

The Rufford Small Grants Foundation Final Report

Congratulations on the completion of your project that was supported by The Rufford Small Grants Foundation.

We ask all grant recipients to complete a Final Report Form that helps us to gauge the success of our grant giving. We understand that projects often do not follow the predicted course but knowledge of your experiences is valuable to us and others who may be undertaking similar work. Please be as honest as you can in answering the questions – remember that negative experiences are just as valuable as positive ones if they help others to learn from them.

Please complete the form in English and be as clear and concise as you can. We will ask for further information if required. If you have any other materials produced by the project, particularly a few relevant photographs, please send these to us separately.

Please submit your final report to jane@rufford.org.

Thank you for your help.

Josh Cole, Grants Director

Grant Recipient Details	
Your name	Elildo Alves Ribeiro de Carvalho Junior
Project title	Using Unmanned Aircraft Systems to monitor protected areas and survey wildlife in Brazil
RSG reference	13580-1
Reporting period	May 2015 to June 2016
Amount of grant	£ 3390
Your email address	elildojr@gmail.com
Date of this report	May 25, 2016

1. Please indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
Assess the feasibility of using low-cost UAS as a platform to support monitoring and enforcement of Grande Sertão Veredas National Park (GSVNP) in central Brazil			X	We conducted 15 aerial missions inside GSVNP and along its boundaries, in areas representative of threats such as deforestation, fire and illegal grazing. We also conducted missions along rivers and roads to demonstrate the feasibility of using the UAS to detect vehicles and boats invading the park. The missions succeeded in demonstrating the usefulness of the equipment for the surveillance and management of the area. Furthermore, the park staff received practical training in the use of the equipment (both hardware and software) and received a complete kit including two airframes, radio transmitter, batteries, charger and accessories.
Assess the feasibility of using low-cost UAS as a platform to survey wildlife distribution in the Park		X		We conducted 15 aerial missions to evaluate if UAS imagery can be used to detect wildlife in the park. Results were unsatisfactory and we failed to detect any wildlife besides a few waterfowl. However, this may have been because of the airspeed, altitudes and cameras used (images were blurred at low altitudes and lacked resolution at higher altitudes). To complete this objective, we will return to the park to conduct additional missions, flying at lower altitudes and using a still camera with high shutter speeds to avoid blurring.

2. Please explain any unforeseen difficulties that arose during the project and how these were tackled (if relevant).

Overall, the project ran quite smoothly and suffered only from minor problems. These caused undesirable delays and compromised the schedule, but never the project goals. The main issue was fitting the agendas of the team. During the first months of the project, the team was too dependent on the services of a model airplane expert, which was helping on a voluntary basis. This was necessary because most of us were newbies with little background in model airplane. Although his assistance has been essential to the success of the project, it resulted in several delays because we depended on combining our busy schedules with his own, even busier. Only after some months (and with his help) we became sufficiently acquainted with the matter to be able to proceed with independence (yet, we express our gratitude for his help, given voluntarily and with no expectation of reward).

Other causes of delay included bad weather (above average rains precluded test flights in Atibaia for almost two months in 2016) and equipment failures (requiring the buying of replacements and waiting for their arrival). In particular, we had problems with the configuration of the chosen model airframe, the FPV Raptor. The plane flew well in the first tests, but suffered a number of crashes when we used dummy weights simulating the payload (autopilot and camera). It turned out that the stock electronics was poor. We lost precious time repairing the plane and experimenting alternative motors, electronic speed controllers, etc.

To prevent further loss of time, we ordered cheap and reliable "zagi wing" airframes, equipped them with autopilots and lightweight action video cameras, and went immediately to Grande Sertão Veredas National Park to conduct our first campaign in May 2016, quite late according to our original schedule. The zagi wings provided satisfactory results for our first objective, namely evaluating the use of UAS in park surveillance. Action camera imagery was good enough to monitor condition of vegetation cover and to detect threats such as deforestation, fire, cattle and vehicles. However, results were unsatisfactory for the second goal, surveying wildlife. This is because images taken at low altitudes (< 50m) were blurred, and images taken at higher altitudes (> 75m) lacked resolution for the detection of wildlife. Because of their small size, the wings could not carry the heavy still camera needed to take pictures at high shutter speeds.

