Invitation to Collaborate Using

RIVER TRANSECTS IN PARROT POPULATION MONITORING

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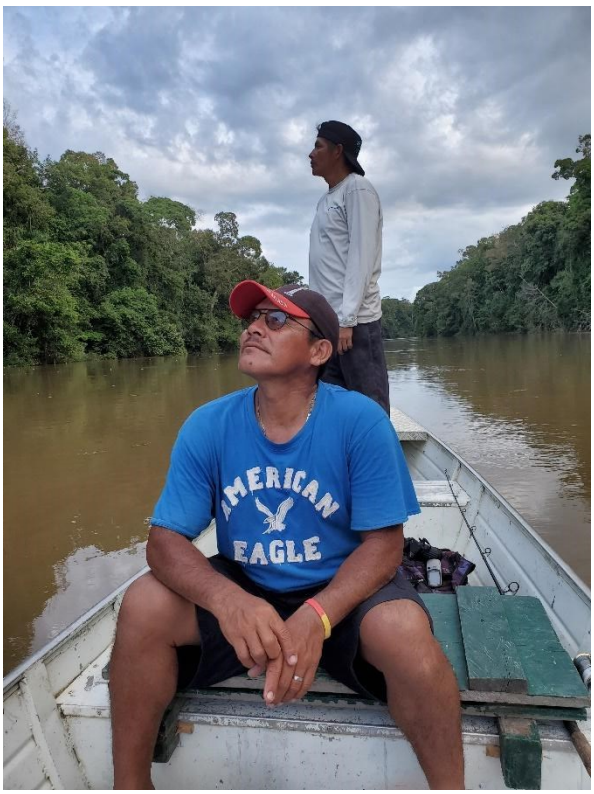

One Earth Conservation

Published by One Earth Conservation
Draft Edition 1.0, February, 2021
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Cover photo: Deputy Toshao Andrew Albert, Karasabai Village and Davis Edwards, Rewa Village on Rewa River. Inside photo: Dexter Dasilva, Nappi Village, on Ireng River, (left), Cain Edwards, Rewa Village on Rewa River (right), Dedication page: Rewa River

CONTENTS

To the people and parrots of Guyana, who showed me the beauty of many waters

Summary

Many areas within the Americas face tremendous threat from trapping, poaching, and ecosystem degradation, yet it is largely unknown what impact these activities have on parrots. Population monitoring, especially in hard-to-reach areas, takes resources and capacity which is not readily available in many regions. To assess the parrot populations in one such area, Guyana, we experimented with a methodology to survey parrot populations from rivers. Rivers are often the only way to access remote regions or to cover large areas while minimizing resource use. This method builds upon other approaches to assess parrot populations, in particular, "Guide to Multiple Fixed Transects in Parrot Monitoring." The methodology of terrestrial line transects was adjusted to transects covered by moving boats. Each moving river transect was two hours in length, stopping every 15 minutes and 500 meters, for a total of four kilometers in length. A complete transect consisted of two moving transects: one up river from a single fixed-point count and one downriver. These structured formal counts were combined with casual observations to develop a river survey methodology, which was then tested on the Rewa and Rupununi rivers 2016-2018, followed in 2019 by seven days of a river parrot survey going up the river from Rewa. The results obtained are descriptive in nature and indicate how this methodology might be used to support a community's conservation and ecotourism goals. We found it helpful for our conservation efforts in Rewa, in part because Rewa runs an ecolodge where tourists use the river for fishing and wildlife viewing. We were able to grow our understanding of local species of parrots as well as their locations along the river. Perhaps this methodology could assist others, especially in the Guiana Shield where little is known about the status of parrots by large rivers. This method could be used to quickly evaluate entire countries and river systems, so as to plan and initiate next steps in the conservation management of these species. River transects could also be used as a baseline for repeated counts so as to assess population trends. We invite conservationists, researchers, managers, and communities to experiment with this method, or to offer comments and suggestions so that we may learn together.

The Use of this Invitation

 Currently, this volume is only in English. If you are able to work with us, we would be delighted to translate it to Spanish and French, as well as other indigenous and local languages. In the meantime, please contact us if you'd like to access PowerPoint presentations. We can also answer questions by email or set up an in-person workshop to address how to adapt methodology to a particular species, terrain, and/or socioeconomic realities. To date, we have taught variations of this technique to children, youth, university students, government agencies, indigenous villages, non-profit conservation organizations, community members and leaders, and other parrot conservationists.

Our goal is to collaborate with others so we can investigate the usefulness of this methodology. We seek funding and collaborators to repeat this survey technique on the Rewa River and extend it to other river regions. We hope one day this document will develop into a useful guide. With every input and development, we will update this invitation, as we plan to make edits and additions based on comments from readers and their use of the methodology. You can help contribute to future editions of this guide by sending us your comments at info@oneearthconservation.org. Check regularly on our website to see if we have a new edition, and if you leave us your email, we will contact you when future publications are released.

It is important to consider that this is not an exhaustive work – in reality it is an addendum to **"A Guide to Multiple Point Fixed Transects in Parrot Monitoring.**[1]**"** Please use that guide in conjunction with this document, as some material is not repeated in this invitation to river monitoring. We have also published a Case Study to that original guide which demonstrates its use over a seven-year period in Nicaragua. All three documents should be used together for maximum understanding and possibility of how these techniques might be of service to your work in conservation. In the meantime, please use this invitation to help you in any way possible. The parrots of the world need you to count them because they are counting on us to understand, cherish, and adapt human behavior and initiatives to keep them flying free. We would be glad to meet with you in person or train counters in this methodology, as well as assist in conducting counts. Alternatively, do not hesitate to contact us for additional information or virtual training.

In summary, this document and methodology might be valuable to you by:

- Providing a descriptive overview of the parrots on the Rewa and Rupununi Rivers during November 2019
- Providing a methodology that can be used on other rivers
- Providing examples of ways to use the data or to develop further investigations
- Providing a method that could be used to more precisely estimate the characteristics of a population throughout the seasons of a year and over a period of years
- Providing a method to get a quick snapshot of the parrot population so as to design further conservation and management plans

- Providing a method to learn more about the parrots in a river region so that the information can be used for ecotourism or scientific tourism
- Providing an outlet for intellectual and scientific curiosity and the chance to contribute to parrot conservation through a collaborate investigation of the use of this method

Introduction

History and Use

This technique is new and has only been tested in Guyana, South America. It came about because of the need to survey parrot populations in forested areas in Guyana that do not easily lend themselves to other methods of parrot monitoring. Most forests do not have trails for moving land transects, and have very few open patches for counting parrots during point or roost counts. Because of the forest cover, identification would rely heavily on vocalizations when using moving transects. Existing trails also tend to not conform to straight linear transects.[1] Line transects that require a straight line are usually designed for estimating the absolute density of parrots, with repeated counts needed for more precise estimates of the entire population. To cut such trails would take valuable time and resources, and would further damage the forest. Alternatively, trails could be designed for conducting counts, and then later be used for other purposes, such as ecotourism to maximize resource use. Our goal, however, was to quickly survey parrot populations throughout Guyana without a large investment of resources while incorporating local community members.

We began with the community of Rewa in the Rupununi (Region Nine Guyana). They are a river-based village that can only be accessed by river, or by crossing a river after using a land vehicle through a swampy road (only accessible in the dry season). We were able to conduct single point counts at their river-based observation deck, as well as at their boat landing, which we do on a monthly basis to get an idea of population trends throughout the year. We also conducted several different fixed transects around the village and in a few open spaces along the Rewa River for determining relative density and the Minimum Number of Distinct Individuals (MNDI).[1] The Rewa, especially in the rainy season, does not generally have open views along the flooded river banks; rocks and beaches are typically inundated. Multiple points with adequate views counted at the same time could be done with the use of many boats anchored in the middle of the river, but this would require a lot of resources (people hours, boats, fuel, meals). Single points placed wherever possible along open spaces could also be done; however, if we wanted to survey an entire river region, we would be at the mercy of where such points occurred, and would be limited to data from only one point counted.

What we needed was a standard methodology that would make it possible to compare various segments of the river at various times of the year, and also possibly compare to other rivers. For such a technique, we would need to cover the same distance at the same rate of movement during the same time of day, much as is used in other avian land population methods where a set distance is walked at a certain rate with some expected time of no movement every set distance.[2,3] The challenge is that rivers do not move in a straight line, or if they do, not reliably

along the entirety of their length. We had to decide whether to measure distance as the length of the river bank covered or as the absolute distance from the starting point as the bird flies. We elected to use absolute distance from the starting point, because as most parrots observed were in flight, we wanted to diminish the chance that we would count them more than once as the river often doubled back on itself. In other words, we hoped to extend the distance from the starting point so that we weren't counting close to the same area more than once. In addition, on some river segments, traveling four kilometers of river bank length might mean only moving one kilometer from the starting point, while others would be over three kilometers from the starting point. We also chose distance from starting point to match more closely to moving transects conducted on land that move in a straight line from the starting point.[2]

After a couple of years of practice, we finally set out to survey the lower Rewa river from the Rupununi River to Corona Falls in November 2019. We hope that the methodology we used, along with the results and discussion, will lend itself to use by others as well as by ourselves as we work in other similar areas, such as in the rest of Guyana and in the other countries of the Guiana Shield.

Methodology: River Population Monitoring

River regions can be surveyed in a variety of methods, including point counts, roost fixed transects, and even plane flyovers. For this current methodology in our river counts, we used a combination of casual observation while at camp or moving between camps, formal single point counts at each camping location (which uses the methodology in our fixed transect guide[1]), and moving river transects both upriver and downriver from each camping location. This basically meant that we were recording all observations of parrots heard and seen as long as we were awake. The single point counts are exactly in the middle of a nine kilometer stretch of river that is divided into two moving transects, each four kilometers long and beginning either 500 meters upriver or 500 meters downriver from the point count. Please use the fixed transect guide for a more detailed explanation of how to do point counts and fixed transects in general.

Some special considerations do apply to conducting a river point count as selecting a view of 360 degrees is challenging due to the often heavily-forested river banks and sudden riverbends. For optimal results, counting points should be selected with the greatest view, both into the forest and up and down river. We camped at our counting points, which made it easy to place people without needing extra time and resources. With enough resources, the central counting point can be set at regular intervals along the river – it just means taking more time to get people in place if the camping location is further up or down river from when the count either begins or ends.

Finding camping areas that can also serve as counting points can be challenging. Flooding of the river can eliminate solid ground for camping and open views; camps must also be selected at certain distances from previous camps to optimize area covered and standard distances between river transects. To address some of these challenges, we added a second boat with the two counters who were conducting the single point counts at each location. Even if the campground didn't have a good view for counting, a boat in the middle of the river would. This was not always possible due to rapid river flow and other characteristics of the river; an anchor might not

hold or might get hung up. Other than these special considerations, the information gathered, equipment, and considerations before and after the count conforms to that described in the transect guide.

For the remainder of this document, we will only be specifically describing Moving River Transects, as other counting methodologies are described elsewhere. In this paper, we will include the center single point counts as they are part of the methodology for river surveys.

Equipment

The equipment needed is similar to that of counts conducted on land with some notable exceptions (Table 1). Further resources and training are also often needed, and can make the team more comfortable and competent (Table 2).

Table 1. Equipment for River Survey

Binoculars
Pen
Data Sheets
Hard surface to write on data sheets
Light sources (headlamp, flashlight, or phone)
Color guide of parrot species
Timepiece (watch of cell phone)
Compass
GPS
Calculator (on phone)
Camera
Range finder
Audio recordings of parrot calls
Boat with anchor and life vests (two preferable)
Map of river
Camping gear and supplies: hammocks and tents, rain tarps, kitchen supplies, food, latrine functions, machetes, shovel, many ropes, insect repellent, flashlights, matches, etc.

