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REPORT ON EXPEDITION / PROJECT

Expedition/Project Title:	Scarlet Macaw (<i>Ara macao cyanoptera</i>) Nest-Site Selection and Biodiversity Monitoring in La Moskitia, Honduras
Travel Dates:	June 10th - July 10th
Location:	La Moskitia, Gracias a Dios, Honduras
Group Members:	Lara Piffaretti, Ana Machado Reis, Lily Milligan, Rachael Hattan, Caitlin Jenner
Aims:	To investigate the tree, cavity, and landscape characteristics associated with scarlet macaw nest-site selection in the Caribbean pine forests of La Moskitia, Honduras. To develop practical tropical fieldwork skills, including ecological surveying, biodiversity identification, field data collection, and working safely and effectively in a remote tropical environment.
Photography consent form attached: (<i>please refer to your award letter</i>)	☒ Yes ☐ No

Outcome (a minimum of 500 words):-

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Introduction

Scarlet macaws (*Ara macao*) are among the most recognizable birds of the Neotropics and play an important ecological role as seed dispersers. Although the species is currently classified as Least Concern by the IUCN (BirdLife International, 2022), the Mesoamerican subspecies, *Ara macao cyanoptera*, has experienced substantial population declines associated with habitat loss, forest degradation, and poaching for the illegal wildlife trade (Wiedenfeld, 1994; Joyner & Portillo-Reyes, 2018; Portillo-Reyes, 2015). In Honduras, La Moskitia contains the country's largest remaining population, making the region particularly important for long-term conservation and ecological research.

Scarlet macaws are long-lived birds that depend on suitable nesting cavities, often in large mature trees. Females typically lay two to four eggs, although successful fledging of multiple chicks is uncommon. Across much of their range, nesting has been documented in large tropical hardwood species including *Schizolobium parahyba*, *Ceiba pentandra*, and *Caryocar costaricense* (Guittar et al., 2009; Renton et al., 2015). In contrast, scarlet macaws in La Moskitia use mature Caribbean pine (*Pinus caribaea* var. *hondurensis*) forests as well as mixed tropical forests (Portillo-Reyes, 2015; Joyner & Portillo-Reyes, 2018). These pine ecosystems are rarely represented in published research on scarlet macaw nesting ecology, creating an important gap in understanding whether nest-site characteristics differ between habitats.

Scarlet macaws are secondary cavity-nesting birds, meaning they depend on pre-existing cavities rather than excavating their own nest sites. This makes the availability and characteristics of suitable cavities an important component of their breeding ecology. A review of parrot resource requirements found that parrots generally select cavities in large trees, often high above the ground, with cavity dimensions that correspond to their body size (Renton *et al.*, 2015). Research on scarlet macaws in southeastern Peru similarly found that the species used a relatively broad range of cavity resources, although cavity availability and competition with other large macaws influenced patterns of cavity use (Renton & Brightsmith, 2009). More broadly, tree cavities are considered an important structural resource for forest biodiversity, with their availability influenced by tree size, decay processes, forest structure, and environmental conditions (Remm & Löhms, 2011; van der Hoek et al., 2017). Consequently, characteristics of both the tree and the cavity may influence where scarlet macaws are able to establish nests.

Previous studies demonstrate that scarlet macaw nesting characteristics can vary considerably between populations and habitats. In Costa Rica, scarlet macaws used cavities in at least 14 tree species, with *Caryocar costaricense*, *Schizolobium parahyba*, and *Ceiba pentandra* among the most frequently used nesting trees (Guittar *et al.*, 2009). In the Maya Biosphere Reserve of Guatemala and the Chiquibul Forest of Belize, most nests were also associated with tall, emergent trees, and many cavities appeared

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to form following branch breakage and subsequent decay (Britt *et al.*, 2014). Studies in Peru have further shown that both natural and artificial cavities can support scarlet macaw reproduction, highlighting the importance of suitable nesting cavities where natural resources are limited (Olah *et al.*, 2014). These findings suggest that nest-site selection cannot necessarily be generalized across the species' range and that understanding the specific tree and cavity characteristics used within different ecosystems is important for conservation. This is particularly relevant in La Moskitia, where *A. m. cyanoptera* uses mature Caribbean pine forests, a habitat that has received substantially less attention in the published literature than the tropical hardwood forests in which scarlet macaw nesting has more commonly been studied.

