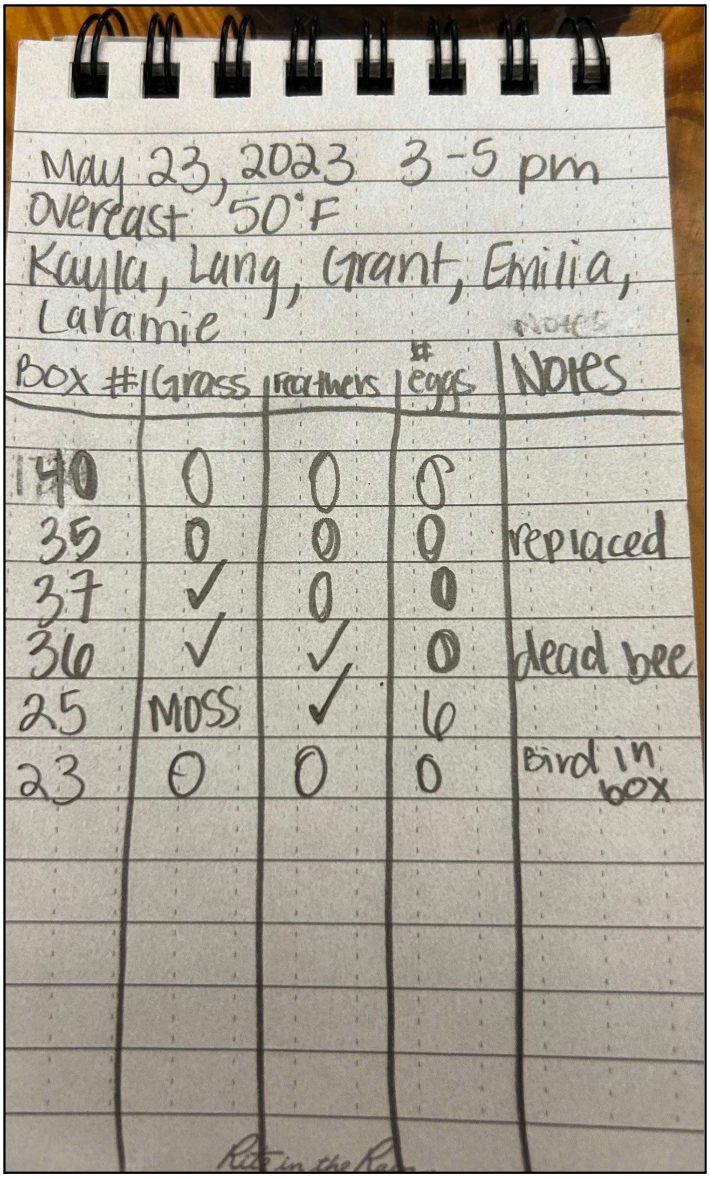
Data Recording and Management

CACS' swallow ecology project stands out as a collaborative approach to research, engaging young people and adolescents not just as participants but also as partners in the crucial tasks of gathering and recording data. While an abundance of volunteers is invaluable, it also demands vigilant oversight to preserve the quality and accuracy of the collected information. Essential components of the project's data management strategy include: (1) field notebooks for on-site observations; (2) individual nest record sheets, adult banding, and nestling banding records, all organized within a site-specific binder for field use; (3) a digital data template for each location, annually updated and accessible on the CACS shared Basecamp drive.

Field Notebooks: All students will be given a field notebook at the beginning of the field season and are highly encouraged to use them throughout the entire season. This is a great opportunity for leadership personnel to teach students how to keep and maintain a field notebook. Please share what to record and show them your notebook so they can see what a good example of one looks like. When students begin to check nest boxes, **at least one person** in each team should have a field notebook to record data. Take this time to teach students how to safely check nest boxes and record data. Make sure you are telling students to record ***only what they observe***, even if it does not make sense or what they expected. It is important that we maintain a safe environment for asking questions and making sure all students feel comfortable asking for help. Students will keep their field notebooks at the end of the season, **but all data should be recorded in staff notebooks and/or on hard copy nest record banding sheets.**

What should be recorded in your field notebook?

- Date, time, weather, and names of everyone in the crew that day should be listed at the top
- During nest building period: record box #, presence/absence of: grass, feathers, and eggs
    - Once there is an egg present, the nest is considered active
- Create a nest record sheet and transfer all data from prior nest checks to the nest record sheet



This is an example (not real data) of what your field notebook should look like. At top of each page, a date, time, weather, and the names of who is with you should be present.

Nest Record Sheets: Every active nest will have a nest record sheet. This is a single record sheet that contains all of the nest checks for each box and summarizes important dates. These sheets should be printed (by hand) on rite-in-rain paper (most field notebooks use this kind of paper) so that weather will not impact data recording. All nest records are kept in a binder for a single site so that they are easily accessible.

