Achieving greater impact at the North Carolina Coastal Federation through Unmanned Aerial Systems (UAS)

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Executive Summary

Environmental NGOs have a significant opportunity to enhance their work by leveraging drone technology. Identifying specific areas where programming and advocacy can be significantly improved by using enhanced imagery, monitoring and data collection is the first step toward integrating drone use. NGOs that choose to embark on drone-based projects can make the most effective use of time and resources by implementing the program in the most effective way possible.

The paper establishes a three-step action plan that will help environmental NGOs move toward implementing drone use. The three steps are as follows: (1) execute a pilot project, (2) establish foundation for program decision-making, (3) create a program plan. To establish the most appropriate structure to be utilized in the planning phase for the NCCF, I utilized a strategic framework, based on the classic “Build, Borrow, Buy” framework, and a customized cost model.

I. Introduction

Environmental non-governmental organizations (NGOs) must collect immense amounts of data on a range of critical topics, ranging from breeding habits and coastline change, to achieve their missions. UAS technology, commonly known as drones, offers an opportunity to collect environmental data more frequently and efficiently than traditional aerial methods – at a fraction of the cost. Safety is another primary reason environmental organizations are considering drone use. Aviation accidents are the cause of the greatest mortality among wildlife workers and this number of fatalities could be significantly reduced by conducting flights remotely [1]. Despite these benefits, there is still a great deal of uncertainty within many organizations on how to outline a path toward integrating the use of drones into their work. This paper offer a three-step action plan to assist the North Carolina Coastal Federation (NCCF) in integrating UAS; and utilizes a strategic framework, based on the classic "Build, Borrow, Buy" framework, to recommend the most efficient structure for the organization's drone program.

II. The North Carolina Coastal Federation (NCCF)

The mission of the NCCF is to "empower coastal residents and visitors from all walks of life to protect and restore the water quality and critically important natural habitats of the North Carolina coast." The organization was founded in 1982 when eight grassroots groups concerned with coastal issues joined forces under the current executive director, Todd Miller. Its main areas of focus are protecting and restoring the NC coast through advocacy, education, and habitat restoration and preservation [2]. NCCF has been successful in preserving more than 10,000 acres of threatened coastal land over its lifetime, while also remaining active in improving water quality and waste water discharge through advocacy. In 2015 alone, the group restored 1,025 acres of habitat and 17 oyster reefs [3].

III. The North River Farms Wetland Restoration

The NCCF's North River Farms project is a 6,000-acre wetland restoration in eastern Carteret County. It is one of the organization's signature projects. The goal of wetland restoration is to re-develop the area in a manner that provides the environmental benefits of a wetland system in the most efficient way possible. With respect to North River farms, the project is intended to improve the water conditions of the downstream estuaries by returning the farmland to its original state: forested, freshwater, and tidal wetlands.

The North River Farm is particularly important to the downstream oyster reefs and is like many other areas in eastern Carolina that hold significance for many species. Miler writes,

> "Much of the land East of Interstate-95 in eastern North Carolina is wet. These wetlands are characterized by bottomland hardwood forests, "swamps on the hill" that the Native Americans called pocosins and brackish and saltwater marshes that fringe 2.1 million acres of coastal estuaries. These wetlands are home an astounding variety of wildlife: black bears, ducks, geese, swans, wading birds, shorebirds, raptors, red-cockaded woodpeckers, river otters, American alligators, red wolves, deer, raccoons, rabbits, snakes and neo-tropical migrating birds. They also support numerous species of plants – many that are considered endangered or threatened – and extremely productive marine fisheries that depend upon a delicate balance of fresh and salt water [4]."

This importance to biodiversity is one of the factors that has made the project a marquee restoration for North Carolina.

Wetland restorations require a great deal of care in planning and implementation. "Poor site selection, inappropriate designs and inefficient implementation will result in restorations that

are much too expensive and fall short of achieving target ecosystem services, whether the restoration/creation project is required for compensatory mitigation or a volunteer effort [5].” Within the North Rivers Farms project, the use of UAS could have made a critical difference in the efficiency of the project since it would have allowed the NCCF to conduct mapping, data collection, and monitoring more frequently and at a lower cost.