Table 2: Additional Resources and Training

Classroom training: Theory, identification of species, practice of method Field training: Practice session on a boat before extended counting trip begins Field transportation and fuel Field notebooks for each person Computer Backpack and rain gear for each person Snacks, meals, stipends Local people joining the count Good management and people skills of leaders Time allotted for data summary, community and relationship building, and celebration before, during, and after the counts

Placement of Transects

Consulting with local people helped us determine where the birds are and where best to place beginning and ending points for the moving transect. If one is surveying an entire river, this may not matter; however, if the aim is to do a regular count to look for trends, then you want to count within an area where there are actually parrots, and if possible, a variety of species. One can also look for transects to survey a river by mapping out locations on the river at set distances before arrival. Suitable camping locations and river characteristics, such as rapids, might mean choosing transect locations at variable distances to one another. Distances between counts are also dictated by the resources available. With more resources, more transects can be conducted, even to the point that every kilometer of the river is surveyed. Alternatively, you can decide to place transects based on how many days and how much fuel you have, spreading them out as regularly as possible. In the Rewa Example, we had to conform our transects to the number of days available for counters, the amount of funds available to pay stipends, the amount of accessible gas, unnavigable falls upriver, occupancy of river camps by large survey groups from the Guyana Mining Commission, and flooded river camps after rain. Good camps are selected also for safety and ease. They need to be high enough above river level in case of flooding and offer space for placement of hammocks, tents, and rain tarps.

If you hope to repeat transects in the future, choose transects that are the easiest to get to and conduct. Also. choose places where the river is straightest, so as to minimize duplicate birds. We have two such river transects that we repeat yearly, which are close to the village, do not require camping, and traverse a segment of the river that is nearly linear.

It may not be possible to pick ideal locations for river transects on the first attempt. It is advisable, however, to decide upon exact locations of transects and points as soon as possible so data from one year or one season can be compared to another.

Timing and Distance

As in fixed transects, we conduct counts for two hours: 30 minutes before sunrise and 90 minutes after, and 90 minutes before sunset and 30 minutes after. We start each evening transect 4500 meters upriver from the camp. This means that for most of the time we are floating downriver, and after two hours, will end only 500 meters from camp. This means it takes little energy to get to camp in the dark. It also minimizes the chance of counting any of the birds that the center point counters observed because of the 500-meter distance. It also helps that moving counts begin or end when very few birds are observable, lessening the chances that birds will be counted twice. For the same reason, in the morning we begin 500 meters down river from the count. Both evening and morning counts maximize the time that we are floating in the direction of the river current, minimizing motor noise (and use of costly fuel) and reducing the amount of time motoring to distance locations in the dark.

Each 500 meters (distance as the parrot flies) from the initial point is covered in exactly 15 minutes. If the river is too slow to go 500 meters in 15 minutes, we will have to motor as slowly and silently to the 500-meter mark. If the river is too fast, when we get to the 500-meter mark we either have to drop anchor or move to the side of the river and "grab a branch" to halt the movement of the boat. After 15 minutes is up, the anchor is lifted or the branch released, and then we repeat the process for the next 15 minutes and 500 meters. This means that a total of four kilometers is traveled in two hours at the same rate of velocity (33.3 meters/minute), regardless of the flow of the river. This is like a moving transect where it is a combination of moving and stationary counting, and in one description, they suggest walking 33.3 meters/minute.[2] There is a general sameness to the counts because you go 500 meters in 15 minutes, but from one year to the next there might be more or less time at the end of the 500 meters due to differences in river flow.

We had a total of four people in the boat during moving transects. One was the captain, who ensured safety and function of the boat and also handled anchoring. The captain was also an extra set of eyes. We then had a primary spotter whose sole job was to call out species of bird, number, and flight direction (see data collection sheet Figure 1). Another person was recording parrot data, while another was handling the watch and GPS to ensure that the appropriate distances are covered at the right time; all 500-meter points were recorded on the GPS and data sheet. With practice, it might be possible to use only one data recorder for all tasks. Sometimes the birds are so plentiful, however, that accurately recording the birds, instances of human disturbance/presence, and the time that the boat stopped at each 500 mark, as well as keeping the appropriate velocity and 500-meter point would be very challenging. We record how much time the boat is stopped at each 500 mark because it allows us to estimate the flow of the river as well as the time motoring, which might impact hearing the birds. We also want to see how much variation there is for the amount of stoppage time at the 500-meter mark.

Data Collected

We collected a host of data (Table and Figure 1), which varies from what is normally collected during our usual fixed transects.[1] For instance, we do not collect the direction the birds are flying in, but instead if they are going up or down river, and going from the left to right side of the river. This directional information is gathered more to help us remember if a bird has been possibly counted before, and to help understand the behavior of the birds (i.e., nesting, foraging, and roosting behaviors) .

The name of the transect refers to where the transect is being conducted and includes the river name. We also included the camp name. We then indicated whether the count is upriver or downriver from the camp. We then recorded the GPS coordinates at the end and the beginning of the count, starting at 500 meters from the camp and extending for four kilometers as the parrot flies. The date is written out in longhand (January 24, 2020) because abbreviated numbers can be confusing for people from different countries. For instance, in the USA the date for March 5 would be 3/5/2020 but in other countries it would be 5/3/2020, causing confusion on whether it is a day in March or May.

Beginning and ending times were written in 24-hour format. People's names were written according to their jobs – spotters, scribes, captain, or any combination. The weather was a rough description at the beginning of the count. Temperature was listed as cold, cool, warm, hot, or very hot. Wind was recorded as zero, slight, moderate, or high. Cloud cover was estimated as a percentage of the total sky; for example, 75% meant that 75% of the sky was covered with clouds. If there was any precipitation during the count, its length and amount was recorded here. The page number was listed as #/# - the first number was the order of the page and the second number was the total number of pages. For instance, 2/3 means that that is the second page out of a total of three pages.

For each sighting, time was entered in a 24-hour format (0 – 2400). In the next column, the species was recorded. We suggest using an abbreviation which is quicker to write down during the rush of counting (such as SUP for sun parakeet and OWA for orange winged amazon). In the summary section at the bottom of the page, we spelled out the name to ensure no confusion. The following column was the number of birds seen. This might be the trickiest part of the entire data sheet, and attention was given to ensure that all counters recorded the data in the same fashion. If only one bird parrot was seen, this was a "1." If two birds were flying obviously as a pair, as many parrots do (wing to wing), this was a "2." If three birds were flying more or less wing to wing, this was a "3." If the three birds consisted of a clear pair and then another bird, often this year's chick in certain species (such as amazons and larger macaws), somewhat separated but within 50 meters, it was written as "(2+1)"; later, it can be determined if this is a trio and likely a family group, or not. If three birds were not flying wing to wing, but are clearly of the same group, and within 50 meters of each other it was recorded as "(1+1+1)". The same system was used for birds of 4, 5, 6 and more together. For instance, a group of 5 birds might pass by as a pair and then a group of 3 (likely fledglings); this was recorded as "(2+3)". The parenthesis

indicates that the group was flying together more or less. For larger flocks, we tried our best to determine how they were flying, although birds in larger groups or smaller birds may not fly in clear set formations. For instance, a group of 29 birds that fly over might be recorded as "(29)" if they are all as a group, such as with white-eyed parakeets coming low into a roost site; they might also be written as "(2+2+2+4+3+3+2+2+2+5+2)", such as orange-winged amazons flying high coming into a roost site. The reason for this nomenclature will become clear during the section on data merging and tabulation.

If the birds were flying further apart than 50 meters, but were flying at the same time in the same direction, they were recorded with a separation of a comma, such as 2,2,2,3,2. Sometimes birds were far away, flying too quickly or too many at one time to get an accurate count. In cases such as these, the flock size must be estimated, making sure to be as conservative as possible. For example,, if a high-flying group of green parakeets comes swirling into a roost site 300 meters away and no camera is available, the counter would be instructed to write the number of individuals that they could clearly identify. Such a sighting would be recorded as "(12+)" signifying that it is a flock of at least 12 individuals but probably more. The same system is used for birds that are only heard – the number represents how many distinct voices are clearly heard. For instance, a flock of painted parakeets that fly low in the trees and are barely glimpsed, but heard, might only be listed as 3+ but could in fact be as many as 10 birds because not all of them were chattering, or could not be heard at the distance. It is important in the methodology to be as conservative as possible, and if you have to err, err on the side of underestimation .

The direction that the birds are flying is then roughly estimated. If they cross the river, they are listed as left to right (L→R), or right to left (R→L). If they are perched you just circle "Perch." If they are flying along the right side of the bank, you circle "R" and for along the left, you circle "L." If they are flying over the river at an angle or along the riverbank, you can circle "up" or "down" river. If they are flying directly away from the river, then you can circle either "R" or "L" but not "Perch." You can also record whether the bird vocalizes even if you can't see them.

We only marked every 500-meter point, along with the GPS coordinates. If we wanted, we could also mark and record the GPS along every sighting, especially for nest sightings or unusual observations. At every 500 mark, we recorded the width of the river with a laser range finder (adding the distance to the left bank and summing it with the distance to the right bank). We did not record altitude, distance from the boat, or have a drawing because of the limited site of view; having only one boat counting makes this data meaningless or not helpful enough to distract from primary parrot sightings and recording. We primarily use these observations to rule out duplicate birds counted between multiple fixed points in a transect.

Table 3: Minimum Data Collected

Name of transect (General location)
Direction from Camp: Up or down river
Start GPS; End GPS
Date
Begin Time; End Time
Persons:
Weather: % Clouds, Wind, Temperature, Rain?
Page number
For each parrot sighting:
- Time
- Species
- Size of group
- Direction of flight in relation to river
- Flight going up or down river
- Distance from Center of the River
- Vocalizations
- Comments

For each human sighting: number of humans and activity.
For each 500 mark and beginning and end:
- Time
- GPS
- River width
- Canopy height right and left bank

Additional information can also be gathered with which we experimented. For instance, one could record human presence and activity along the transect (for example, numbers of people, boat type, activity, camps, etc.). One can experiment with measuring the height of the bank on each side of the river, but this is difficult to measure because where a bank begins/ends when under vegetation is difficult to discern. The idea of measuring the bank height could possibly help determine river height and could also be used to obtain true tree canopy, as measured from the ground and not from the often lower position of the observer on the river).

At each 500 mark, we recorded the height of the tree directly across from the boat's stopping point. This gave us an idea of canopy height. However, only taking one data point is hardly sufficient to characterize the canopy in a given stretch of river as there are much more complex and robust methods for measuring both canopy cover and height.[18,19] Forest characteristics and land use can impact avian populations and an initial survey such as this can indicate the need to study any correlations between parrot species and abundance with other environmental characteristics, including canopy height, forest type, tree species observed, and forest alterations due to storms, flooding, or human activity.