Adult and Nestling Banding Sheets: For adult and nestling birds, a distinct set of information is captured, hence the necessity to employ the appropriate banding data sheet for each. The specifics for recording this data are outlined in the banding protocols for

both adult and nestling birds, with all the necessary codes explained directly on the data sheets. To ensure durability, these banding sheets are to be printed on all-weather 'rite-in-the-rain' paper and kept in a binder designated for each specific site. The purpose of these sheets is to facilitate the input and verification of the banding information.

Data Entry and Proofing: at the end of each field season, data is entered and proofed in individual excel spreadsheets. This spreadsheet records individual nest checks, compiles the timeline of each nest, includes and banding data, and has an individual summary tab.

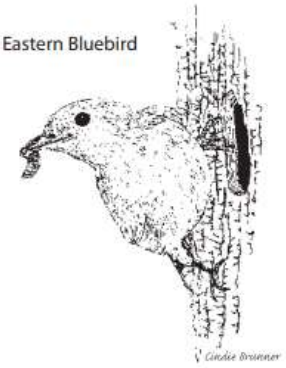
Final notes on data collection: As a staff member it is extremely important to be familiar with the nest box sites. Know where every box is located and make sure you know which boxes are active. Always transfer data you collect in the field to the nest record sheets. This allows you to find inconsistencies in your raw data/observations and allows us to have a copy of the data on the cloud. It is super important to update these data sheets daily since the season is very fast-paced and the window to mark specific benchmarks is narrow.

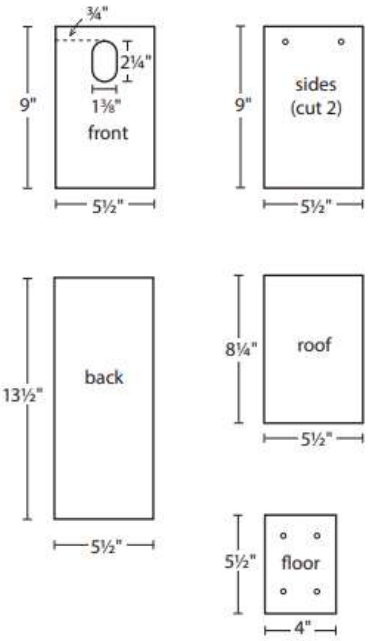
Nest Box

Eastern, Western, and Mountain Bluebirds;
Tree and Violet-green Swallows

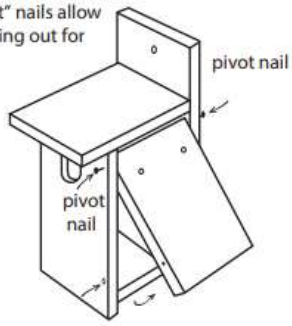
Note: Western Bluebirds need a 1½" diameter round entrance hole and Mountain Bluebirds need a 1 9/16" diameter round entrance hole. Swallows are smaller than bluebirds and will be able to enter holes 1 ⅜" or larger.

Eastern Bluebird



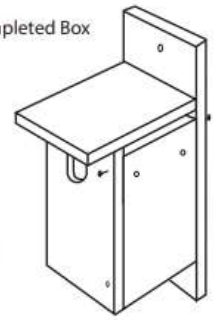


Two "pivot" nails allow side to swing out for cleaning.



Use a nail or screw at bottom to keep side closed.

Completed Box

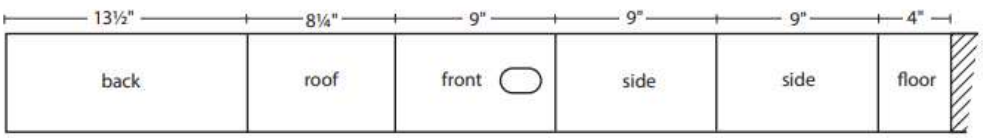


Note: these dimensions are for ¾" thick board. Some cedar boards are ⅝" thick. If so, the floor must be 3¾" wide, not 4".

Increase Your Chances of Nest Box Success!

Information on natural history, habitat, nest box placement, and management for Midwestern birds is available in Woodworking for Wildlife. Order at minnesotasbookstore.com

Lumber: 1" x 6" x 6'



TheCornellLab NestWatch

Report your nesting birds to NestWatch.org

Useful Resources

Cornell University
https://www.allaboutbirds.org
https://blogs.cornell.edu/golondrinas/
https://merlin.allaboutbirds.org/

Tree Swallows
https://www.audubon.org/field-guide/bird/tree-swallow

Purple Martin Mentoring Program
https://www.purplemartin.org/?loc=ON

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[5] Tree Swallow Life History, All About Birds, Cornell Lab of Ornithology. (n.d.). . https://www.allaboutbirds.org/guide/Tree_Swallow/lifehistory.