Despite our difficulties with the Raptor, we still believe it is a good airframe choice and will yield satisfactory results in the near future. The plane is well regarded by the UAS community and is recommended by the conservation drones team in their website. We will return to the park soon to conduct additional wildlife surveys with the FPV Raptor. The plane will be loaded with a canon still photograph camera, set to take photos at high shutter speeds to avoid blurring. Only then we will consider our second goal fulfilled.

As we already mentioned, because of the aforementioned delays, we were able to conduct only one campaign in the Park, instead of the two that were originally

planned. However, we stress that we will undertake the second trip to the Park as soon as possible (most likely in August or September 2016).

3. Briefly describe the three most important outcomes of your project.

The main outcome of this project was the implementation of an unmanned aerial system to support the surveillance and management of Grande Sertão Veredas National Park. We trained GSVNP staff in building and using the equipment (both hardware and software) and donated a complete kit, including two airframes, radio control system, batteries and accessories, which will enable them to keep using it as long as its lifespan allows. A further airframe will be donated soon.

Another important outcome is the internalization of the basic technological skills needed to build and operate a low cost UAS within our institution (ICMBio - Instituto Chico Mendes de Conservação da Biodiversidade). These skills were learned by the team (both at CENAP and at GSVNP) during the project execution and will remain within the institution long after the end of the project and eventual depreciation of the equipment.

A third outcome is the practical demonstration of the feasibility of using UAS in protected area management in Brazil. Our experience can be used as a case study and example for other protected areas. In fact, managers of other areas already contacted us, showing interest in adopting the technique in a number of applications.

A predicted outcome which was not fully achieved (yet) was the evaluation of the UAS as a tool for wildlife survey. We still expect to solve this pendency as soon as possible.

4. Briefly describe the involvement of local communities and how they have benefitted from the project (if relevant).

Since this is a mostly technical project aimed for reserve managers, there has been no involvement of local communities.

5. Are there any plans to continue this work?

Yes. In the first place, we still have additional equipment to test and donate to GSVNP (the main one being the original FPV Raptor model airplane). This will be done soon, most likely in August or September 2016.

In the second place, managers of other Brazilian protected areas in Pantanal and Amazonia became aware of our project and contacted us, interested in testing the equipment in a number of applications (from counting exotic buffalo and cattle populations within reserves to checking the aftermath of bush fires). We hope to meet at least some of these requests up to the first semester of 2017.

6. How do you plan to share the results of your work with others?

After completing the second goal, we plan to publish our results in a technical report in a journal directed to conservation practitioners.

We also want use this case study, as well as our newly-gained skills, to disseminate the technology within our institution (which is alone responsible for the management of more than 300 protected areas covering 10% of the Brazilian territory). During this project, we were already approached by a number of reserve managers, interested in potential uses of UAS in their areas. We will search for additional funding to train and equip the staff of some of these areas.

7. Timescale: Over what period was the RSG used? How does this compare to the anticipated or actual length of the project?

The grant was used from July 27, 2015 (when my bank finally made the cash exchange and released the funds for use) to May 25, 2016 (date of finishing this report). We underestimated the length needed for the project and still have a pending field campaign to undertake. At the present point, we can confidently affirm that building and operating a low-cost conservation drone is easy – but this was not the case when we started the project many months ago. To be able to finish the project within the anticipated timescale, we should have included in the budget the costs of paying the services of a model airplane technician, instead of depending on a voluntary service.

8. Budget: Please provide a breakdown of budgeted versus actual expenditure and the reasons for any differences. All figures should be in £ sterling, indicating the local exchange rate used.