During summer 2026, we undertook a four-week volunteer internship with the Wildlife Conservation Society (WCS) Honduras-Nicaragua program at the Mavita field station in La Moskitia. Working alongside WCS biologists and local field technicians, we contributed to scarlet macaw nest monitoring, camera-trap surveys, biodiversity observations, and an independent research project examining nest-site selection.

The primary aim of the research project was to identify structural and environmental characteristics associated with scarlet macaw nest-tree selection in Caribbean pine forest. We predicted that nest trees would differ from available non-nest trees in characteristics such as trunk diameter, canopy cover, tree condition, and cavity availability. We also investigated whether proximity to roads, water sources, or communities was associated with nest-tree selection. A Random Forest machine-learning analysis will be conducted as part of the subsequent manuscript preparation to assess which variables are most useful for predicting nest-tree status.

Study Area and Fieldwork



Figure 1. The field conditions in the pine tree landscape of La Moskitia. The widely spaced trees are found with an open grassy understory, meaning nest sites are generally accessible via foot and vehicles.

Fieldwork was conducted around Mavita in La Moskitia, Honduras, within the Río Plátano Biosphere Reserve region. The study area consists of extensive Caribbean pine forest interspersed with mixed tropical vegetation and areas affected by human activity. The remoteness of the field site meant that sampling often required travel by vehicle and walking through dense or uneven terrain.

The fieldwork took place over 12 days using 14 non-linear transects. Scarlet macaw nests were often located high above the ground, and many cavities could not be directly accessed. Consequently, nest status and cavity characteristics were assessed from the ground using direct observations, visible cavity features, macaw activity, feathers and claw marks, and information from local field guides familiar with the nesting sites.

Experimental Tree Selection

A total of 292 trees were sampled:

- 101 nest trees (N), identified from WCS's existing records of scarlet macaw nesting trees.
- 100 adjacent non-nest trees (A), selected as the nearest suitable unoccupied pine to each nest tree.
- 91 in-between non-nest trees (W), selected along transects at approximately 3-minute intervals when travelling by vehicle or 10-minute intervals when travelling on foot.

The adjacent and in-between trees were combined for analysis, producing 101 nest trees and 191 non-nest controls.

A minimum trunk circumference of 150 cm was used to determine whether a tree was sufficiently mature for inclusion, corresponding to a DBH of approximately 47.75 cm. This threshold was selected specifically for the Caribbean pine ecosystem. Larger thresholds used in some studies of scarlet macaws in tropical hardwood forests could have excluded many mature pines within the study area, including known nest trees.

The combination of adjacent and more spatially separated controls was intended to provide two forms of comparison. Adjacent trees allowed comparison between a nest tree and a nearby tree experiencing broadly similar local conditions, while in-between trees provided a less directly associated sample of available pine trees within the wider study area.

One exception occurred on June 17, when two nest trees, 17N10 and 17N11, were sufficiently close together that the same adjacent tree, 17A12, was suitable as a control for both.

Quantitative Data Collection

A standardized set of structural and environmental measurements was collected for each tree.

Tree Location and Landscape Variables

Tree locations were recorded using What3Words, which provides a location estimate of approximately three metres. These locations were converted into geographic coordinates and imported into QGIS. Distances from each tree to the nearest road, water source, and community were then calculated to investigate whether human accessibility or landscape position was associated with nest-tree selection.

Tree Structure

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DBH was measured at 1.37 m above ground using a measuring tape. Tree height and cavity height were estimated using the Arboreal Tree app. Canopy cover was measured using the %Cover app from the approximate level at which a cavity was detected, with the phone sensor held at an angle of approximately 80 degrees. An example of how canopy cover was calculated is presented in figure 2.



Figure 2. Canopy Cover Example Derivation. An example of an upward view of a tree's canopy photo, which was used to calculate percentage cover of the canopy. The image was uploaded to the %Cover canopy app to quantify the area occupied by leaves and branches, using a standardized detection level of 80.

For trees containing cavities, we recorded:

- number of visible cavities
- cavity height
- cavity dimensions
- cavity orientation
- cavity position on the tree
- whether the cavity was located in the main trunk, a broken top, or both.

Cavity dimensions were estimated using single-image photogrammetry, with an example of our process shown in figure 3. A person approximately 165 cm tall was included within the image as a scale reference, with photographs taken from approximately 20 m where possible. Images were subsequently analyzed using GIMP. Cavity orientation was recorded using OS Locate.



Figure 3. A summary of the methodology for measuring cavity dimensions. A photo was taken of the entire tree with an individual from the team next to it, using no zoom on camera. The known height of the person was used to create a scale, thus allowing cavity dimension to be estimated.