Tree Swallow Nest Monitoring Protocol

Start by inspecting every box at your location. It's important to carry out this inspection at your earliest opportunity, and to do so **before** any Tree Swallows arrive. By May 1st, make sure all the nest boxes are cleaned of any debris, structurally sound, and waterproof (meaning all openings should shut properly, the lid must be fastened firmly, and the box should not have any leaks). Aim to perform your nest box inspections at a consistent time each day throughout the breeding season. **Log the date on which you observe the first Tree Swallow at each location in your field journal.**

Once the Tree Swallows have made their appearance, commence a survey of every box at each site to check for signs of nest construction. Document when the construction of nests starts and concludes in each box. It's possible for swallows to start building in multiple boxes. A nest is deemed **"active"** when you find the first egg in it. For each active nest, set up a nest record sheet to maintain a log of all the inspections and to summarize data related to timing and banding activities for each nest.

The following are important dates to pay attention to once nests become active.

1) **CLUTCH INITIATION DATE:**Record the date the **first egg is laid**, marking the start of an active nest. Make sure to inspect the active nests at minimum **every three days.** You can do so more frequently, but exercise extreme caution to avoid disturbing the birds, which could lead to nest abandonment. If inspections are less regular or you encounter a clutch that has already begun, use the "one egg per day" guideline to estimate the start-of-egg-laying date, keeping in mind that egg-laying usually occurs in the morning, though not exclusively. This means you can assume a female will be laying one a day.
2) **CLUTCH COMPLETION DATE & INCUBATION DATE:**The date when the final egg appears marks the **completion of the clutch**. Record this date and the clutch size, which is usually between 4-7 eggs. The warming of the eggs date is when the female begins incubation, generally after the second-to-last egg is laid. Project this date as one day prior to the completion of the clutch and record it. **Assume the incubation date is one day before the clutch completion date.** Following the completion of the clutch, reduce the amount of nest inspections until the expected hatch date nears to minimize disturbance during this critical phase. **There's no need for another check for at least 7 days post-incubation.**
3) **PREDICTED AND ACTUAL HATCH DATE:** Tree Swallows usually incubate their eggs for 14-16 days. **Record** the earliest chick emergence date (ex: day 14 of incubation) and document it, considering the warming of the eggs date as **DAY ONE**. From day

14 onwards, inspect the nest daily. Since eggs hatch at varying times, **log the chick emergence date when the first chick hatches**. Return the following day to **confirm and note the total hatched eggs.** Treat the chick emergence date as **DAY 0** in determining chick age, and **age the clutch as a unit** without needing to age each chick individually. Post-hatching, **visit each active nest every 2-3 days up until the nestlings are banded (typically on day 11). Tally and record** the number of nestlings sighted, to monitor any early chick deaths. Refrain from opening nest boxes after **day 12.**

4) **PREDICTED AND ACTUAL FLEDGE DATE**: This is the last important date to record. Starting from day 16, check each active nest to see if the young have begun to leave. Select a comfortable spot to observe from a **distance for at least 10 minutes**. Watch for activity indications like parent birds bringing food or chicks peeking out of the entry. If such activity is seen, you can conclude your watch.

   This means that the young birds have not fledged or left the nest yet. **Plan to visit the nest again tomorrow** to check on their status. Continue this daily routine until a day **comes when you observe no sign of activity for at least 10 minutes.**

   If after a 10-minute observation period there's no activity, **proceed to the nest with caution and listen for any sounds**. If you can hear the chicks inside, they haven't left the nest yet. In this case, you should **return the next day** to assess their status.

   If there's neither sight nor sound of activity after a 10-minute watch and a careful listening at the nest, gently approach the nest. Block the entrance, then slowly and minimally open the door to look inside with speed and care. If you find the nest empty, **mark down the current day as the departure day. If they're still present, shut the door** without disturbing them, keep the entrance covered for a short while longer, remove your hand gently, and leave quietly. Check again the following day.

   Avoid nearing the nest if you can see the nestlings at the entrance, as this could spur an untimely departure. Young swallows that leave the nest too soon may struggle with flight and can easily fall prey to predators, which greatly diminishes their chances of survival. If the nestlings are visible, you may either keep observing from a safe distance to witness their actual departure, or come back later to confirm if they have departed.

Adult Capture & Banding Protocol

Before heading out to the field, verify that you have all the appropriate banding equipment and authorized permits. **Tree Swallows usually fit into size 1 bands while Violet-green swallows may require either size 0 or size 1**. Use a leg gauge as needed to select the proper band size. Along with an assortment of bands, **make sure you also have** clean bird bags, banding pliers, tools for band removal, a wing ruler, leg gauge, calipers, a weighing scale, spare batteries, a weigh cup, data sheets, and materials for trapping (details below). Additional helpful items may include binoculars, a tarp, and a camera.