The North River Farms project began in 1999. The restoration was completed in several phases, as shown in Figure 1 [6], and each of the phases held potential UAS applications.

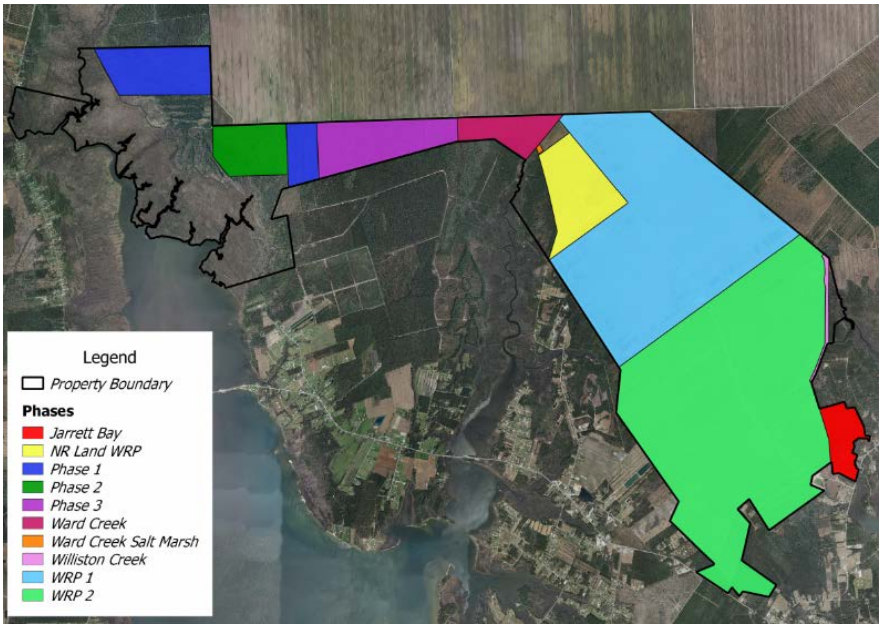

Figure 1: Overhead view of the North River Wetlands Preserve

North River Phase I (NR I): The NCCF partnered with N.C. State University and experimented with several restoration techniques, such as field contours. At the time of this phase, UAS use outside of military applications was in its infancy. However, potential applications for drones include monitoring and data collection.

North River Phase II (NR II): This restoration included restored 111 acres. The techniques included shallow water depressions and planted more than 200,000 wetland plants. The primary

potential UAS implications within this phase were mapping, data collection and monitoring. This phase also offered an opportunity for secondary applications, such as aerial planting techniques.

North River Phase III (NR III): During this phase, the NCCF converted 206 acres to forested wetlands and shallow water waterfowl and shorebird habitat. Outside of the monitoring and aerial planting applications within this phase, the NCCF and its partners could have leveraged drones to automate the water sampling procedures during the construction and post-construction monitoring of the shallow water waterfowl and the shorebird habitat.

Ward Creek Phase I (WC I): 116 acres restored. Processes included evacuation of 17 wetland depressions, planted 41,300 wetland trees, and 14,600 marsh plants. Within this phase, the NCCF could have utilized UAS for aerial planting, monitoring, and data collection.

Jarrett Bay Phase I (JB I): 89 acres restored. Techniques included ditch plugs, and two water control structures. Much like the previous phases, UAS would have been a potential tool for conducting the monitoring, data collection and mapping within the project.

IV. Process for identifying the most efficient organizational structure

The “Build, Borrow, Buy” (BBB) framework is a tool traditionally used to assist large organizations in identifying the most appropriate way to achieve growth [7]. The “build” strategy is one in which the company takes internal development approach (e.g., building a new product). Companies employing a “borrow” strategy have decided to seek qualified partners to help achieve growth. The final strategy, “buy”, is one in which companies buy their way into a new market (e.g., via acquisition). Most effective implementations of this framework involve a combination of the three strategic options.