Qualitative Data Collection

Tree condition was classified as healthy, declining, or dead, coded as 0, 1, and 2 respectively. Human disturbance was also recorded, including visible carving, painting, machete marks, attempted felling, or successful felling.

Nest occupancy was determined using a combination of direct observations and indirect evidence. This included observations of scarlet macaws entering or leaving cavities, feathers, claw marks, other signs of occupation, and confirmation from local guides familiar with the nesting trees and their reproductive history.

Biodiversity observations were recorded throughout fieldwork using Merlin Bird ID and iNaturalist. These observations provided an additional record of the species encountered in the study area beyond the focal scarlet macaw research.

Statistical Analysis

Data was analyzed using Python 3 in Noteable. Descriptive statistics were calculated for the measured variables, including means and standard deviations. Data distributions were assessed using histograms, Q-Q plots, and Shapiro-Wilk tests.

Nest trees were compared against the combined non-nest sample. Independent t-tests were used for approximately normally distributed continuous variables, while Mann-Whitney U tests were used

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where assumptions of normality were not met. Categorical variables were assessed using contingency-table tests. Pearson or Spearman correlation coefficients were used to examine relationships between continuous variables.

The analysis also considered relationships between tree and cavity characteristics. For example, tree height and cavity height were examined to determine whether taller trees simply provided higher cavities.

Results

Across the 12 field days and 14 transects, 101 nest trees, 100 adjacent trees, and 91 in-between trees were sampled. After combining the two non-nest groups, the analysis contained 101 nest trees and 191 non-nest trees.

Several structural characteristics differed significantly between nest and non-nest trees.

Variable	Nest trees	Non-nest trees	P-value
DBH	74.05 cm	66.60 cm	3.54×10^{-5}
Tree height	24.75 m	24.45 m	0.59
Canopy cover	24.06%	30.52%	6.34×10^{-12}
Number of cavities	2.37	0.09	7.41×10^{-31}
Cavity height	19.15 m	17.04 m	0.33
Cavity dimension	69.56 cm	55.55 cm	0.53

Nest trees had significantly larger DBH than non-nest trees. Nest trees also had substantially lower canopy cover, averaging 24.06% compared with 30.52% in non-nest trees.

The number of cavities showed the largest difference between groups. Nest trees contained an average of 2.37 cavities, compared with only 0.09 cavities in non-nest trees.

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Tree conditions also differed strongly between groups. Fourteen percent of nest trees were dead compared with 6% of non-nest trees, while only 28% of nest trees were classified as healthy compared with 70% of non-nest trees. This difference was highly significant (χ^2 , $p = 9.56 \times 10^{-12}$).

Tree height itself did not significantly differ between nest and non-nest trees. Similarly, cavity height and cavity dimensions were not significantly different between groups. However, tree height and cavity height were strongly correlated ($R = 0.77$), indicating that cavity height was partly associated with the overall height of the tree. Cavity height and cavity dimension also showed a moderate positive relationship ($R = 0.53$).

Cavity orientation did not differ significantly between nest and non-nest trees, as demonstrated in figure 4. The cosine and sine components of orientation produced p-values of 0.58 and 0.46 respectively.