It's essential to be well-informed about the schedule for each nest in your study zone and arrange your trapping and banding activities accordingly. Females can typically be trapped and banded securely during the later stages of incubation (from day 8 onwards) up until around 5 days post-hatching. Males, on the other hand, are most readily caught shortly after the chicks hatch, during their most active feeding period. If your objective is to band both sexes, **it's advisable to do so at the same time.**

Data Collection Priorities: Whenever feasible, attempt to band all mature birds involved in breeding. This yields more valuable insights regarding site fidelity, mate selection, and survival rates over time. When faced with constraints in time or resources, give precedence to banding all females as they are less challenging to trap and can often be caught opportunistically during a wider time frame when inspecting nests. Next in line for priority is the banding of nestlings, which saves time as they do not require the effort of trapping. Consult the Nestling Banding Protocol for further guidance on banding young birds. Comprehensive data collection should cover females, nestlings, and males.

Banding Adult Female Tree Swallows: In interior Alaska, adult female Tree Swallows are particularly amenable to being trapped inside the nest box during late incubation (from day 8 onward) and just after the chicks hatch. It's advisable **not to trap** the females during the early stages of incubation or while they are laying eggs, as they might abandon the nest if they experience too much disturbance during these times. **However, from day 8 of incubation, females tend to remain on the nest more reliably, and you can usually trap them** by approaching the box from behind, covering the entrance, and gently taking them out through the side door. Be careful when you handle the females as they can often clutch onto nesting material, eggs, or even the young! If you also intend to band the males, the best approach is to trap and band both sexes at the same time, soon after hatching has occurred.

Banding Adult Male Tree Swallows: Male Tree Swallows are skittish and considerably more challenging to trap. Be ready and recognize that if you fail to capture a male, he will likely become even warier for future attempts. We've seen the greatest success in trapping males **shortly after their chicks have hatched,** up to roughly day 5 when feeding is most frequent and both parents are entering the nest box often. As the chicks grow, males start to come into the box less frequently, and may stop entering entirely as the young birds are capable of reaching up to the entrance to get food.

To catch a male, watch for when he goes into the nest box or replaces the female while she feeds. Trapping one adult—usually the female—first is an effective strategy. You can hold this bird in a bird bag for a maximum of 25 minutes, and it's common for the other parent to enter the nest box during this period.

Sometimes, we trap birds that display ambiguous plumage or lack clear sex traits, which may not belong to the main nesting pair but are still associated with a nest box. In such instances, it's acceptable to categorize the bird's sex as ***'U' for unknown*** *if you are not sure.*

Trapping: You can silently approach the nest box from the rear, cover the entrance, and carefully reach inside to secure the bird. However, employing a trap door can be much more effective. There are diverse designs of these trap doors, but they generally operate by the bird or researcher triggering the door to close as soon as the bird enters the box. Despite this, some birds may attempt, and occasionally succeed, in quickly escaping. It's imperative to collect the bird promptly. The Alaska Songbird Institute has had success using a simple method where they place a piece of cardboard weighted with a coin on the inner top of the box, taping it there and holding it open with a blade of grass. The bird dislodges the grass upon entering, causing the cardboard to drop and seal the box. It's crucial to retrieve each trap from every nest box post-trapping. Labeling the traps with numbers is advised to ensure you can account for all of them at the end of the banding operations.

Bird Safety: Select a shaded spot not far from the nest box as your workstation. Lay down a tarp to prevent tools and bands from getting lost in the vegetation. **It's important to avoid processing birds under harsh conditions like intense heat, direct sunlight, or cold rain**. Make a note of the time you capture each bird. Under favorable weather conditions, it's typically safe to keep adult birds for up to 25 minutes, making sure not to exceed 30 minutes. Due to their need for regular feedings and inability to maintain their body heat independently, young chicks must be reunited with their parents swiftly. ***Therefore, refrain from capturing adult birds in periods of cold or wet weather***.

Data Collection: The Adult Banding Sheet includes detailed descriptions of various scales and codes used. During the mating season, the gender of Tree Swallows can be identified by the presence of a brood patch or a cloacal protuberance. Females display plumage with considerable brown coloring on their back and bodies, indicating they are in their second year **(SY).** However, caution is advised, as some mature females may also exhibit brown feathers on the forehead, face, and under the wings. Unless the female has extensive brown, she should be classified as **After Hatch Year (AHY)**, since some SY females may also possess the blue/green feathers typical of older birds. Because male plumage doesn't provide reliable age information, they are generally categorized as AHY in the field observations.

Wing Chord & Flat Wing: When measuring the wing chord, hold the wing to mimic its natural position as much as possible, making sure that the primary feathers are aligned naturally. The flat wing measurement is taken by pressing down on the covert feathers with your thumb to flatten the wing against a ruler, compensating for the wing's natural curve. This results in a measurement approximately 2% longer than the wing chord and is valuable for comparison with comprehensive international data.