Figure 1. Data sheet for use on river

River Transect Counting Form

Name Transect:_____ Direction From Camp: Up Down Start GPS:_____ End GPS:_____ Date:_____

Begin Time:_____ End Time:_____ Person(s):_____ % Cloud:____ Wind:_____ Temp:_____ Rain?:_____ Page #:_____

TIME	SPECIES	# BIRDS	DIRECTION Flight	UP or DOWN River	DISTANCE from Center River	Vocal? Only, No, Yes	Distance Travelled	Width River	GPS
			L→R R→L Perch	Up Down		Only No Yes			
			L→R R→L Perch	Up Down		Only No Yes			
			L→R R→L Perch	Up Down		Only No Yes			
			L→R R→L Perch	Up Down		Only No Yes			
			L→R R→L Perch	Up Down		Only No Yes			
			L→R R→L Perch	Up Down		Only No Yes			
			L→R R→L Perch	Up Down		Only No Yes			
			L→R R→L Perch	Up Down		Only No Yes			
			L→R R→L Perch	Up Down		Only No Yes			
			L→R R→L Perch	Up Down		Only No Yes			
			L→R R→L Perch	Up Down		Only No Yes			
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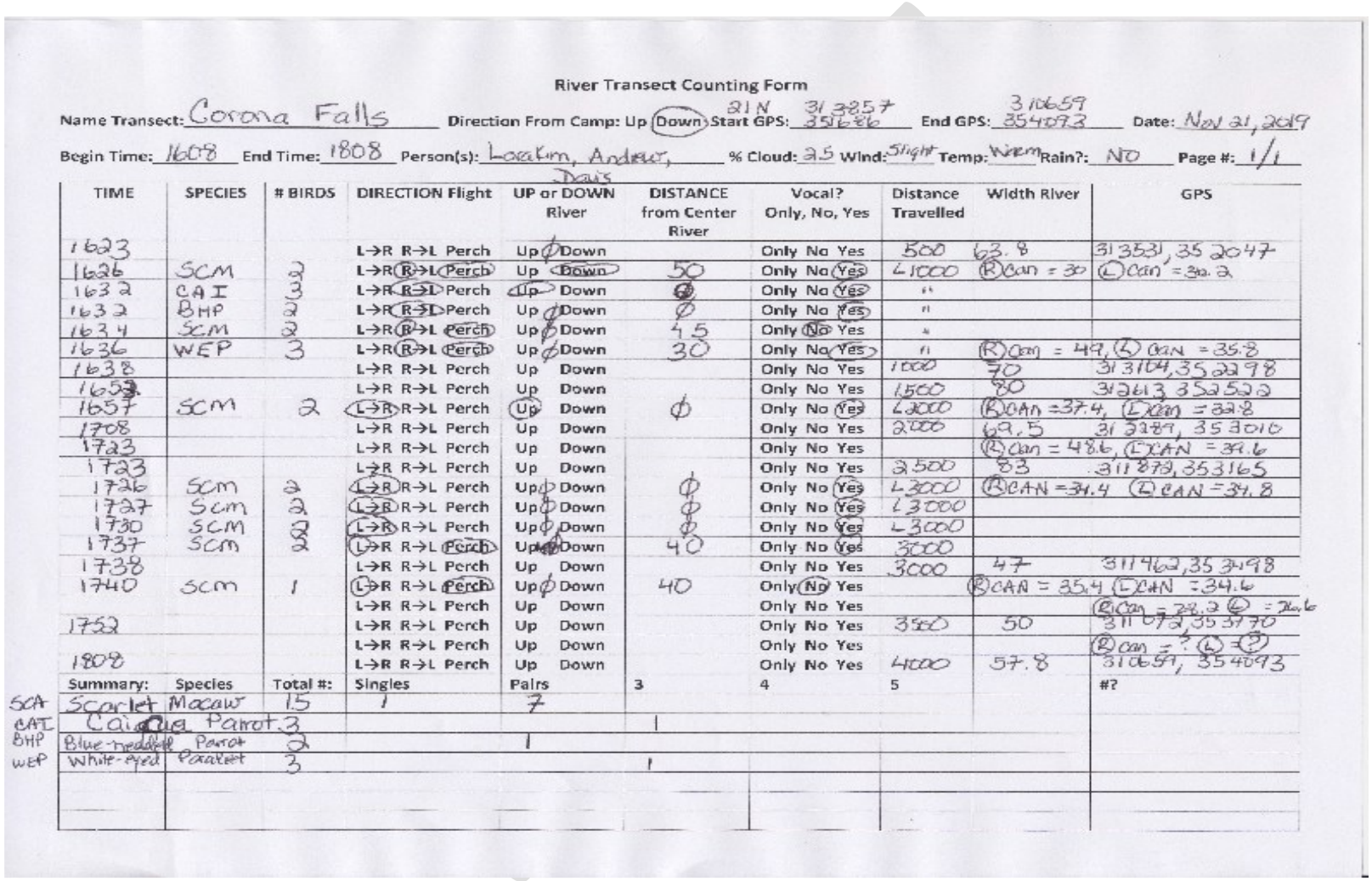
			L→R R→L Perch	Up Down		Only No Yes			
			L→R R→L Perch	Up Down		Only No Yes			
			L→R R→L Perch	Up Down		Only No Yes			
			L→R R→L Perch	Up Down		Only No Yes			
			L→R R→L Perch	Up Down		Only No Yes			
			L→R R→L Perch	Up Down		Only No Yes			
			L→R R→L Perch	Up Down		Only No Yes			
			L→R R→L Perch	Up Down		Only No Yes			
			L→R R→L Perch	Up Down		Only No Yes			
Summary:	Species	Total #:	Singles	Pairs	3	4	5		#?

Figure 2. Completed data collection sheet used in Rewa, Guyana.



River Transect Counting Form

Name Transect: Corona Falls Direction From Camp: Up (Down) Start GPS: 21N 313257 3516786 End GPS: 310659 3540973 Date: Nov 21, 2019

Begin Time: 1608 End Time: 1808 Person(s): Loakim, Andaur, Davis % Cloud: 25 Wind: Slight Temp: Warm Rain?: NO Page #: 1/1

TIME	SPECIES	# BIRDS	DIRECTION Flight	UP or DOWN River	DISTANCE from Center River	Vocal? Only, No, Yes	Distance Travelled	Width River	GPS
1623			L→R R→L Perch	Up Ø Down		Only No Yes	500	63.8	313531, 352047
1626	SCM	2	L→R (R→L) Perch	Up (Down)	50	Only No (Yes)	1000	(R) CAN = 30	(L) CAN = 30.2
1632	CAI	3	L→R (R→L) Perch	(Up) Down	Ø	Only No (Yes)	"		
1632	BHP	2	L→R (R→L) Perch	Up Ø Down	Ø	Only No (Yes)	"		
1634	SCM	2	L→R (R→L) Perch	Up Ø Down	45	Only (No) Yes	"		
1636	WEP	3	L→R (R→L) Perch	Up Ø Down	30	Only No (Yes)	"	(R) CAN = 49, (L) CAN = 35.8	
1638			L→R R→L Perch	Up Down		Only No Yes	1000	70	313104, 352298
1653			L→R R→L Perch	Up Down		Only No Yes	1500	80	312613, 352522
1657	SCM	2	(L→R) R→L Perch	(Up) Down	Ø	Only No (Yes)	2000	(R) CAN = 37.4, (L) CAN = 32.8	
1708			L→R R→L Perch	Up Down		Only No Yes	2000	69.5	313289, 353010
1723			L→R R→L Perch	Up Down		Only No Yes		(R) CAN = 48.6, (L) CAN = 39.6	
1723			L→R R→L Perch	Up Down		Only No Yes	2500	83	311879, 353165
1726	SCM	2	(L→R) R→L Perch	Up Ø Down	Ø	Only No (Yes)	3000	(R) CAN = 34.4	(L) CAN = 34.8
1727	SCM	2	(L→R) R→L Perch	Up Ø Down	Ø	Only No (Yes)	3000		
1730	SCM	2	(L→R) R→L Perch	Up Ø Down	Ø	Only No (Yes)	3000		
1737	SCM	2	(L→R) R→L (Perch)	Up Ø Down	40	Only No (Yes)	3000		
1738			L→R R→L Perch	Up Down		Only No Yes	3000	47	311462, 353498
1740	SCM	1	(L→R) R→L (Perch)	Up Ø Down	40	Only (No) Yes		(R) CAN = 35.4 (L) CAN = 34.6	
			L→R R→L Perch	Up Down		Only No Yes			(R) CAN = 28.2 (L) = 26.6
1752			L→R R→L Perch	Up Down		Only No Yes	3500	50	311072, 353170
			L→R R→L Perch	Up Down		Only No Yes			(R) CAN = ? (L) (?)
1808			L→R R→L Perch	Up Down		Only No Yes	4000	57.8	310659, 354093

Summary:	Species	Total #:	Singles	Pairs	3	4	5	#?
SCA	Scarlet Macaw	15	1	7				
CAI	Caique Parrot	3			1			
BHP	Blue-headed Parrot	2		1				
WEP	White-eyed Parakeet	3			1			

River characteristics other than river width and bank height can be obtained, such as the flow rate and river height. These measures can correlate with weather data including as rainfall. Potential for river flooding, and amount of flooding, as well as their flow rate impacts vegetation in terms of species, tree species relative density, and whether the potential nest trees can withstand bank erosion. We casually observed flow rate by seeing how long it took to float 500 meters. There were differences depending on whether we were in the rainy season or if there had been recent significant rainfall. How river flow might relate to parrot populations is unknown without further data collection, and it is likely that parrot abundance and relative density shifts based on the time of year and corresponding changes in river flow rate and river height. River flow can be measured with a variety of methods, including doppler and mechanical current meters.[20, 21]

Merging and Tabulating the Data After the Count

After the count, each species is tabulated to arrive at a total number of individuals and their distribution according to flock size. Any possible birds that may have been counted twice (and marked with a "Dup" for "Duplicate" during the count) are not part of the final total. Summary comments are also noted for each transect and point, such as "probably roost site to the North," "suspicious nesting activity at tree #2," and "34 birds probably slept in one roost site near here."

Information Produced

River transects can produce a wealth of information, although the aim is to collect the minimum data on the observation sheet (Figure 2) from which the specific information can be tabulated (see Rewa River Example in this document).

Ancillary descriptive information can also be collected but because counts are conducted while observers are moving, getting descriptive data of bird behavior and movements is more challenging than with fixed transects.

Specific information yielded by the observation sheet includes:

- Estimation of number of different species and their relative density mapped according to location along a river
- Estimation of density of parrots seen per kilometer of river traveled (this is not an absolute density)
- Indication of group sizes and percentages of chicks, juveniles, and adults in certain species
- Occurrences of human activity on the river and numbers of humans observed

Additional possible descriptive data which can be obtained:

- Approximate direction in which roost sites might be located. For instance, if you see 100 orange-winged amazons flying over the river in the same direction as it gets dark, this kind of behavior usually indicates the presence of a roost site in the direction to which the

birds are flying. As roost sites are valuable places for assessing parrot populations, these locations can be marked for future investigation.
- Location for future counts and repeatable counts for greater precision
- Sites of future conservation efforts (depending on the number and species of parrots, and the use and owner of the terrain)
- People or communities capable of or interested in future conservation efforts
- Chance observation of nest sites
- Species of food eaten and foraging behaviors/locations
- Species of nest trees and nesting behavior
- Flight patterns

One major difference between this method and that of fixed transect guide is that we are not attempting to obtain the Minimum Number of Distinct Individuals along the river. This is because the boat is moving and hence, the frame of reference for observing birds is constantly shifting. We also only have one single point of observation (the boat) and can't know if birds are coming and going from this point as we don't have other points set to rule out duplicate counts. Sometimes it is clear that a given bird is a duplicate; for example, we might see a flock of eight painted parakeets cross the river and fly into the brush on one side of the river and then before we are out of site, we observe eight painted parakeets fly from this tree and move down river. Birds in cases like this would not be counted a second time and their numbers would not be entered on the data collection sheet.

Relative Density

We can quickly calculate the relative density of the parrot species in a given area. We calculate this for each point count: moving upriver evening count, moving downriver count (morning counts), 8-kilometer river count (up and down river combined), total count (includes river and point count), and casual counts outside of the formal counting period. This helps us see the distribution of parrot species, which might give indications of stress on the population, such as poaching and trapping for the wildlife trade. For example, we may find no macaws in a given area and a very low percentage of parrots known for their ability to talk and relative ease to have as a pet, such as a yellow-crowned or black-headed parrot. Normally in many areas of the Guiana Shield there would be many species mixed in with the other parrots, but their absence might suggest past and probably ongoing hunting pressure. In some parts of South America, we only find a majority of orange-winged amazons, a species not highly prized in the pet trade. In other regions, we may find only parakeets because the common poaching and trapping pattern is to take the larger and more talkative parrots first. Habitat destruction restricts food and access to available nesting areas; this might also impact the relative density, but without further detailed studies (and historical data), it is difficult to pinpoint the exact cause. However, with the number of species, the numbers of each species, and the relative density, we can inform stakeholders who are or could be part of local and regional parrot conservation. Together, we can plan further steps to develop conservation actions and to test any theories.