Within the context of this paper, “growth” is defined as an increase in mission-related impact and UAS represents a new option for achieving growth within environmental organizations. Establishing this context offers an easy to follow way of considering several organizational alternatives for integrating the use of drones. When evaluating the integration of drones for the NCCF, I used four hybrid options based on the BBB framework. These options are summarized in Figure 2.

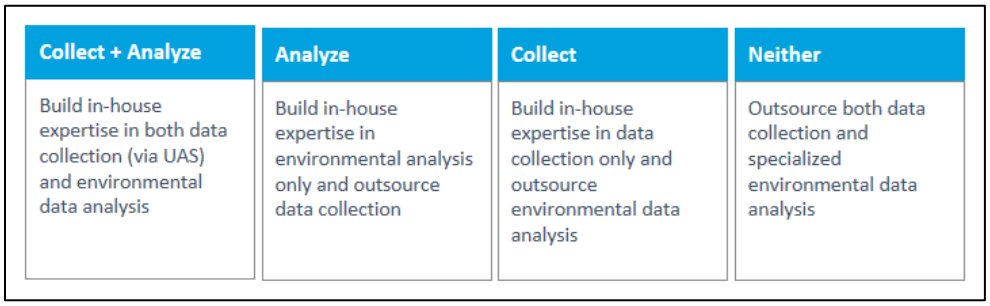

Figure 2: Organizational scenarios considered within project scope

The “Collect + Analyze” option focuses on organizations that use internal resources to build an in-house program. The “Analyze” and “Collect” alternatives represent options in which the organization focuses internal resources on data analysis or UAS-based data collection only. The final option, “Neither” represents a scenario where both the data analysis and UAS flights are outsourced to an outside company. Within the analysis for the NCCF, I compared each of the scenarios by modeling the impact on cost and ease of implementation. This comparison was based on the following inputs: type of UAS platform, type of sensors required, type of data analysis package, number of flights per year, and size of flight area.

V. Recommendations for the NCCF

Step I: Execute a pilot project

Identify a partner to develop a pilot project to further clarify a specific use case for drones. For non-profits such as the NCCF, academic partners are typically the best option due to cost. Duke's Marine Laboratory, for example, works with organizations to help identify specific projects to establish specific use cases for UAS. Some of the most common applications for drones within coastal management are monitoring (e.g. erosion) and planning (e.g. topographical analysis). Select a pilot project that would potentially supplement or replace an existing application. For example, using drones to monitor a recently restored wetland could offer a much faster and easier solution. One common way of identify potential applications for UAS is to first focus on the type of data that is being collected (e.g. thermal imaging, NIR) and think of areas where this type of data is already being use (or could potentially be used) within your work. Then think of the drone as an easier means of capturing this data. Due to current limitations on drone speed and flight time, the suggested size for pilot projects is <1,500 acres.

Step II: Establish foundation for program decision-making

There are four actions that must be taken to establish a foundation for decisions as you build a drone program. The first is to identify an internal champion within the organization. This individual should be willing to stay up-to-date on new technology and understand the organization's work well enough to identify opportunities to employ new technology. The second action is to determine the geographic location of the area in which you intend to collect data. This will have significant implications on the regulatory requirements, partnership opportunities, and total cost of a drone program. The third action is to determine the total acreage

you intend to fly per year and the average size of each survey area. This will impact decisions on the type of drone used and whether you should supplement UAS data with satellite or aircraft imaging. The final action is to identify the type of analysis that is necessary for your application and what data types this will require. This information will drive decisions around platform type (e.g. fixed or rotary wing), payload, and overall project cost. This information is summarized in Figure 3.