Culmen Measurement (from nares to tip): Use calipers to measure the distance from the anterior (distal) end of the nostril to the tip of the bill.

Signs of Stress: Ensuring the birds' welfare is of utmost importance, and should always be the first priority. Looking for signs of distress during bird handling and banding is crucial, and any signs of discomfort should be promptly attended to. Preventative measures are highly effective. As banding often occurs on warm summer days with limited shade, it's essential to protect the birds from direct sunlight, shading them using your own body as cover. Conversely, during colder temperatures, it's advisable to reduce the duration that birds are held. **Avoid capturing or banding birds in rainy or other harsh weather conditions.** Birds kept in bags should always be cradled in someone's hand rather than placed on the ground or on a tarp. Be on the lookout for the following distress indicators:

1) Closing eyes
2) Panting or gaping
3) Limpness
4) Fluffing up feathers

Upon noticing any of these symptoms, promptly reposition the bird to an upright stance (if it isn't already), and allow it to rest from the banding process. Move the bird back into the bird bag and ensure it stays cool if the weather is hot. Usually, birds will recuperate quickly.

Remember, it's always better to err on the side of caution and release the bird rather than risk its well-being by continued handling.

Nestling Banding Protocol

Research on the growth patterns of Tree Swallow nestlings across locations and over successive years is conducted by measuring and banding them. This research also examines their overall health, site preference, and survival rates. Nestlings are identified as "locals" **(L)**. *Consistency in measurements and banding is best maintained by having the same person—either a bander or a volunteer—handle all nestlings in a single nest when feasible.*

Optimal Banding Period: Typically, the period for banding Tree Swallow nestlings is from day 9 to day 12 post-hatching, with the hatch day counted as day 0. For the Alaska Songbird Institute, day 11 is optimal, and efforts should be made to band on this day. CACS may discover after a few years that a different day is more optimal than day 11, but that is yet to be determined. Nevertheless, growth rates can fluctuate, particularly in years of scarce food resources, which may occur due to inclement weather. **When the primary feathers break sheath and the legs lengthen and become scaly, it's time to band the nestling**. It's important to note that banding too soon may injure the bird's leg and impede growth, while banding too late increases the risk of nestlings leaving the nest too early.

Additional Considerations: The growth pace of nestlings can be influenced by various elements such as weather, food abundance, and parasite presence. Also, nestlings from the same nest may not progress uniformly due to factors like asynchronous hatching, resulting in some chicks being smaller or less mature than their siblings. If there's any uncertainty, **it is better to postpone and return to band the lagging chicks after a day or two.** *Above all, the safety and health of the birds take precedence, and delaying the banding of certain chicks from a nest is acceptable if needed for their well-being.*

The maturation of a nestling's feathers is a reliable indicator for determining if it's the appropriate time for banding. In birds, new feathers develop within a protective sheath, known as a "pinfeather" before the vane emerges and the feather unfurls. A nestling that only possesses pinfeathers, with no part of the feather protruding from the sheath, is too immature for banding. **However, if the feathers are beginning to spread or extend approximately a quarter of an inch from the sheath**, the nestling is at the right stage.

Additionally, evaluating leg growth and pigmentation is important to decide if a chick is ready to be banded. As Tree Swallow nestlings age, their legs transform from being short and chubby to longer, thinner, and scaly. It's crucial to wait until the leg bone, or tarsometatarsus, is sufficiently elongated so that the band won't restrict the active growth zones at the ends of the bones, which could hinder growth and circulation. If there's any doubt about the chick's readiness for banding, a **leg gauge** can be used to verify. **All Tree Swallows, both nestlings and adults, should accommodate a size 1 band comfortably**.

Once the primary feather sheath breaks and the legs take on a more slender form, it's time to proceed with banding as soon as possible, usually around day 11. **Tree Swallows develop quickly in the far north, so *Tree Swallow nestlings should not be disturbed after day 12.*** Similar to handling adult birds, be mindful of exposure to direct sun and refrain from banding during cold or wet conditions.

If you are not sure whether a bird is bandable or not, do not attempt to band the bird. Ask your project lead for next steps before any steps are taken. Bands can be difficult to remove, and unbanded, healthy, nestlings are always more important than banded, injured, nestlings.

Handling Chicks: Nestlings are delicate and should be handled with utmost care. Carefully lift each one by supporting the entire body from the bottom, doing so one at a time. Nestlings, like the adults, instinctively grasp onto any surface when they are picked up. Employ the same method to remove them from the nest box as you would with adult birds, ensuring you lift the chick a few inches and clear its feet before fully taking it out of the nest box. Anyone with long fingernails should be extra cautious.

Ensure you transfer nestlings individually, yet house all of the brood together in one bird bag. Count each chick as you place them inside the bag and count again when returning them to the nest to ensure all are accounted for. Keep in mind that nestlings are quite vulnerable to temperature extremes; keep them protected from direct sunlight, wind, and adverse weather conditions.