Group Size and Distribution

Further valuable information is a preliminary understanding of the demographic distribution of a given population. Generally, we assume that groups of three, four, five and even six are family groups (parents with this year's fledglings) in species that typically move in pairs or family groups (many amazons and larger macaws) or groups of juveniles.[6] We can then calculate the percentage of first year birds in the general population because in each group there are two parents and the rest are first year birds. This helps us see the possible replacement generation of young birds before first year mortality, and if few family or juvenile flocks are seen, then we are suspicious that there are limiting factors to reproduction; this includes poaching, trapping, or other forms of high nest mortality, which can occur with a reduction in the numbers of adults . If we wish to use flock size distribution, counts need to be conducted within a few months after fledging season, which can vary from region to region even with the same species. This is because fledged chicks often remain with their parents for several months, including amazon parrots and macaws. Flock distribution can also tell us if family groups are present and how many, as well as indicate the stage of the breeding season. Single birds in macaws and amazons are often males foraging for the female laying or with eggs in the nest, and lack of family groups means low reproductive rate. To use flock size distribution to estimate the percentage of fledged chicks in a population, we need information like when birds fledge and where family groups migrate to after breeding seasons, if at all. Roughly speaking, even a few counts in an area can quickly suggest reproduction limitations in specific species that move in either pairs or family groups if you are counting during the time of family group movement (such as within six months post fledging in yellow-naped amazons).

Advantages and Disadvantages of Moving River Transects

Advantages

Specific advantages for moving river transects are many, even when compared to the disadvantages given that they aren't oriented towards precision or testing a hypothesis when performed only once. They are more for a rapid assessment over a large area, upon which further counting and monitoring methods, and conservation practices can build. This method's primary aim of getting a quick overview of parrot populations over a large and dense forest area holds true regardless of the challenges and drawbacks of this methodology. Many high-rivered areas have not had any population work of parrots conducted, so even with a rapid assessment, we can start to confirm a common situation; the majority of parrot species populations are decreasing or are already threatened. Repetition of transects, more transects, comparisons to other methods, and further pilot studies in different areas can help us understand the possible applications of this methodology. For this reason, we encourage others to use this method so that we can learn its usefulness in parrot conservation.

The general advantages are:

- A large area can be surveyed rapidly in difficult locations only accessible by boat or challenging forest trains, because for each transect, a total length of nine km of distance is covered
- More species and individuals can be observed then simply doing single point counts along a river (see Rewa River Example)
- Data can be rapidly assimilated to design initial conservation plans and to raise awareness of possible stakeholders
- Local community members or visitors can be incorporated into the count as extra pairs of eyes, increasing awareness and possible commitment, although the number of people involved depend on space in the boats and number of boats (and hence resources) available
- The methodology allows counters to develop an understanding of parrot behavior; by learning to focus on parrots, counters not only learn about the parrots, but suddenly become more aware of them as active agents in their world, increasing curiosity, connection, and commitment to preserving them

Disadvantages

This is basically a brand-new method, and we have not tried it out in large and varied areas. There might be many ways to improve upon this technique.

The general disadvantages are:

- Difficulty in placing camps at regular intervals along a river
- Difficulty in discerning absolute density of each species due to lack of visibility and river bends
- Challenge to always anchor boat with same amount of visibility at each 500 mark
- Use of engine might drown out some vocalizations
- High observational capacity needed to recognize parrots by sound
- High resource use (boats and fuel) and time-consuming (days on river if more than one transect is desired further away from human habitation)
- Practice needed to be able to record all data and coordinate distance and timing
- Difficulty obtaining “distance from transect line” (which is the middle of the river) because of tree cover obscuring bird movements. An alternative method to locate birds along a terrestrial transect is to obtain bird distance from the observe and angle from observer, both of which are also difficult to obtain on a moving boat.[3]
- River surveys only cover a portion of a given survey area and may not represent the extent and variability of the species present in the area not near a river
- River surveys target a particular riverine ecology (for example, where flooding occurs in the rainy season) and might not represent the extend and variability of the species present in the area

Conclusion on Methodology

There are many different ways to monitor the status of parrot populations, as well as statistical manipulations,[4 – 16] all of which can be coupled with the use of moving river transects. All of them have advantages and disadvantages, and some of them can increase precision with repetition. Even still, in any method, the margin of error in accuracy is large given the variability of bird movements and counter consistency. Each counter is able to see and hear differently, impacting the count as does having a variable number of counters at each point or in the boat. For instance, having more than one counter at a site can increase the number and accuracy of birds observed. If we could just teach the birds to number off and count themselves, our work would be so much easier and more accurate!

We now present an example of this methodology and information so the reader themselves can discern possible advantages and uses of this method.

Example of Methodology: Rewa, Guyana

Rewa village is located at the confluence of the Rewa and Rupununi in southern Guyana (Figure 3). Some of the village's territory borders on marsh forest and savannah, but most of it is in lowland tropical forest. One Earth Conservation teamed up with this village because they were interested in knowing about their parrots and had an affinity for scientific data gathering that can lead to better land management. As a community, they had agreed to end trapping of parrots, which they had engaged in since the 1950s. This was because in 1992, their parrot populations had plummeted due to the legal exportation of parrots (as per local stories). Since 1992, they knew their parrot populations had rebounded somewhat after trapping ceased, but weren't sure of the health or long-term trends of this group of birds. Most of their territory consists of trees forming a tall canopy that obscures visual confirmation of parrot species, except at their farms, in the village, or at the ecolodge they built to attract visitors. In previous years, we therefore chose these locations to count parrots, as well as points along the river that had more open sky than most, such as rocks, beaches, and the middle of the river within ten kilometers of their village. We were interested in surveying a larger part of their territory beyond these convenient open places, and the only method for moving through their lands was by river, and the only open sky for doing counts was alongside the river and actually in the river. Doing single points up the river would mean many days on the river leapfrogging from one camp to the next; placing multiple points on a fixed transect would take a lot of people, time, and fuel to place the points within the forest or along the riverbanks. Instead, we opted for developing a technique where we could cover a lot of territory, while being consistent with our methods so that we could compare stretches of the river. We also wanted to try using moving river transects to see if they would be a tool for repeated counts so we could determine long term trends, and compare the Rewa river to other rivers in Guyana (which is made up by large rivers with few roads). In fact, Guyana in Amerindian language means the land of many waters.

Methodology

We used the methodology described previously in this document with some adaptations due to weather, terrain, river flow, and access to river-side camps. Over a period of seven days in November 2019, we covered approximately 173.3 kilometer of the Rewa river and 12.1 of the Rupununi river as measured by distance the boat travelled following the middle of the river, and 78.9 kilometers of the Rewa River and 9 kilometers of the Rupununi river as the parrot flies (Figure 3). We also kept a log of all birds seen outside of the formal counts, calling these summaries "Casual Counts." Thus, in effect, we noted all parrots seen 30 minutes before sunrise until 30 minutes after sunset.

Figure 3: Map of Guyana showing the Rewa and Rupununi river where the survey was conducted. Red line shows the length of each river where parrots were surveyed. (By Kmusser - Own work using Digital Chart of the World and GTOPO data., CC BY-SA 3.0, https://commons.wikimedia.org/wiki/File:Essequiborivermap.png)

This distance was covered by doing seven different river surveys, which consisted of a central point count, and two moving river transects, going upriver from the camp for the afternoon count, and downriver from the camp for the morning count. Our camps were Rewa Village, Toucan Falls, Riverburst, Puma, Bamboo, Backbone, and Corona Falls at 0, 18.7, 30.9, 43.5, 53.9, 62.1, and 78.9 kilometers from Rewa as the parrot flies (Figure 4). Ideally, we would have picked standard distances between the camps but the availability of places to camp was restricted by river height flooding out certain campsites and government use of other sites. Due to rain, we were unable to complete two morning counts (Bamboo and Corona Falls), and in the final count, due to lack of fuel, food, and an attack by army ants in the early morning, we missed the last count on the Rewa River at Sewall and instead shifted to the Rupununi River. The afternoon

count at Bamboo was terminated 25 minutes and 1 kilometer early due to a thunderstorm, thankfully at the end of afternoon counts when few birds are usually observed. This meant we did a total of five morning moving counts, seven evening moving counts with one partially terminated, and twelve point counts.

Figure 4: Location of seven base camps along the Rupununi and Rewa rivers where parrots were surveyed

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Figure 5. Riverburst transect showing the upriver beginning point marked at 0 meters "RB 0" and then marked every 500 meters up to "RB 8" and then showing the downriver beginning point marked at "RB 9" and then marked every 500 meters up to "RB 17."

Each downriver count began 500 meters down river from the camp and extended for four kilometers, and each upriver count began four-and-a-half kilometers up river and ended 500 kilometers from each camp (Figure 6).

We were only able to use the anchor to stop our boat's forward progress every 500 meters during one transect, thereafter halting the boat by grabbing branches on the riverside ("grabbing the bank snakes"). For the river transects, we had four people, which meant four sets of eyes for scanning parrots; however, two were largely involved with data recording.

Our total team consisted of two boats, two boat captains (who also kept a look out for parrots), two point counters, and three boat counters for the moving counts. One counter only observed birds and called out findings, as well as grabbing hold of river side branches to stop the boat. The other two counters were largely data recorders, but also contributed to birds seen and heard. The second boat was our camp boat and would aid the two point counters near camp by placing them in an ideal location. There was also a cook who stayed in camp and did not participate in bird observations.

Results

These results are displayed in a descriptive format, not so as to confirm with any certainty comparisons, trends or correlations, but which could suggest some patterns as well as future research options. As mentioned previously in this document, we were looking mostly at the number of species, kinds of species, relative density of species, location of species (temporal and spatial), and group size distribution.

A total of 19 parrot species and 1538 individuals were seen across the twelve moving counts, the twelve point counts, and seven days of casual counts during November 2019 (Figure 7). A total of seventeen species and 804 individuals were seen during the moving counts (Figure 8): 14 species and 503 individuals for the twelve point counts (Figure 9) and fourteen species and 231 individuals for the seven casual counts (Figure 10). The most numerous birds in descending order of occurrence were the golden-winged parakeet, the painted parakeet, the orange-winged amazon, the scarlet macaw, and the blue-headed parrot (all over 100 sightings). The high number of orange-winged amazons was due to a point count at the Rewa village where there was an orange-winged amazon roost.

We then compared the absolute numbers of all species of all moving counts (12 total) with all point counts (twelve total) so as to look for differences in counting methodology (Figure 11). We then described the total numbers of parrots seen during morning moving transects versus evening moving transects, although there were two fewer morning transects counted (Figures 12, 13). We also compared the total number of parrots seen of each species, comparing morning to evening counts (Figure 14).

To compensate for having different numbers of moving counts, we switched to organizing the data as “density” instead of absolute numbers. In this case, density does not refer to how many birds were seen per given area, but how many birds were seen per kilometer of river (1000 meters as the parrot flies). We then plotted this as distance from the village Rewa (Figure 15), showing both morning and evening counts. The idea was to see if characteristics of the population shifted the further we got from a village and a greater concentration of people.
To compensate for having fewer numbers of point counts in the morning than in the afternoon, we looked at how many birds were observed/hours of observation (Figure 16). We then plotted this as distance from the village Rewa (Figure 17).

We plotted out the density during moving counts by grouping parrots (large macaws, amazons, parrots, and parakeets as described in Figure 6), comparing morning to evening counts, which allowed us to compensate for the two rained out morning counts (Figure 18). We then charted out each major group by their distance from Rewa (Figures 19-22).

We also tabulated the density of parrots, width of river, and right and left canopy height averages and standard deviations (Figure 23), and compared the density of parrots to river width and canopy height. We have no idea if any of this correlates with species seen or forest habitat characteristics. We show this to suggest possible future investigation.

Width of the river for both morning and afternoon counts were plotted against the density of all parrots during the twelve moving counts (Figure 24).

Though our canopy measurements were crude, we did plot density of parrots versus the average canopy height of the four- kilometer transect (Figure 25).

For a quick look at flock size, we charted out the percentage of total numbers of each species that fly most frequently as pairs and family groups (three, four, five, or six birds) and chicks (Figure 26).

We also noted human activity during all counting periods. For casual counts, on Day One there were two large camps on the shore that housed many people involved in mining exploration, one about 30 minutes by boat from Toucan Falls (which was a camp for us) and one at Anteater Camp (which was about 40 minutes by boat from our Puma Camp). Day Two had one motor boat on the river and one parked boat on the river side with no people. Day Three had the same parked boat as on Day Two. Day Four had no human activity. Day Five had one motor boat. Day Six had two motor boats. Day Seven had two motor boats. During the moving counts, the only human activity was one large motor boat during one morning count, and during the Rewa-Rupununi count, there were two motor boats in the afternoon and four in the morning.