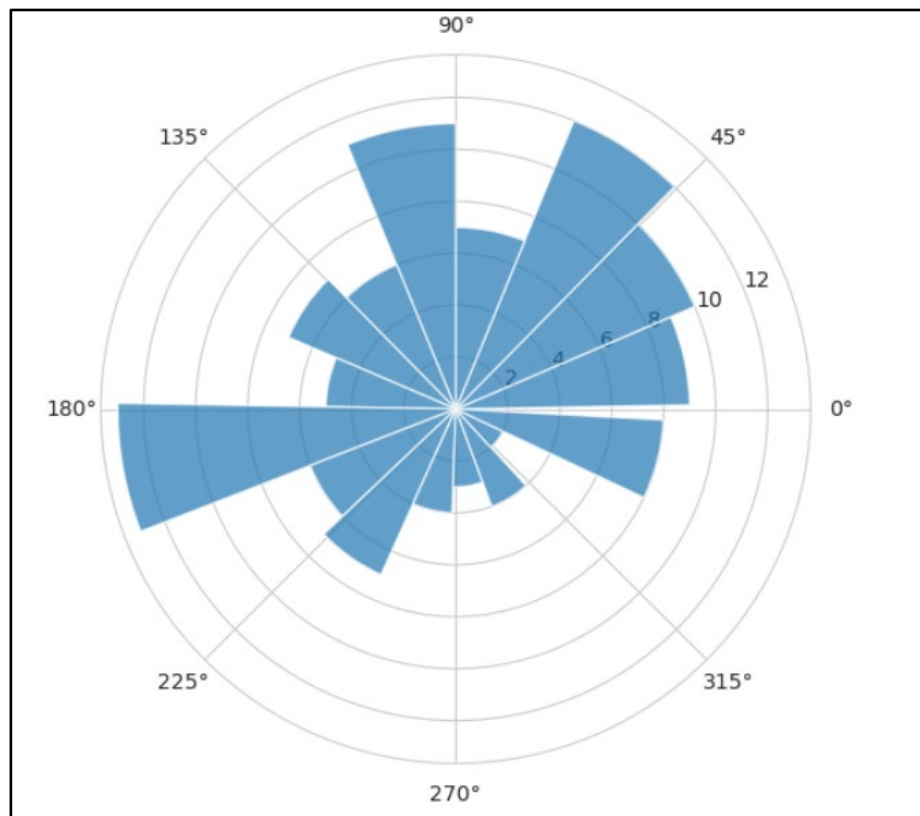


Figure 4. A polar chart representing the distribution of cavity orientations for all sampled trees (nest and non-nest). The angular position of each bar represents the compass orientation of cavity openings (0° = East, 90° = North, 180° = West, and 270° = South), while the bar length indicates the number of cavities within each 22.5° orientation interval (16 bins).