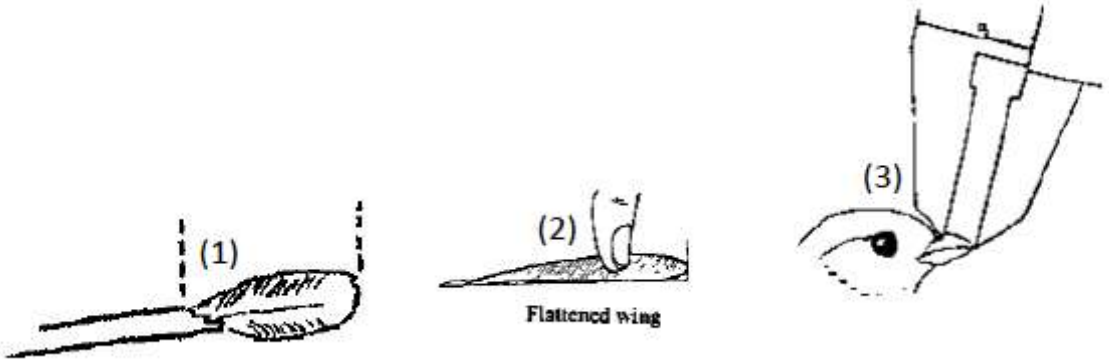
Since nestlings are not at risk of flying away, banders can use a very **gentle touch**. These young birds are not yet capable of flight, but they may wriggle and squirm, which can complicate the processes of measuring and banding. There is no universally preferred way to hold chicks among banders – *find a method that is comfortable for you and safe for the nestlings.* Many banders use the "banders grip" similar to how they would hold an adult: keeping the wings snug against its body, the head secured between the index and middle finger, and the belly facing up in the palm of the hand.

Unlike adult birds, nestling chicks may not show obvious signs of stress during handling. It is **normal for them to keep their eyes closed, appear limp, and be unable to fluff up their feathers.** It's important to be observant of any subtle changes in their movement or breathing. Give them time to rest if there are any indications of stress, no matter how minor. **Gaping, or opening their mouths**, is a clear sign of distress in chicks. Because nestlings are not yet fully feathered, they are particularly vulnerable to temperature and environmental conditions. Ensure they are always shielded from wind and direct sunlight. The presence of humans at the nest box can be very distressing for the parent birds. Therefore, when working near a nest box, position yourself a little away, where you can be shaded from the sun. Keeping the period that chicks are away from their nest box to the absolute minimum is critical. *Aim to conduct your work swiftly, calmly, and efficiently to lessen the impact on both the chicks and their parents.*

Data Collection: Whenever feasible, aim to band all the nestlings from one nest simultaneously, while keeping in mind the critical safety and timing discussed earlier.

The banding procedure for chicks mirrors that of adult birds. Both chicks and adults typically use a size 1 band, which is generally placed on the right leg. Verify the band's fit using a leg gauge to ensure that once closed, it can rotate freely around the leg, similar to how the bands fit the adults. For recording measurements and observations, refer to the details provided on the Chick Banding Sheet.

Longest exposed primary: To measure the longest exposed primary feather, use calipers to measure from the sheath's endpoint (where the feather becomes visible) to the feather's end. (1)
Flat Wing: For the flat wing measurement, the wing is spread flat against a ruler for accuracy. (2)
Measuring the Culmen: Use calipers to measure from the anterior (distal) edge of the nostril to the tip of the bill to accurately determine the culmen length.(3)



(Alaska Songbird Institute)

Returning Chicks to the Nest Box: After handling, nestlings are typically calm when placed back in their nest box. If they seem agitated, indicated by flapping or vocalizing, lightly cover the nest box entrance temporarily until they become tranquil. ***Always count the nestlings when placing them back in the nest box to ensure all are accounted for, and leave the nesting area quietly.***

Nest Box Clearing

Nest Box Maintenance Post-Fledging: Once it's confirmed that all nestlings have left the nest boxes, it's important to clear out the old nests to ready the space for the next breeding season. Document any instances of unhatched eggs, deceased chicks, or signs of irregular food items, parasites, or predation within the nest. Avoid cleaning with any chemical solutions or bleach; simply remove the nest material from the box. Below are the detailed instructions and required materials.

Materials:

- Large-sized brown paper lunch bags
- Permanent marker
- Spatula
- Stapler and staples
- Field notebook and pencil for note-taking
- Optional: Large trash bags, wagons, or garden carts to transport the old nests

Always verify that the nest is **inactive** before initiating clean-out procedures. Boxes with recently fledged young may contain considerable amounts of feces and dust, posing a potential hazard for those with allergies or respiratory issues.

Data for each nest box should be recorded on the lunch bag, field notebook, and then transferred to the Nest Record Sheet.