During each count, we calculated how long we were stationary at every 500-meter mark, and tabulated these only for six evening counts, as the count at Bamboo Creek was terminated early due to rain (Figure 27). We did note how long we had to motor to be able to get to each 500-meter mark, though in most cases, the river was moving fast enough that we did not have to motor much.

Discussion

We remind the readers that this data is descriptive and was collected once at each location and time frame. Any conclusions, trends, or correlations are speculative, but serve as a basis for future research, conservation measures, and ecotourism activities. From anecdotal evidence, and the monthly point counts we are conducting at Rewa village, we know that the variety and abundance of parrots varies depending on the time of year.

Species, Number of Individuals, and Relative Density

In Figure 7, all observations were compiled, resulting in 19 species and 1538 individuals. There are definite duplicate sightings, although we tried to minimize this by beginning and ending the moving counts 500 meters from each point count and spreading out the camps along the river. Because of the possibility of duplicates and having only one data set per location and time, we do not attempt to make projections about the absolute density of each parrot species in the area or absolute numbers.

With this in mind, and coupled with anecdotal evidence, there are more parrots seen in this area than in the 1990's before Rewa Village prohibited trapping. There is also a wide variety of parrot species, of which there are 29 in Guyana. In the territory of Rewa, according to the local guides, we only missed observing the dusky-billed parrotlet which is rare and usually seen further south,

the chestnut-fronted macaw which is rarely if ever seen, and the green-rumped parrotlet and brown-throated parakeet which occur more in the savannah patches to the north of the village. We were glad to see the rarer species for this lowland river area: the blue-checked amazons, the lilac-tailed parakeet, and the white-eyed parakeet. Our ability to see so many species was due to the spotters' exceptional abilities to identify parrots by sound, silhouette, and flight and behavioral patterns at a distance. This exemplary ability explains why we only had two birds (one pair during one morning count) that could not be identified. If we are to compare this river survey to another season, another part of the river, or to other rivers, we might need to use the same guides to control for variance in guide ability. Alternatively, we could require that future guides undergo a lot of practice and then be tested to discern if they can identify parrots as well.

Differences in Counting Methodology

Figures 8, 9, and 10 break down all observations by type of count; moving, point, and casual. It is notable that we saw more birds and species during the moving counts, because a much greater area was covered during the same time that point counts were conducted. It is surprising that point counts resulted in so many species and individuals, as they basically only covered one km of observable river length (the maximum distance that you can hear the larger parrots). Observing less birds during casual counts made logical sense as these were times of the day when parrots are normally less active, when participants were concentrating more on camp activities, and when the boat motor might have out-competed bird song. Casual counts, on the other hand, covered much more river territory while moving between camps, sometimes over long distances. Small numbers of different species were seen in each method of counting, and every type of count picked up the same eleven species: scarlet macaws, red-and-green macaws, mealy amazons, yellow-crowned amazons, orange-winged amazons, dusky parrots, blue-headed parrots, caica parrots, black-headed parrots, painted parakeets, and golden-winged parakeets.

The moving counts mirrored the overall observations in that the same species were found to be most abundant, but in slightly different decreasing order: golden-winged parakeets, painted parakeets, scarlet macaws, orange-winged amazons, and blue-headed parrots. The point counts differed in the five most common species in descending order: orange-winged amazons (because of the roost site of this species at the village), painted parakeets, yellow-crowned amazons, painted parakeets, and scarlet macaws. The casual counts varied with having golden-winged parakeets, blue-headed parrots, painted parakeets, red-and-green macaws, and scarlet macaws as the most common. We could infer from this that blue-headed parrots, golden-winged parakeets, and painted-parakeets can be observed throughout the day, as well as the larger macaws, but that the amazon parrots are mostly seen during early morning counts and later during evening point and moving counts.

Figure 11 also compares moving to point counts and in almost all cases, more of each species is seen during the moving counts than in the point counts. The only deviation from this is the high numbers of orange-winged amazons, but that is likely because we suspected one of the points counts was in the flight path of a roost site for this species. One point count (Rupununi) also observed more red-shouldered macaws (15), resulting in there being more of this species on point counts, although this is just one flock of 15. We also saw six of this species on one moving count. More yellow-crowned amazons were seen in point counts, who like the orange-winged

amazons, roost in the Rewa village area. Such distributions indicate that moving counts gather more observations, but that point counts can indicate roost sites and flight patterns, resulting in higher numbers and better understanding of the behavior of the birds.

We wanted to know if moving morning counts differed from moving evening counts, not just in terms of when guides might want to take tourists out, but also to let us know when we might only want to count once a day in the future (to save time and financial resources) to learn about parrot behavior patterns. Figures 12 and 13 show the distribution of absolute numbers of all species observed, comparing this distribution to location along the river. Figure 15 shows absolute numbers, but in terms of when the birds were counted. Even with two less moving morning counts (due to rain), there were more than double the numbers of individual birds seen in the morning (754) compared to evening (228). There were 12 species counted in the morning and 14 in the evening. We saw that golden-winged parakeets were more common in the morning, and red-fan parrots in the afternoon. Recording bird numbers as density (# of birds/kilometer of river) confirmed that more parrots are seen in the morning than in the afternoon, although large macaws were seen equally at both times (Figure 18). The only species that appeared to be more visible in the afternoons were red-and-green macaws, red-shouldered macaws, and red-fan parrots. There might be better times to see certain birds, meaning that we need more observations and counts along the river to confirm this for each species.

Location Along River

For moving counts, we broke down the sightings by location. We organized the data by putting them in terms of how many birds were seen per kilometer of river traveled (density) to account for the fewer number of morning counts (Figure 15). For all cases, there were more birds counted in the morning. This was confirmed by looking at the average density of birds in the morning (20.5) and in the evening (8.2), as shown in Figure 24. There is greater deviation from the average in the morning count as a result of the higher counts seen at Toucan Falls and Riverburst at 18.7 and 30.9 kilometers away from Rewa, respectively. The highest overall density of parrots was highest at Toucan Falls in the morning (64), followed by Riverburst in the morning (37.3), and then Rewa in the morning (19.3). Figures 20-23 break down the density of birds by type of parrot along the river and it appears that the higher the density of amazons at Toucan Falls, the higher density of parrots at Riverburst. The higher density of parakeets at both Toucan Falls and Riverburst are responsible for most of the overall increase in overall parrot density at these locations.

To compare point counts in terms of morning and evening counts and location along the river, we looked at the data in Figure 16 (by species) and Figure 17 (by distance from Rewa). We converted the data to numbers of birds per hour to compensate for the fewer morning counts. As these counters were not moving, we couldn't estimate this as birds per kilometer of river. We found that in this case, morning and evening counts are similar in regards to the number of birds, with more seen in the afternoon. Similar to moving counts, we saw more birds at Toucan Falls and Riverburst. The most birds were seen at Rewa where the orange-winged amazon roost existed.

The fewest birds during point counts were seen the furthest from Rewa, and it even seemed as if they dropped off in a somewhat linear fashion. We do not know why this is so. We had thought

we might see changes along the river based on distance from Rewa, perhaps due to changes in human disturbances. Gas is expensive to reach these farther areas, and it's a long paddle from the village. Ongoing trapping is one reason why we might see changes along the river, although the guides repeatedly reported that there was no poaching in the area. Distance from the village might easily correlate with factors other than trapping.

River Characteristics

The river width did not consistently narrow as we went upriver until we reached the two farthest camps from Rewa, which is not surprising as this is where the Rewa River splits off from the Kwitaro River. Comparing width of the river to density of all parrots during moving counts did not show an obvious correlation (Figure 24). We also looked at tree canopy, crudely measured by just recording the height of one tree every 500 meters on both sides of the river. Given the scant data and rough measurements, we did not see any correlation (Figure 25). Our average stop time at each 500-meter mark was 5.2 minutes and ranged from zero to eight minutes. In some cases, we floated straight through the 500-meter mark as the river was slow or we had to cover more distance using the motor to get 500 meters from the last mark as the bird flies because the river was curving back on itself (Figure 27).

Flock Characteristics

We only looked at the non-parakeet species in terms of flock size since parakeets often forage and fly together in numbers greater than the nuclear family. We did not see a large percentage of single birds, suggesting that November is not the early breeding season in this region. This seems confirmed by other information and anecdotal reports (Figure 26), although we are not sure when each species breed here as there has never been a nest monitoring project here. We began a nest monitoring project in 2020, looking for macaw and amazon nests. Based on just one year of data, we saw that the macaws fledged in July and August.

In many species, a single bird indicates a male in search of food to bring back to a female incubating eggs or with young chicks. Flocks of 3, 4, 5, 6 indicate parents with this year's fledglings, or juvenile flocks, although knowing exactly when each species fledges gives more credit to use flock size as a means to determine fledging rate.[3] Since we don't know for sure the breeding season or its variability every year, we can't really say much about the data of flock size. Also, some species don't continue flying as family groups, but instead merge family groups into larger flocks, so the method of using flock size to estimate the number of young in certain species populations has less merit.

Normally, using flock size to estimate numbers of fledglings in a population works well with the larger macaws and amazons, as they fly in pairs most of the time except when with their recently fledged young. We don't know how it works for the other species. We did see many amazons in family size flocks, which means they may have just fledged, that they may stay in family groups longer than the other amazons, or that we were observing juvenile flocks. Yellow-crowned amazons also seemed to be in family groups, with orange-winged amazons less so. The non-amazon parrots, other than the black-headed parrots were also in family groups, the significance of this unknown at this time. We can say with more confidence that the scarlet macaws were

mostly in pairs with few family size groups. This can mean that the chicks from last year are on their own now, parents are close to nesting again, there are not many chicks that are fledging in the area, or that family size groups have moved to other areas.

Human Disturbance

During moving and point counts, we only saw one boat on the river except near the village where a total of six motor boats were seen during the morning and evening count. The village area always sees boat movement, especially as it is at the junction of two rivers. There were nine observances of human activity during the casual counts, a little more than one per day. Normally, there is very little traffic on the river, except for tourism and the occasional local traffic for fishing and farming. Most of the traffic during the casual counts was from boats used for mining exploration. We could not discern any impact of the number of boats on the numbers of birds observed. If mining or logging starts up along the river, there could easily be not only stress-related impacts on the birds, but also a drop in ecological health and a situation where wildlife is a greater risk for hunting and poaching. We were glad that we were able to get a rough baseline of the population so that the village can use these numbers to argue against harmful economic activity on the river.

Ecotourism

Based on these preliminary results, it appears that the best way to show the most variety of species and highest numbers is to move along the river, floating with some stopping and some quiet motoring in the early morning and late afternoon (Figures 9 and 12). The best locations to see the highest number of birds, either through floating or just observing from the camp, is at Toucan Falls and Riverburst; they are both fairly close to Rewa village and within range for tourists for an easy overnight camp at the established Riverburst camp.

With more data, the graphs could suggest where and when to observe certain kinds of birds with the greatest chance of probability, all of which probably depends on the time of the year.

Further Work

This case study is only the first step in refining this technology for river moving transects. We do not know the variability between different days of counting; thus, we cannot be sure that the day we counted is representative of the normal range of parrot observations. We would need to conduct another study repeating the counts over several days at each location, as variability could easily change based on location of the river. It would be helpful to repeat counts to gain greater precision and statistical strength, so we might actually be able to see if there were statistical differences between different segments of the river, different rivers, and different times of the year to one another. Currently, we present the results in a descriptive manner, which might be adequate for beginning ecotourism and conservation activities in Rewa and other river communities.

In the case of Rewa, we need to map out the parrot distribution based on forest ecology and human disturbance, especially if logging and mining come to the river. For instance, we don’t

know why the greatest number of parrots were found at Toucan Falls and Riverburst. We only have this descriptive study for one part of the river during one short time period. How might the data change given the season and time? Are there more or less young birds at different times of the year? Based on our monthly point count in the village, we know that the parrot population changes, but we aren't sure how that corresponds to parrots along the river. Ideally, regular point counts should be done along the length of the river. In conjunction with these counts, we need to do a nest monitoring program to define the breeding seasons and success, characterized by the numbers of adults needed for successful nesting. For instance, the birds we observe might be mainly adults and there might not be much nesting in this area or there is a high failure rate of nests.