Landscape Variables

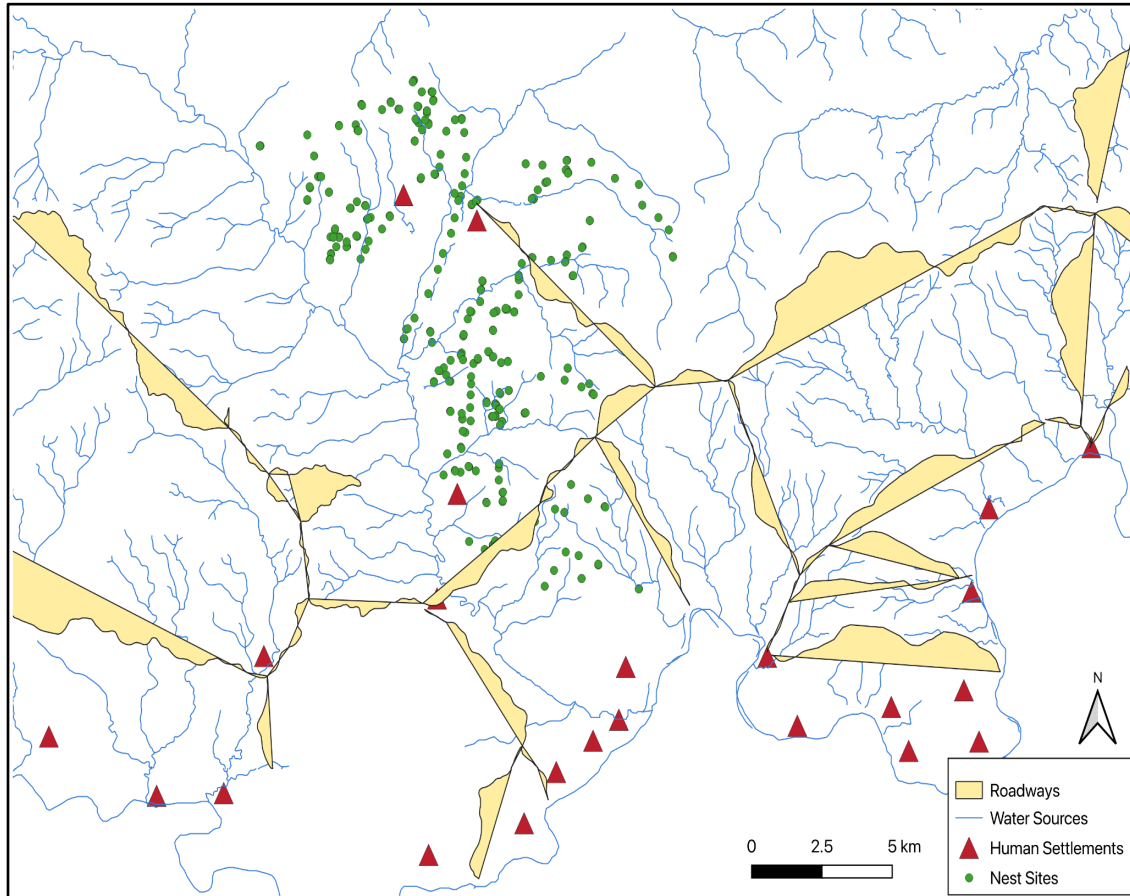


Figure 5. GIS map showing the spatial distribution of surveyed tree sites, human settlements, water sources, and roads in the study area. Tree sites are shown in red, human settlements in green, water sources in blue, and roads in yellow. The map was generated in QGIS using tree-site coordinates collected during fieldwork and spatial datasets provided by WCS. These spatial layers were used to calculate the distances between each tree site and the nearest human settlement, water source, and road for subsequent quantitative analysis.

As figure 5 demonstrates, QGIS analysis did not identify significant differences between nest and non-nest trees in their distance from roads, water sources, or communities.

Distance to roads had a mean of approximately 0.05 ± 0.03 km in both groups ($U = 11,497$, $p = 0.361$). Distance to water was also not significant ($U = 10,667$, $p = 0.853$), as was distance to communities (approximately 0.03 ± 0.01 km in both groups; $U = 10,335$, $p = 0.532$).

These results suggest that, within the sampled area, the measured landscape-scale variables were less useful for distinguishing nest trees than the structural characteristics of the trees themselves. However, the absence of a significant relationship does not demonstrate that human accessibility or landscape context has no effect on nesting. The study measured distance to broad landscape features rather than all aspects of human disturbance or habitat configuration.

Discussion

The results appear to indicate that scarlet macaw nest-tree selection in the sampled Caribbean pine forests of La Moskitia is particularly associated with tree structure and cavity availability.

Our findings are consistent with previous research showing that scarlet macaw nest-site selection is closely associated with the availability and characteristics of suitable nesting cavities. Scarlet macaws are obligate secondary cavity nesters and rely on existing hollows for reproduction, meaning that the availability of suitable cavities can influence where breeding occurs (Renton & Brightsmith, 2009; Olah et al., 2014). In southeastern Peru, scarlet macaws used a relatively broad range of cavity resources, suggesting flexibility in the types of cavities they can occupy, while still depending on suitable tree structures for nesting (Renton & Brightsmith, 2009). Similarly, research in Costa Rica found that scarlet macaws used cavities across 14 tree species, with several trees containing multiple nests, demonstrating that suitable nesting resources can occur across a range of tree characteristics and forest conditions (Guittar et al., 2009). In our study, however, the substantially greater number of cavities in nest trees compared with non-nest trees suggests that cavity availability may be particularly important within the Caribbean pine forests of La Moskitia. This supports the interpretation that nest-site selection may depend not simply on the presence of a mature tree, but on whether that tree has developed sufficient suitable cavity resources (Remm & Löhms, 2011; van der Hoek et al., 2017).

The association we observed between nest trees and declining or dead tree condition also has parallels in previous scarlet macaw research. In Guatemala and Belize, Britt *et al.* (2014) documented scarlet macaw nests in both living and dead trees and identified characteristics of the surrounding tree canopy as important to nest survival. Similarly, Vaughan *et al.* (2003) documented the use of both natural and artificial cavities by scarlet macaws in Costa Rica, emphasizing the importance of maintaining suitable cavity resources for breeding populations. The presence of multiple cavities within our nest trees, together with the higher proportion of dead and declining trees among nest sites, may therefore reflect the development of suitable nesting hollows through tree ageing and structural damage (Gutzat & Dormann, 2018; Remm & Löhms, 2011). This does not necessarily mean that scarlet macaws actively select dead trees because they are dead. Instead, tree decline may increase the likelihood that suitable cavities have formed. This distinction is important for conservation in La Moskitia, where removing dead or declining Caribbean pines could unintentionally reduce both current nesting opportunities and

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the supply of future cavities. Our results therefore support maintaining mature and structurally complex pine trees, including suitable declining and dead trees, within scarlet macaw habitat.

Tree Size and Condition

Nest trees had significantly larger DBH than non-nest trees, supporting the prediction that scarlet macaws preferentially use larger, mature trees. Larger trunks provide greater structural volume in which cavities can develop and may also be more capable of supporting large cavities without compromising tree stability (Remm & Löhms, 2011).

This is consistent with the ecological requirements of a large-bodied cavity-nesting species. However, DBH should not be interpreted as a direct causal mechanism. Measurements in the field could be affected by uneven ground, buttressing, trunk deformities, or difficulty maintaining an exact measurement height.