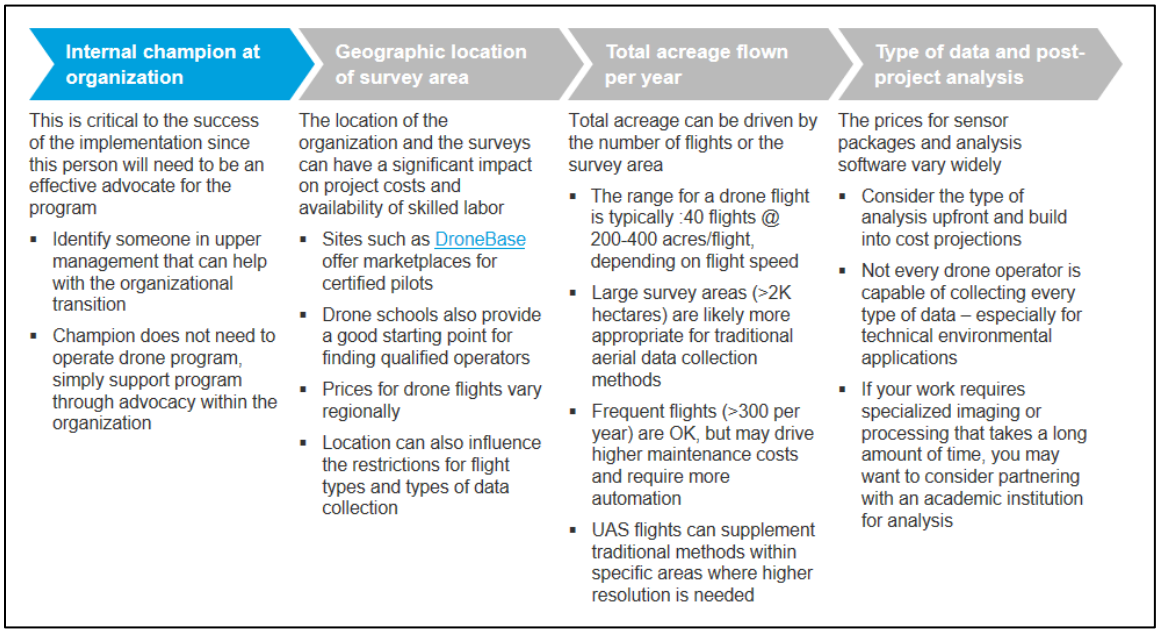

Figure 3: Key drivers to consider when implementing a drone program

Step III: Create a program plan

Environmental organizations such as the NCCF can typically identify enough monitoring, planning, photography and videography application to support between 15 and 30 flights (~5K hectares) per year. As you can see in Figure 4, the most cost effective solution for this number of flights is the "Collect" scenario (i.e. helping an existing employee obtain Section 107 certification and outsourcing in-depth data analysis).

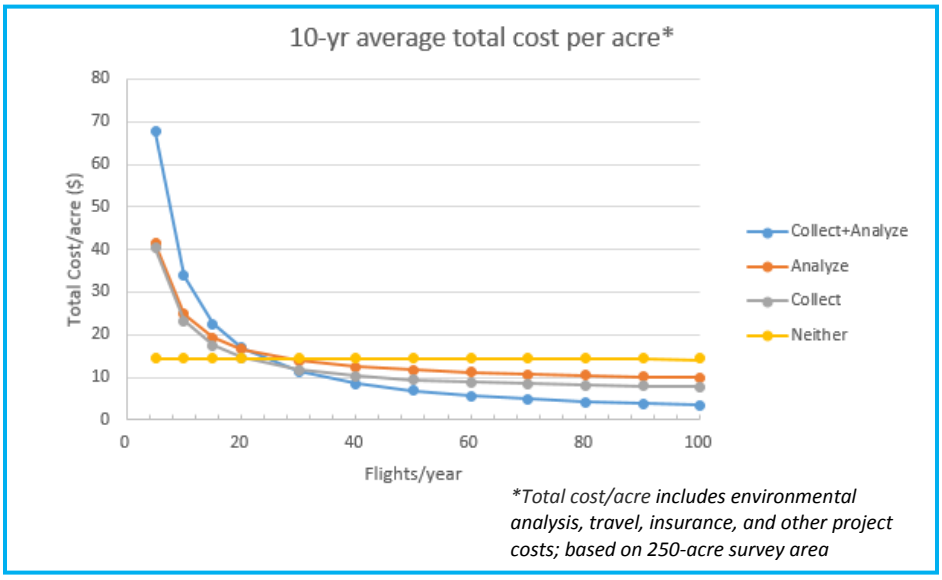

Figure 4: Cost curves for organizational scenarios

My recommendation is to create a plan that includes guidance on each of the eight areas references in Figure 5 below.