Finally, we'd need to do different rivers, because we don't know if Rewa is an outlier for Guyana. Rewa appears to have relatively high numbers of parrots observed based on the author's experience in Guyana and other countries.

There is much work to do and Rewa cannot do it alone. We need others surveying parrot populations along Guyana's rivers so that we can help more parrots and people through improving this technique and gathering more data. To expand this study to other parts of Guyana or the Guiana Shield, we would need to standardize observation and identification methods with all spotters. This would probably take a number of hours of capacity training and practice.

All of these suggestions for further work require resources, including finances and time. We do know that we need to have more specific data for the village and ecolodge where many tourists come to watch birds. This is fairly inexpensive and easy to count, as the guides live there. This single point count, although not optimum, could serve as a rough indication of any possible trends of parrot populations in the area. We will be annexing that data to this Guide in 2021.

Finding out when and where each species nests and nest success is probably the best next step, as it will not only help locate sites for tourists, but will also help us interpret the population data by learning more about breeding. Monitoring nests will also indicate nesting success rates, which is a key component of predicting trends and status of the parrots, as well as what conservation strategies might need to be implemented to ensure that the population flourishes. We began nest monitoring in January 2020, just two months after this survey, and found that red-and-green and scarlet chicks fledged in July-August. We will also be analyzing our two years of point counts in Rewa to see if we can make any estimation of migratory and breeding behavior.

Conclusion

Though this methodology is in its infancy and the results obtained in the Rewa example are descriptive in nature, we suggest that moving river transects can be used to support a community's conservation and ecotourism goals. Furthermore, future work will refine this technique so that it can be used to survey entire river systems and countries. This will serve to get a relatively quick assessment of the health of the population and what could be done to protect them. We encourage conservationists, researchers, and communities to undertake parrot monitoring, working together and using several methods to keep parrots flying free.

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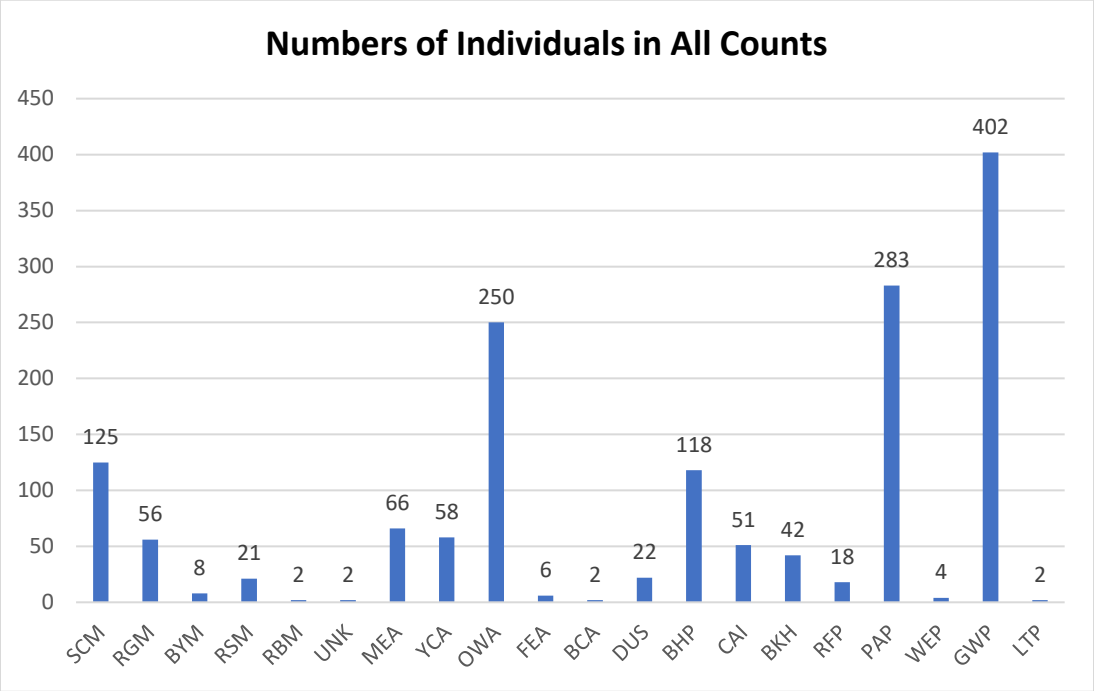
Figures

Figure 6: A total of 19 species and 1538 individuals were seen during the twelve Moving River Transects, the fourteen Point Counts, and the seven Casual Counts. These three letter codes representing each species are used in subsequent figures and were also used during the counts making it easier and quicker to note observations.

Species Code	Common Name	Scientific Name	Individuals	Group Parrot
SCM	Scarlet macaw	*Ara macao*	125	Large macaw
RGM	Red-and-green macaw	*Ara chloropterus*	56	Large macaw
BYM	Blue-and-yellow macaw	*Ara ararauna*	8	Large macaw
RSM	Red-shouldered macaw	*Diopsittaca nobilis*	21	Not grouped
RBM	Red-bellied macaw	*Orthopsittaca manilatus*	2	Not grouped
MEA	Mealy amazon	*Amazona farinosa*	66	Amazon
YCA	Yellow-crowned amazon	*Amazona ochrocephala*	58	Amazon
OWA	Orange-winged amazon	*Pionites melanocephalus*	250	Amazon
FEA	Festive amazon	*Amazona festiva*	6	Amazon
BCA	Blue-cheeked amazon	*Amazona dufresniana*	2	Amazon
DUS	Dusky parrot	*Pionus fuscus*	22	Parrot
BHP	Blue-headed parrot	*Pionites melanocephalus*	118	Parrot
CAI	Caica parrot	*Pyrilia caica*	51	Parrot
BKH	Black-headed parrot	*Pionites melanocephalus*	42	Parrot
RFP	Red-fan parrot	*Orthopsittaca manilatus*	18	Parrot
PAP	Painted parakeet	*Pyrrhura picta*	283	Parakeet
WEP	White-eyed parakeet	*Psittacara leucophthalmus*	4	Parakeet
GWP	Golden-winged parakeet	*Brotogeris chrysoptera*	402	Parakeet
LTP	Lilac-tailed parakeet	*Touit batavicus*	2	Parakeet
UNK	Unknown amazon		2	Amazon

Figure 7: Distribution of the 19 species and the 1538 individuals seen during the 12 Moving River Transects, the 12 Point Counts, and the 7 Casual Counts.



Figures 8: Total distribution and numbers of each species seen during moving counts (N=802 individuals, 17 species). This chart removes two "unknown amazons" seen during one of the counts.

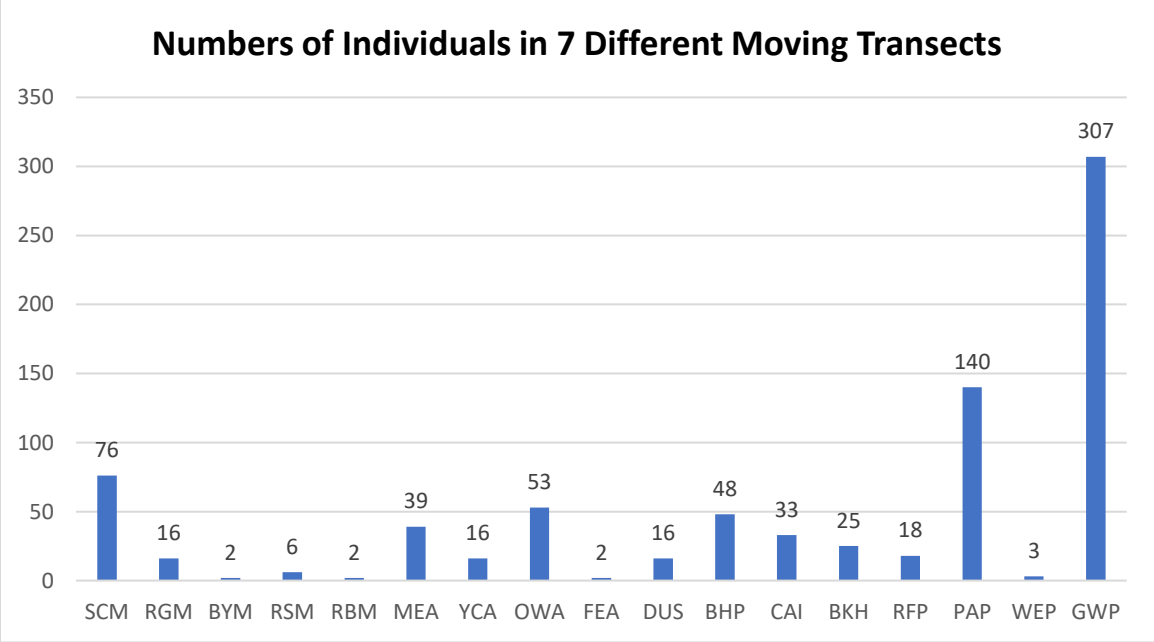


Figure 9: Total distribution and numbers of each species seen during the twelve point counts in seven different locations (N=503 individuals, 14 species)

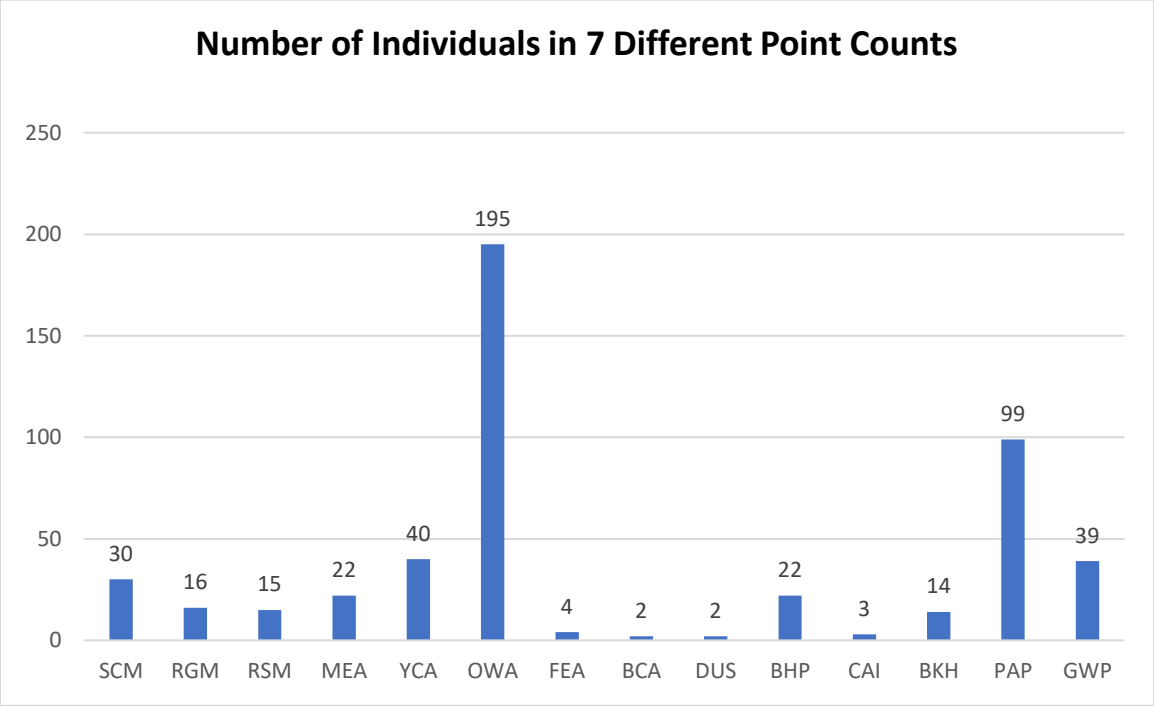


Figure 10. Total individuals counted during the seven Casual Counts (N=231 individuals, 14 species).