Tree condition also showed a strong association with nest use. Nest trees were less likely to be healthy and more likely to be dead or declining than non-nest trees. This is particularly relevant because cavities often form through decay, broken branches, disease, and structural damage. A dead or declining tree may therefore provide a greater number of potential nesting cavities than a healthy tree.

This finding has important conservation implications. Dead and declining trees can sometimes be viewed as low-value or hazardous vegetation and may be removed from landscapes. In the study area, however, such trees may provide essential nesting resources. Their conservation should therefore be considered alongside the protection of healthy mature trees.

Canopy Cover

Nest trees had significantly lower canopy cover than non-nest trees. One possible explanation is that more open-canopy trees provide greater visibility around the nest and easier access to cavities. Alternatively, lower canopy cover may be associated with structural ageing, broken branches, and decay, meaning that canopy cover could be acting as an indicator of the same processes that create suitable cavities.

The data do not allow these explanations to be separated. Lower canopy cover should therefore be interpreted as an association rather than evidence that scarlet macaws actively select trees because they have open canopies.

Cavity Availability

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The strongest result in the study was the difference in cavity availability. Nest trees contained an average of 2.37 cavities, whereas non-nest trees contained only 0.09. This supports the interpretation that nest-site selection may depend not simply on the presence of a mature tree, but on whether that tree has developed sufficient suitable cavity resources (Renton & Brightsmith, 2009; Renton et al., 2015; Remm & Lõhmus, 2011).

The cavity-level Random Forest model supported this pattern, with the number of cavities accounting for the greatest proportion of variable importance at 0.509. This suggests that nesting-site selection may operate hierarchically. At the first stage, scarlet macaws may use characteristics such as tree size, condition, and canopy structure to locate suitable mature trees. Once a tree provides cavities, characteristics of those cavities may become more important in determining whether it is used for nesting.

The high performance of the cavity-level model, with an ROC-AUC of 0.985, supports the importance of cavity characteristics in distinguishing nest trees from other cavity-bearing trees. However, Random Forest variable importance measures predictive usefulness rather than biological causation. They therefore indicate which variables helped the model distinguish between groups, not necessarily which variables directly caused nest selection.

Tree Height and Cavity Characteristics

Tree height did not differ significantly between nest and non-nest trees. This suggests that overall tree height alone may be less important than the structural characteristics that develop within a tree.

Although cavity height also did not differ significantly between groups, tree height and cavity height were strongly correlated. This indicates that taller trees generally contained higher cavities, but that cavity height alone did not distinguish nest trees sufficiently within this dataset.

Likewise, cavity dimensions were not significantly different between nest and non-nest trees. This may partly reflect the difficulty of accurately measuring cavities from the ground. It may also indicate that cavity availability and the presence of multiple potential cavities are more informative than one-dimensional cavity size measurements.

Landscape and Human Disturbance

No significant differences were found in distance to roads, water sources, or communities. Visible human disturbance was also relatively uncommon in the sampled trees.

These findings suggest that, at the scale measured during this field season, tree-level characteristics were more strongly associated with nest-tree status than proximity to the measured landscape features.

However, this result should be interpreted cautiously. Distance from a road or community is only one measure of human disturbance and does not capture hunting pressure, selective tree removal, access routes, noise, or other forms of anthropogenic activity.

Conservation Implications

The findings provide several practical considerations for scarlet macaw conservation in La Moskitia.

First, conservation efforts should protect large mature Caribbean pine trees, particularly those showing signs of ageing or decline. Removing dead or declining trees without considering their potential use as cavity resources could reduce available nesting habitat (Gutzat & Dormann, 2018; van der Hoek et al., 2017).

Second, trees containing multiple cavities may be particularly important. The strong relationship between cavity number and nest-tree status suggests that trees with several potential cavities may provide valuable nesting opportunities, even if not every cavity is currently occupied.

Third, maintaining the structural diversity of mature pine forests may be important for retaining future nesting habitat. Since cavity formation is a gradual process, protecting existing cavity-bearing trees alone may not be sufficient. Maintaining older trees that have the potential to develop cavities could help ensure that nesting resources remain available over longer time periods (Remm & Löhms, 2011; van der Hoek et al., 2017).

Use of Technology in Remote Field Research

A further outcome of the project was demonstrating how relatively accessible technologies can support ecological research in remote field environments. Smartphone applications were used for tree-height estimation, canopy-cover measurement, geographic positioning, species identification, and location recording. QGIS was then used to integrate field observations with spatial landscape data.