Exchange rate of £ 1.00 to R\$ 4.8 (£ Sterling to Brazilian Real).

Item	Budgeted Amount	Actual Amount	Difference	Comments
Travel costs	400	58.84	341.16	Cost of bringing one GSVNP staff to Atibaia. Travel costs were lower than expected because ICMBio paid for the first campaign to GSVNP, and the second is still pending.
Airframes	600	1176.68	-576.68	Costs were higher than expected because we had to buy additional airframes (3) to avoid delays (due to issues with the FPV Raptor). Airframe value also includes replacement parts for the planes, such as motors, ESCs and meal gear servos.
Autopilot system + Data telemetry kit	470	466.62	3.38	We bought four instead of two autopilots (to install in the additional airframes).

Video camera	400	333.96	66.04	We bought two used cameras in good condition for the price of one.
Still photograph camera	300	93.75	206.26	
Battery packs	400	315.10	84.09	
External hard drive	120	56.25	63.75	
Radio control system	700	498.85	201.15	Two units, one for CENAP and the other for GSVNP
Battery chargers	0	199.09	-199.09	Two units (for CENAP and GSVNP)
Transport boxes	0	62.50	-62.50	Wooden boxes to dispatch the FPV Raptors to GSVNP
Miscellaneous accessories	0	247.07	-247.07	Including two tool bags (for CENAP and for GSVNP), safety bags for batteries, propellers and spare parts.
TOTAL	3390	3508.71	-111.71	

9. Looking ahead, what do you feel are the important next steps?

The most important next step is to take the FPV Raptor to the Park and to conduct new missions to complete the evaluation of the technique in wildlife surveys.

The second step is to share our results with the conservation community. This will be done in a number of ways, from the publication of a technical report to presentations in seminars, etc.

10. Did you use the RSGF logo in any materials produced in relation to this project? Did the RSGF receive any publicity during the course of your work?

We used the logo in our [webpage](#) and in a short video about the project, shared on the web. We also used stickers with the RSGF logo in all planes and transport boxes used in this project. Finally, we will use the logo in all future presentations (posters, slideshows) related to the project.

11. Any other comments?

We are deeply grateful to the *Rufford Foundation* for supporting this work. Although we did not fully achieve all goals within schedule, we believe this project was only our first step in a field which will contribute significantly to conservation in Brazil.

Project photographic documentation



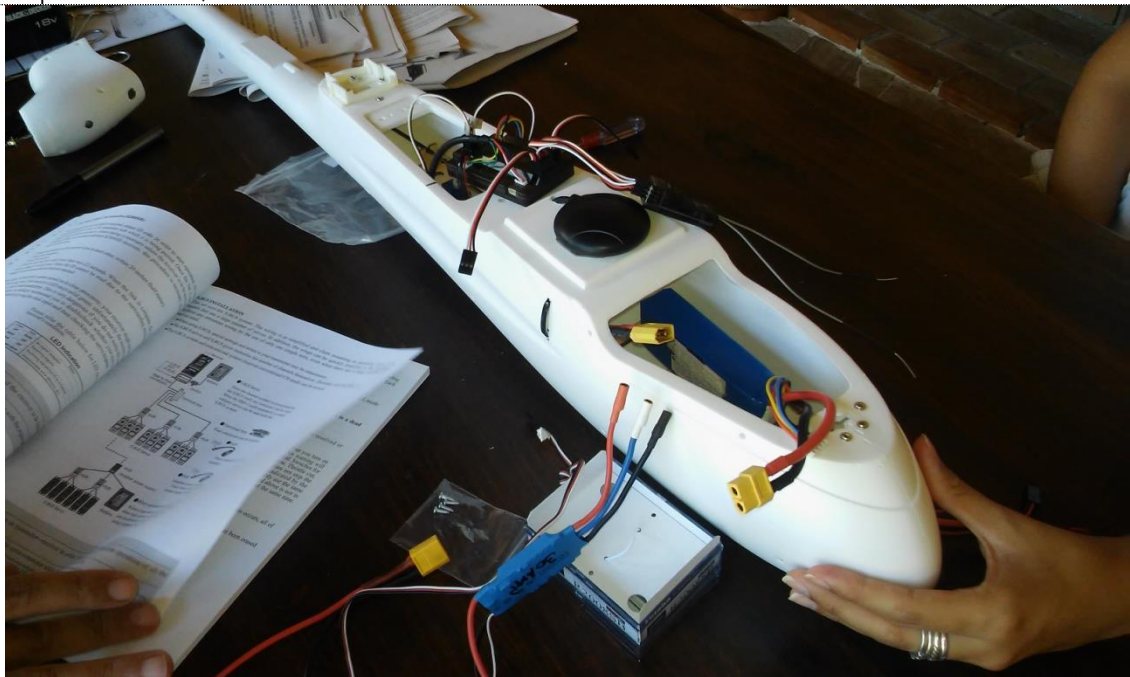
Eduardo Machado and Elildo Carvalho Jr (CENAP) assembling the first FPV Raptor.
Atibaia, October 2015