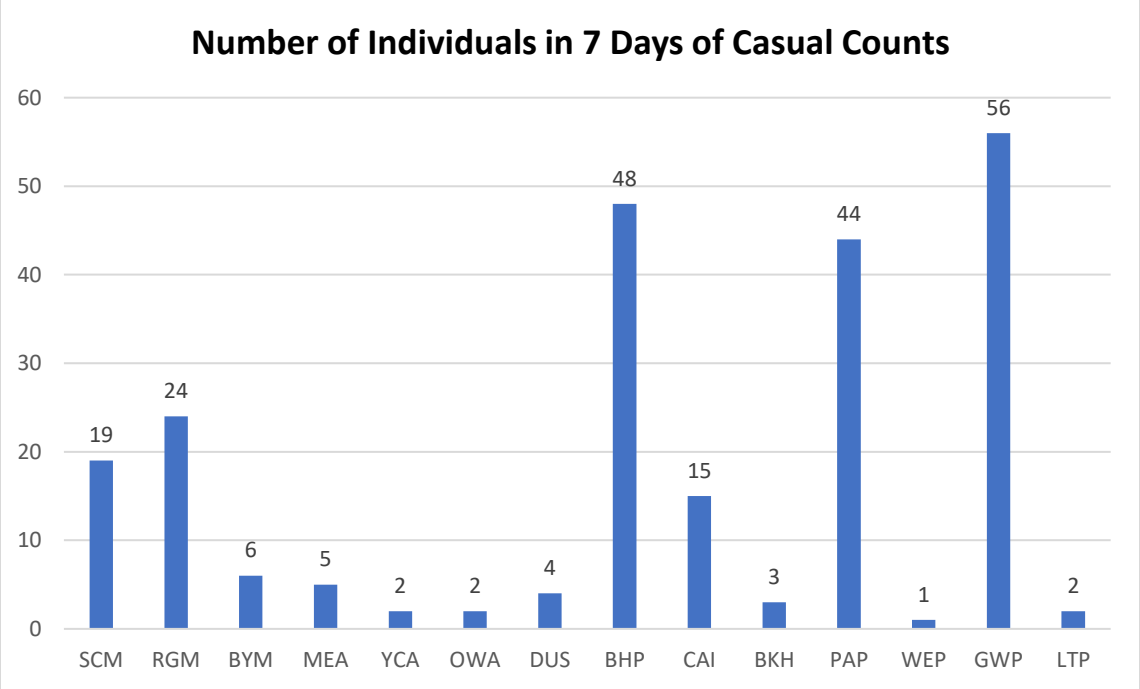


Figure 11. Comparison of total 12 moving counts to 12 point counts in absolute numbers.

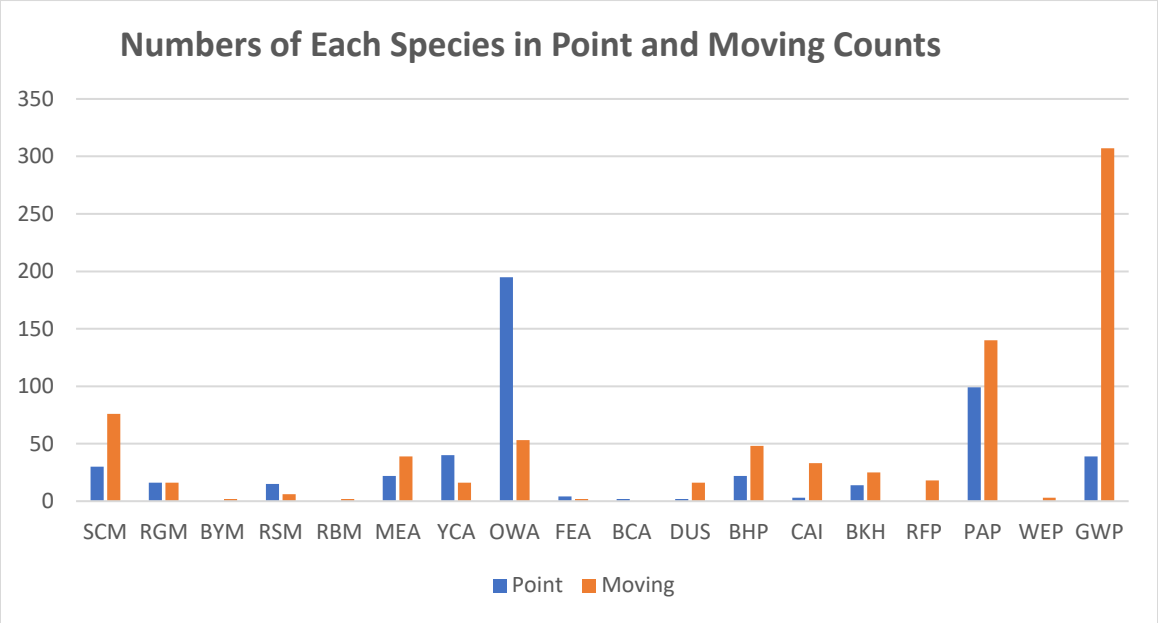


Figure 12: Total number of each kind of species as counted during the 5 morning moving transects (N=574 individuals).

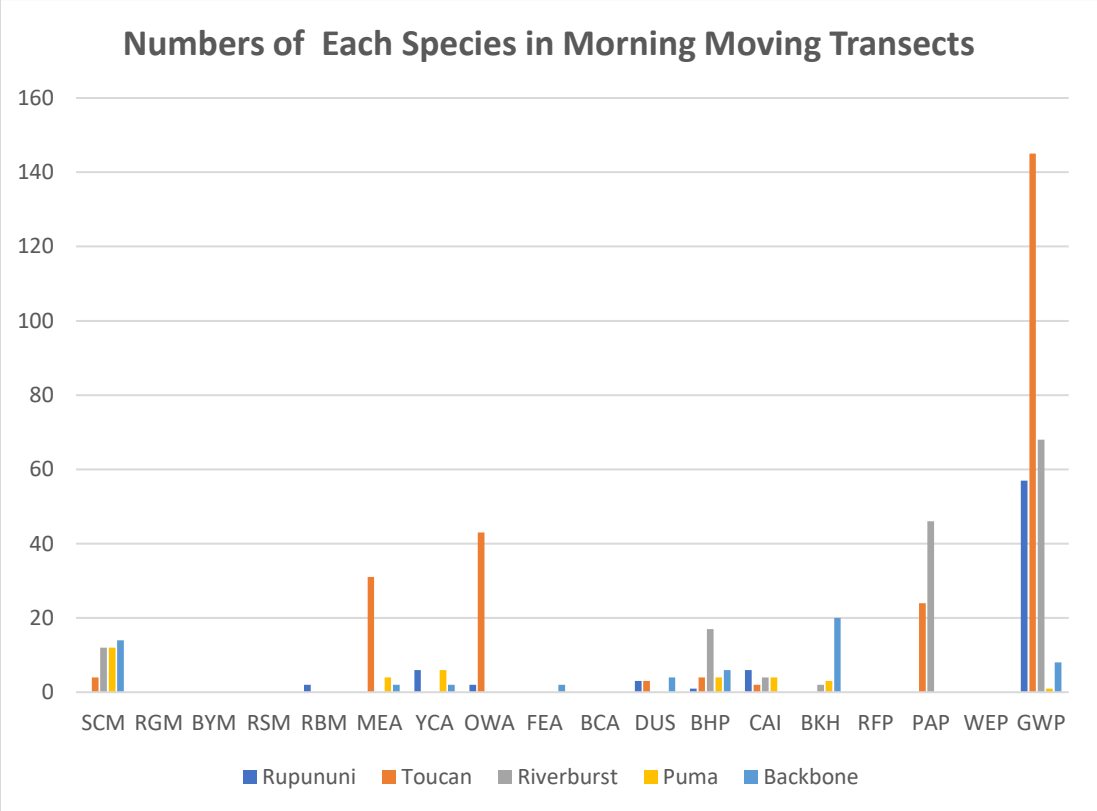


Figure 13: Total number of each kind of species as counted during the 7 afternoon moving transects after removal of 2 unknown amazon species in one afternoon count (N=228 individuals).

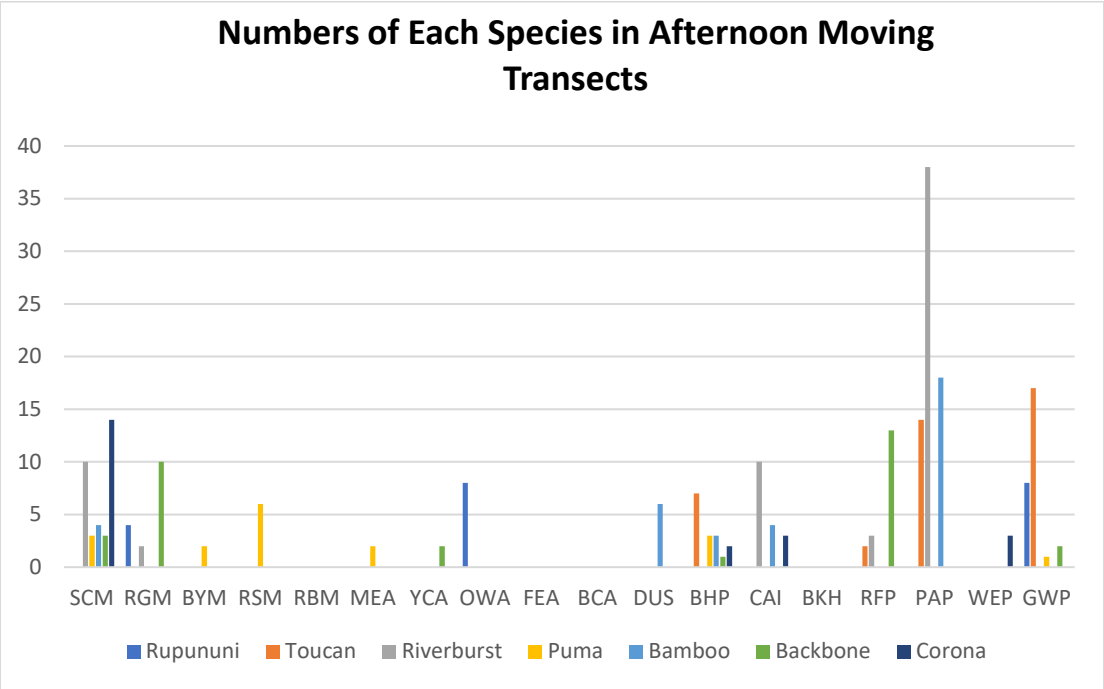


Figure 14: Total number of each kind of species as counted during both afternoon and morning counts (PM = 14 species, AM = 12 species).

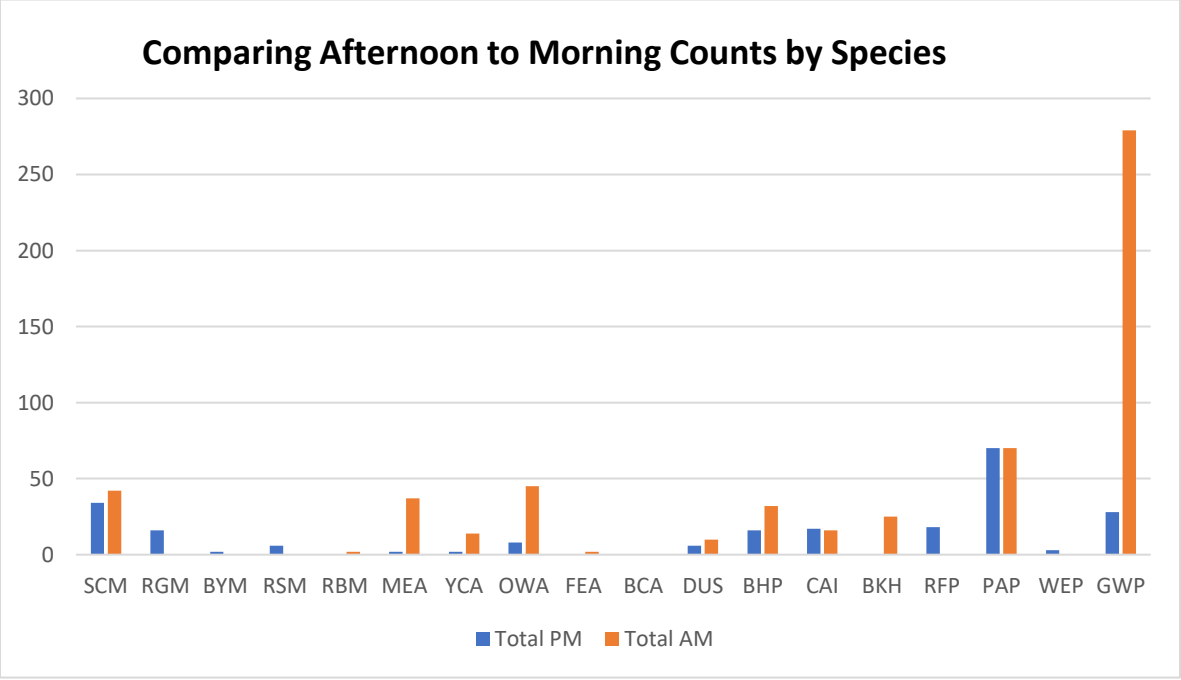


Figure 15: Density of parrots for each of the 7 different transects. The two unknown amazons for the afternoon count at Toucan Falls were added in to reflect the density of all parrots, even if we couldn't identify them. AM counts at 53.9 and 78.9 were rained out.