These approaches made it possible to collect a relatively large and standardized dataset despite limited access to specialist equipment. However, the use of smartphone-based measurements also introduced potential sources of error. Tree-height estimates may be affected by visibility and positioning, canopy-cover estimates can vary with weather and sensor conditions, and cavity dimensions were difficult to measure precisely from the ground.

For future studies, these methods could be supplemented with laser rangefinders, more accurate GPS units, standardized canopy photography, drones, or direct cavity measurements where safe and appropriate.

Future Work and Machine Learning

As a next stage of this project, we will conduct Random Forest machine-learning analyses as part of the preparation of a manuscript for publication in the Edinburgh Student Journal of Science (ESJS). Random Forest is an ensemble learning method that combines predictions from many decision trees, allowing complex, non-linear relationships and interactions between ecological variables to be explored without requiring the assumptions of traditional parametric statistical models. The dataset will be divided into training and testing subsets using stratified sampling to maintain the proportion of nest and non-nest trees in each dataset. Class weighting will be used to account for the greater number of non-nest controls. We plan to initially assess a tree-level model incorporating variables such as DBH, tree height, canopy cover, tree condition, human disturbance, and distance to roads, water sources, and communities. A separate cavity-level model will then be developed using trees in which cavities have been identified, incorporating variables including cavity number, height, dimensions, orientation, and cavity type.

Separating these models will allow us to distinguish characteristics associated with the broader availability or suitability of trees from those associated with the characteristics of cavities within those trees. Model performance will be evaluated using metrics including accuracy, precision, recall, F1 score, confusion matrices, and receiver operating characteristic area under the curve (ROC-AUC). Variable importance measures and SHAP analysis will subsequently be used to determine which predictors contribute most strongly to model classification and to examine how individual variables influence predictions.

These analyses will complement the conventional statistical comparisons presented in this expedition report by allowing multiple ecological variables to be considered simultaneously. The machine-learning results will be interpreted as measures of predictive association rather than evidence of causal mechanisms. The completed analysis will form part of the formal ESJS manuscript and will also provide a reproducible analytical framework that can be expanded with additional WCS nest records and data from future field seasons.

Limitations and Future Research

The study was conducted over only 12 field days and outside the main nesting period, limiting the amount of behavioral information that could be collected. Many cavities were inaccessible, meaning that occupancy often had to be inferred from indirect evidence rather than direct inspection.

Only 101 of approximately 300 known nest trees recorded by WCS in March 2026 were included in the sampling period. A longer field season would allow a greater proportion of known nests to be sampled and would increase the ability to detect variation between sites.

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Future research should therefore extend sampling across multiple nesting seasons and include repeated behavioral observations. Direct confirmation of reproductive activity would strengthen classification of nest occupancy. More detailed measurements of cavity shape, depth, entrance dimensions, internal microclimate, surrounding vegetation, and tree architecture could also help explain why particular cavities are selected.

Further sampling would also allow the Random Forest models developed for the ESJS manuscript to be independently validated and tested on newly identified nest trees.

Overall Project Outcome

The Davis Expedition Fund made it possible for five University of Edinburgh students to carry out hands-on ecological research in one of the most remote parts of Honduras, working alongside WCS biologists and local community monitors throughout the project. Being able to collect data directly in the field, rather than relying only on existing records, gave us the opportunity to investigate scarlet macaw nesting ecology in a habitat that has received relatively little scientific attention.

Over the course of the project, we collected standardized data from 292 pine trees, including 101 known nest trees and 191 non-nest controls. Our results showed fairly clear differences between nest and non-nest trees in DBH, canopy cover, tree condition, and cavity availability. The number of cavities was especially important, suggesting that the availability of suitable nesting resources may be an important part of nest-site selection in these pine forests. The project also gave us a better understanding of scarlet macaw nesting ecology in La Moskitia and provided a dataset that can be built on through future field seasons. We were able to combine relatively simple field methods and smartphone-based tools with GIS and statistical analysis to investigate an ecological question in a challenging field environment, while also establishing a dataset that can support the planned machine-learning analysis for the subsequent ESJS manuscript. While these methods have limitations, particularly when measuring trees and cavities from the ground, they allowed us to collect a substantial amount of standardized information during a short field season.

Perhaps most importantly, the findings highlight the value of retaining mature, declining, dead, and cavity-bearing Caribbean pine trees within scarlet macaw habitat. These trees may provide important nesting opportunities now, as well as cavities that could become suitable in the future. The results therefore give WCS a useful baseline for further monitoring and raise several questions that could be explored with longer-term research, particularly during the nesting season.