Paulo Amaral (CENAP) and Eduardo Machado assembling the first FPV Raptor.
Atibaia, October 2015



Eduardo Machado and Laura Valle França (PNGSV staff) assembling the second FPV Raptor. Atibaia, March 2016



Installing the autopilot, GPS and telemetry in the FPV Raptor. Atibaia, March 2016



Eduardo Machado and Elildo Carvalho Jr (CENAP) testing a FPV Raptor. Atibaia, March 2016



One of the FPV Raptors before a flight test. Atibaia, March 201



FPV Raptor crash. Atibaia, October 2016.



FPV Raptor in the air. Atibaia, March 2016.



A "zagi wing" UAS, ordered as an alternative to the FPV Raptor. Atibaia, April 2016.



Elildo Carvalho Jr (CENAP) testing a zagi wing UAS. Atibaia, April 2016.



Field test of zagi wing UAS with the Mission Planner software. Atibaia, April 2016.



Two zagi wing UAS ready to go to GSVNP. Atibaia, May 2016



Danyanderson Carvalho (CENAP) boxing the zagi wings. Atibaia, May 2016



Entrance of Grande Sertão Veredas National Park (GSVNP). Chapada Gaúcha, May 2016



Laura Valle França (GSVNP staff) with an UAS in the park. Chapada Gaúcha, May 2016.



José Romildo da Silva (GSVNP field assistant) with an UAS in the park. Chapada Gaúcha, May 2016



The Mato Grande waterfall at GSVNP. Chapada Gaúcha, May 2016



A bad landing at GSVNP. Chapada Gaúcha, May 2016



Elildo Carvalho Jr (CENAP) doing a preflight check at GSVNP. Chapada Gaúcha, May 2016



Laura Valle França (GSVNP staff) launching the UAS in the park. Chapada Gaúcha, May 2016



Elildo Carvalho Jr (CENAP) launching the UAS at GSVNP. Chapada Gaúcha, May 2016



One of the UAS flying at GSVNP. Chapada Gaúcha, May 2016



One of our UAS after landing. Chapada Gaúcha, May 2016.



Photo taken by the UAS of a person walking in a burned area inside GSVNP. May 1016



A sharp edge between GSVNP and surrounding farmland. May 2016



Heavily grazed area near the limits of GSVNP. May 2016



A dry oxbow lake at GSVNP. May 2016



Image taken during a river mission at GSVNP. May 2016



Photo taken by the UAS of our vehicle in the park. May 2016



Aerial view of a vereda, typical environment of GSVNP. May 2016



Transport boxes made for transporting the FPV Raptors to GSVNP. Atibaia, May 2016.



One of the FPV Raptors inside transport box, ready for transport to GSVNP. Atibaia, May 2016