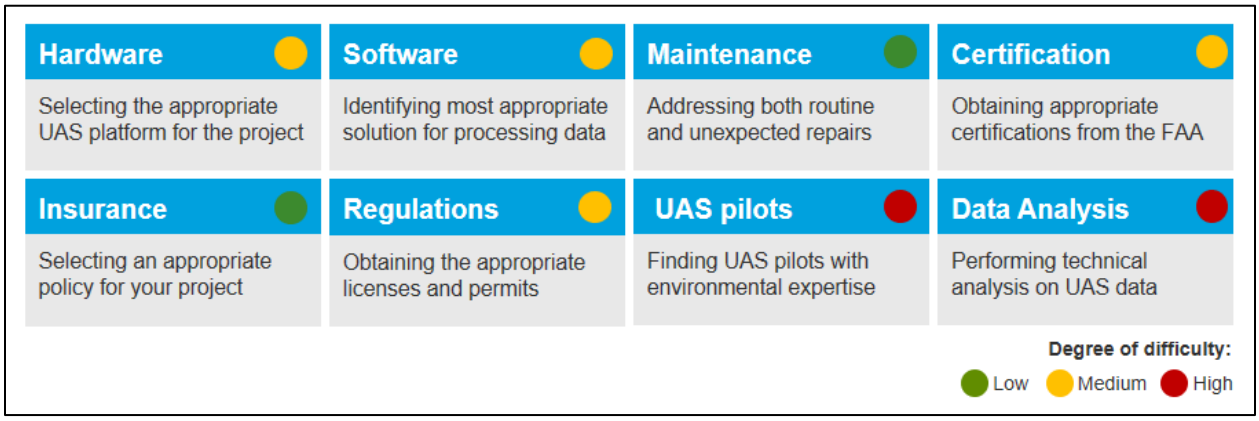

Figure 5: Overview of primary UAS program considerations

- **Hardware / Software:** Budget for an initial investment of ~$8-10K. Fixed wing aircraft tend to work best for large areas, and rotary craft work best for tasks that require hovering. Sensfly and DJI are two of the most versatile platforms available. Start by spending time

researching these two platforms on their websites. For further information, Duke and NC State's drone programs are a great resource.

- **Maintenance:** The drone platforms do not require a great deal of maintenance; however considerations should be made for accidental damage to the craft or part upgrades.
- **Certification:** The Federal Aviation Administration's Part 107 certification option now offers a much easier path to certification than previously existed. More information on the process can be found on the Federal Aviation Administration's website at https://www.faasafety.gov/.
- **Regulations:** Current regulations and "no-fly" zones are listed on the FAA's website. In addition, resources such as http://knowbeforeyoufly.org/air-space-map/ provide up-to-date information. Be sure to clarify whether the land where you intend to collect data is classified as private or commercial.
- **UAS Pilots:** The fact there are still a relatively limited number of drone pilots who are skilled in environmental field work. This should be a primary consideration within your project plan, since it may prove difficult to find operators who live close to the area in which you intend to collect data. Investing in training for an existing (or newly hired) employee is often the easiest and most flexible way to conduct drone flights.
- **Data Analysis:** Identify a partner (e.g. academic institution) to assist with data analysis. This task can be more easily outsourced since the data can be transmitted and analyzed remotely.

VI. Conclusions

UAS technology continues to evolve significantly and the number of applications for drones will continue to rise. For organizations that are like the NCCF and considering integrating

UAS as a tool, the primary challenges will likely be organizational in nature. My hope is that individuals within these organizations who are looking to implement drone technology will be able to use the three-step action plan presented in this project as a foundation and jumpstart the process for integrating drones into their work.

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