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For us as students, the expedition was also an opportunity to develop practical research skills that would have been difficult to gain in a classroom alone. We gained experience in field data collection, wildlife identification, GPS and GIS, habitat assessment, statistical analysis, and scientific research, while also learning how to work effectively in a remote field environment alongside conservation professionals and local community members. The dataset and experience we brought back from La Moskitia have given us a much stronger foundation for continuing to work in wildlife research and conservation.

References

- BirdLife International. (2022). *Ara macao*. The IUCN Red List of Threatened Species 2022: e.T22685563A163778999. <https://doi.org/10.2305/IUCN.UK.2022-2.RLTS.T22685563A163778999>
- Britt, C. R., García-Anleu, R., & Desmond, M. J. (2014). Nest survival of a long-lived psittacid: Scarlet Macaws (*Ara macao cyanoptera*) in the Maya Biosphere Reserve of Guatemala and Chiquibul Forest of Belize. *The Condor*, 116(2), 265–276. <https://doi.org/10.1650/CONDOR-12-141-R1.1>
- Guittar, J. L., Dear, F., & Vaughan, C. (2009). Scarlet Macaw (*Ara macao*, Psittaciformes: Psittacidae) nest characteristics in the Osa Peninsula Conservation Area (ACOSA), Costa Rica. *Revista de Biología Tropical*, 57(1–2), 387–393. <https://doi.org/10.15517/rbt.v57i1-2.11344>
- Gutzat, F., & Dormann, C. F. (2018). Decaying trees improve nesting opportunities for cavity-nesting birds in temperate and boreal forests: A meta-analysis and implications for retention forestry. *Ecology and Evolution*, 8(16), 8616–8626. <https://doi.org/10.1002/ece3.4245>
- Joyner, L., & Portillo-Reyes, H. O. (2018). Seven years of parrot conservation in La Moskitia, Honduras. *Journal of Avian Medicine and Surgery*, 32(2), 144–151. <https://doi.org/10.1647/2017-301>
- Olah, G., Vigo, G., Heinsohn, R., & Brightsmith, D. J. (2014). Nest site selection and efficacy of artificial nests for breeding success of Scarlet Macaws *Ara macao macao* in lowland Peru. *Journal for Nature Conservation*, 22(2), 176–185. <https://doi.org/10.1016/j.jnc.2013.11.003>
- Portillo-Reyes, H. O. (2015). Distribución potencial y estado de conservación de la Guara Roja (*Ara macao cyanoptera* Linnaeus 1758) en la Moskitia Hondureña. *Zeledonia*, 19(2), 54–63. <https://dialnet.unirioja.es/servlet/articulo?codigo=7516666>
- Remm, J., & Löhmus, A. (2011). Tree cavities in forests: The broad distribution pattern of a keystone structure for biodiversity. *Forest Ecology and Management*, 262(4), 579–585. <https://doi.org/10.1016/j.foreco.2011.04.028>
- Renton, K., & Brightsmith, D. J. (2009). Cavity use and reproductive success of nesting macaws in lowland forest of southeast Peru. *Journal of Field Ornithology*, 80(1), 1–8. <https://doi.org/10.1111/j.1557-9263.2009.00198.x>

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Renton, K., Salinas-Melgoza, A., de Labra-Hernández, M. Á., & de la Parra-Martínez, S. M. (2015). Resource requirements of parrots: Nest site selectivity and dietary plasticity of Psittaciformes. *Journal of Ornithology*, 156, 73–90. <https://doi.org/10.1007/s10336-015-1255-9>

van der Hoek, Y., Gaona, G. V., & Martin, K. (2017). The diversity, distribution and conservation status of the tree-cavity-nesting birds of the world. *Diversity and Distributions*, 23(10), 1120–1131. <https://doi.org/10.1111/ddi.12601>

Vaughan, C., Nemeth, N., & Marineros, L. (2003). Ecology and management of natural and artificial Scarlet Macaw (*Ara macao*) nest cavities in Costa Rica. *Ornitología Neotropical*, 14(3). https://digitalcommons.usf.edu/ornitologia_neotropical/vol14/iss3/9/

Wiedenfeld, D. A. (1994). A new subspecies of Scarlet Macaw and its status and conservation. *Ornitología Neotropical*, 5(2), 99–104. https://digitalcommons.usf.edu/ornitologia_neotropical/vol5/iss2/4/