1) Label each brown paper bag with the current year, the field site's name or identifier, and the specific nest box number.
2) In your field observations, note and record additional details about the nest, such as the quantity of deceased young along with their band numbers if applicable, remaining eggs, and count of snail shells.
3) Carefully remove the entire nest using the spatula and transfer it to your labeled bag. ***Any dead nestlings should not be placed in the bag;*** instead, after it is recorded, *they should be laid on the ground beneath the box or into adjacent vegetation.* ***Note down their band numbers both on the bag and in your field notebook.*** Eggs and snail shells may remain in the bag.
4) Fold and staple the top of the bag to seal it after placing all relevant contents inside.

Note: datasheets for keeping track of nest boxes, banding adults, and banding chicks will be provided for CACS in a separate document.

Life of a Tree Swallow

The very first thing I knew was blank white nothingness and the very first thing I thought is this can't be all there is. Even though I am one second old, there must be more. If this is all there is, I will go mad. If I gave up when there was nothing there would be nothing forever. So I pecked and pecked until the nothingness had a hole in it and then there was everything and I hatched.

My mother is blue and beautiful and warm. Our home is a hole inside an old tree older than anyone we know. It shifts and creeks in the wind, and the branches tap like featherless wings, and my brothers move gently in their eggs. The nest is lined with white feathers, not from my mother or my father, but other birds--junco, seagull, bunting, swan--she tells me one day I will go outside and meet other birds, but for now I am safe, and warm, and all I can do is sleep.

My brothers and I are getting bigger. Our parents are tireless bringing us delicious flying insects to eat, around 8,000 a day, but we are hungry and growing fast. I think eating so many wings has stimulated change in my body. We flutter in our little home, hitting our heads and running into each other and falling into a heap. It's hot in here and crowded, and every breeze that blows in ruffles our feathers and stirs us like leaves.

Late at night the starlight pours in, and the cold breeze, and sometimes more, sometimes claws and fangs flash. Our mother defends us fiercely, beating her wings, and our father screams and swoops from his perch outside, until at least the nightmare retreats and we can all breathe again.

Just like when we were in our eggs, when we cannot stand the cramped nothingness any longer, we look out the hole into the clear blue sky. There is so much more waiting for us. If we are brave, and strong, and persistent.

I am 20 days old when I hop out of the nest and spread my wings fully. My legs are short and awkward but when I fly everything moves perfectly. Our parents chase us playfully, and we race through the air. That is who I want to be, the me who flies and catches her own food and lives in the open air. I will never go back to the nest again.

We flock to wetlands, where mosquitoes and dragonflies buzz, and tall grasses sway, and clean water laps. Wetlands are the source of life. The older swallows say they are getting smaller and disappearing entirely. It worries me. Now that I've left the nest, I never want to go back. I meet other swallows and perfect my bug catching talent. But soon the wind blew colder than I'd ever felt, and the insects began to dwindle, and my wings itch to spread and flap. The older swallows tell me it is time to go south, to explore the world.

We fly over great rivers and forests and mountains, always looking for peaceful wetlands to land in. The air is warmer and more full of insects as we move south. We are in no hurry. At night we circle a group of trees, diving down a few swallows at a time, until we have all landed. We nestle against each other in the branches, with strange birds I've never seen before, and some who are as familiar as lupines.

Sometimes insects are in short supply, as we fly over smoggy cities with roaring cars, sometimes over farms they are bitter and poisonous with pesticide.
When we can't find insects, bayberries make a delicious meal. The bushes live strong and hearty in the sands by the ocean, in backyards and lonely fields, wherever they are planted. Their berries are sweet in the salty air. Other birds love them as well.

One introduces herself to me as a junco, and I recognize her white downy feathers from my nestling days. She migrates as well. We fly together for a while.

We find wetlands after searching and searching. They are getting smaller in the south, as well. We flock and feed in mellow winter, until our hearts begin to crave home. Thinking of the holes and hollows, thinking of my old tree, I want to return to claim a home, and have a nest of my own.

My wings ache to fly and my heart aches for home. I want to see my tree and build a nest. Everyone is feeling the same way. Like a cloud, we rise, flapping and swooping and soaring together, back to Alaska.

My tree is gone.

I do not understand it. It has been cut from the ground. Who could need an entire tree? Why take it from everyone who lived there?

For a long time I am not sure what to do.

And I hear calling. Familiar calling of my brothers.

Humans have taken my tree. But other humans saw them take it. And they wanted to make it right. They left us gifts.

Hollow gourds hang from tall posts in an open field, full of flowers and tall grasses and buzzing insects. It's the perfect place to live. Swallows are swooping, diving, and swarming the gourds. It's crowded and overwhelming and I'm already craving the seclusion of a dark cozy nest.I fly on, looking. Boys have claimed the homes themselves. So I'm looking for a home, but also a mate.

I want to meet someone good to have babies with. Reliable, kind, and a good insect catcher like my father. Brave and warm like my mother.

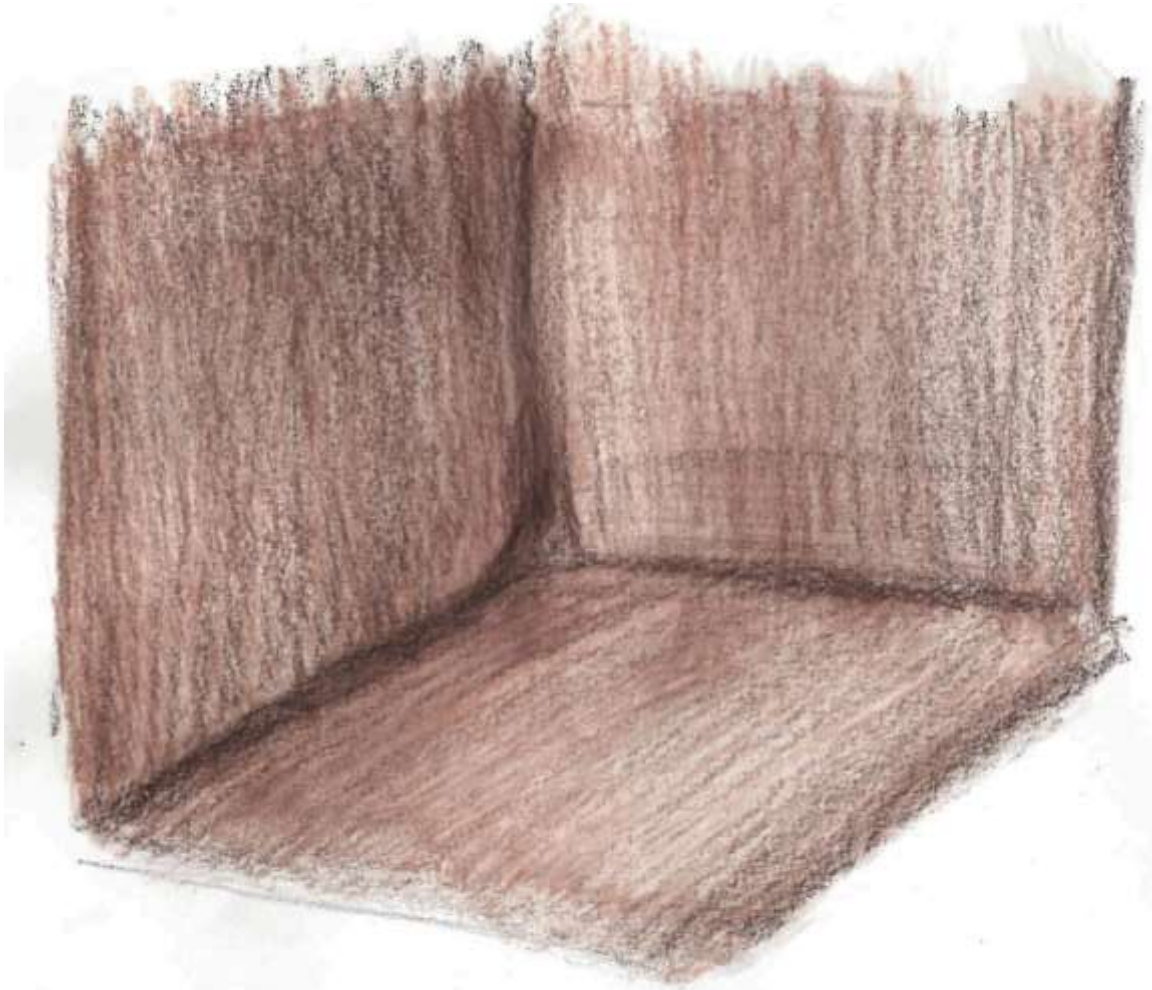
And then someone catches my eye. He is perched on a rectangular box that looks human built.

"Hi!" he says. "I love the way you fly! I found this box and it looks perfect to build a home in."

"It's very square." And very different from my old home.

"I came early from the south to find one just for me," he said. "I wanted to make sure it was the best. I really want to have nestlings. Do you want to take a peek?"

We peer inside...



It is clean.
The floor is large, for a big nest with lots of babies.
The ceilings are high, with room to flutter.
The doorway is small.
No raccoon could poke her snout in.
It smells like wood. Like my old tree.
It is perfect.

"I lost my siblings to a racoon when I was little. So I wanted to make sure I could find a safe nesting place in their honor."

He is kind.

He is thoughtful.

He is warm.

I start to gather soft grasses, to lay the foundations for the nest. And soon I'll look for white feathers, from many different birds, so I can have something to tell my nestlings, a bedtime story.

I'll tell them the story of how there was nothing and then there was everything.

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