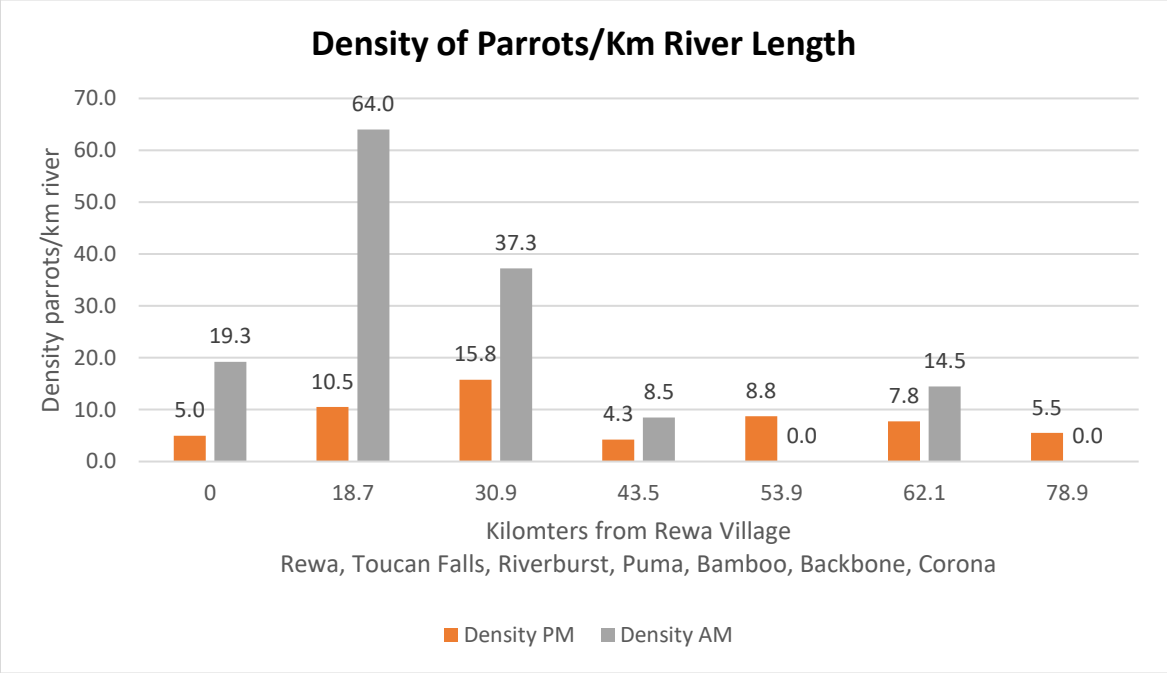


Figure 16: Number of birds observed each hour during 12 point counts as means to compare morning to afternoon counts, because we did two less morning counts that afternoon counts. (PM = 10 species, AM = 12 species).

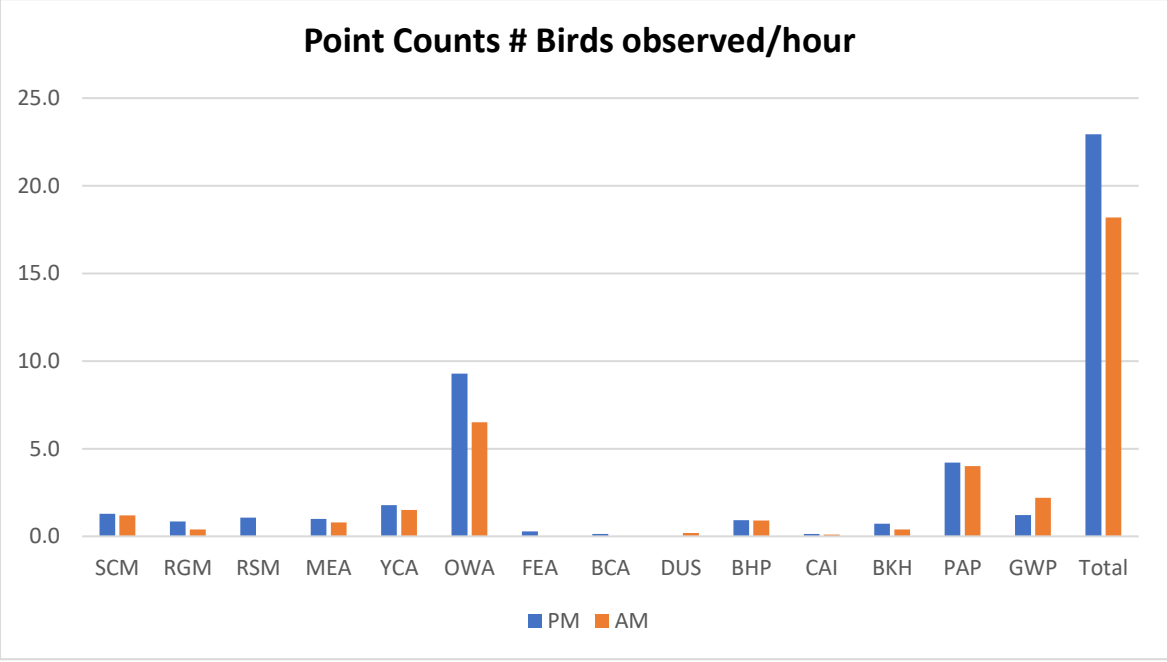


Figure 17: Total number of parrots for each of the 7 different transects (morning AM counts at 53.9 and 78.9 kilometers were rained out).

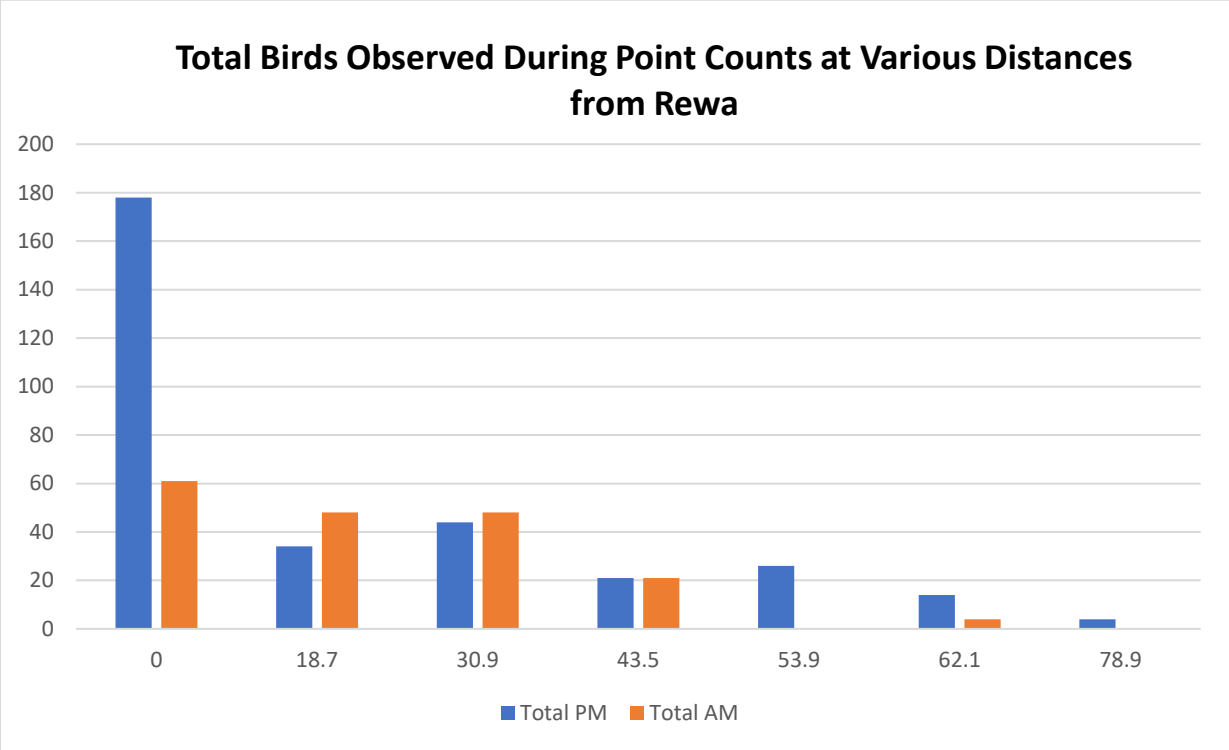
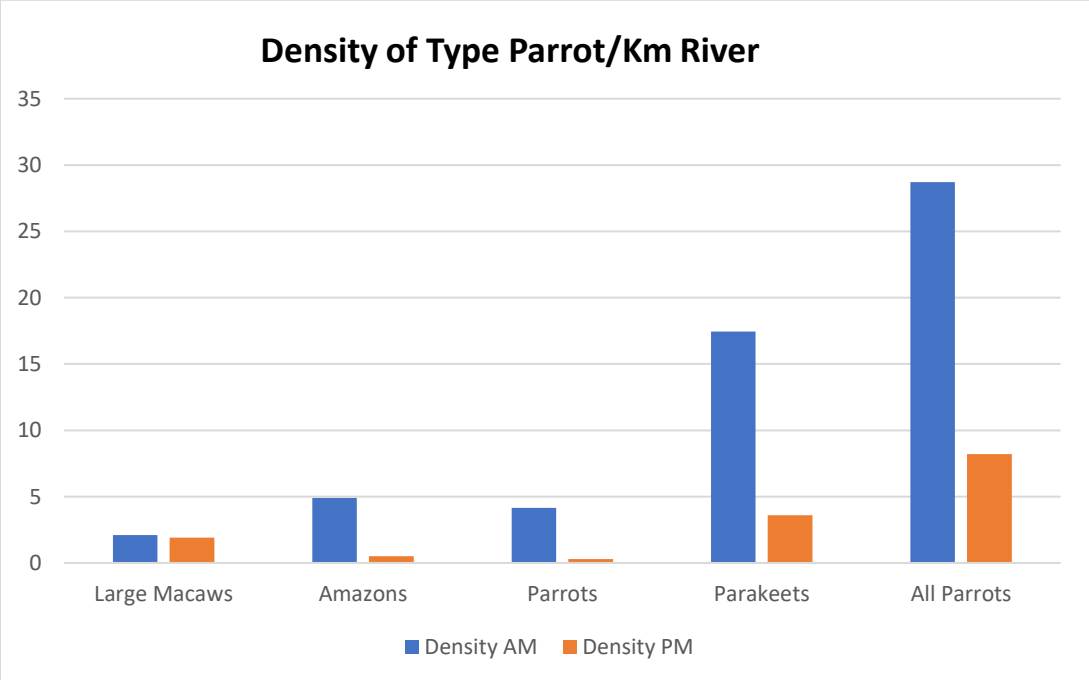


Figure 18: Density of parrots per kilometer river, grouped by parrot type. Large macaws, amazon parrots, parrots that aren't amazons, and parakeets (refer to Figure 7 for groupings).



Figures 19: Density of large macaws per kilometer of river as measured from distance from Rewa village. There were no morning counts at 53.9 and 78.9 kilometers.

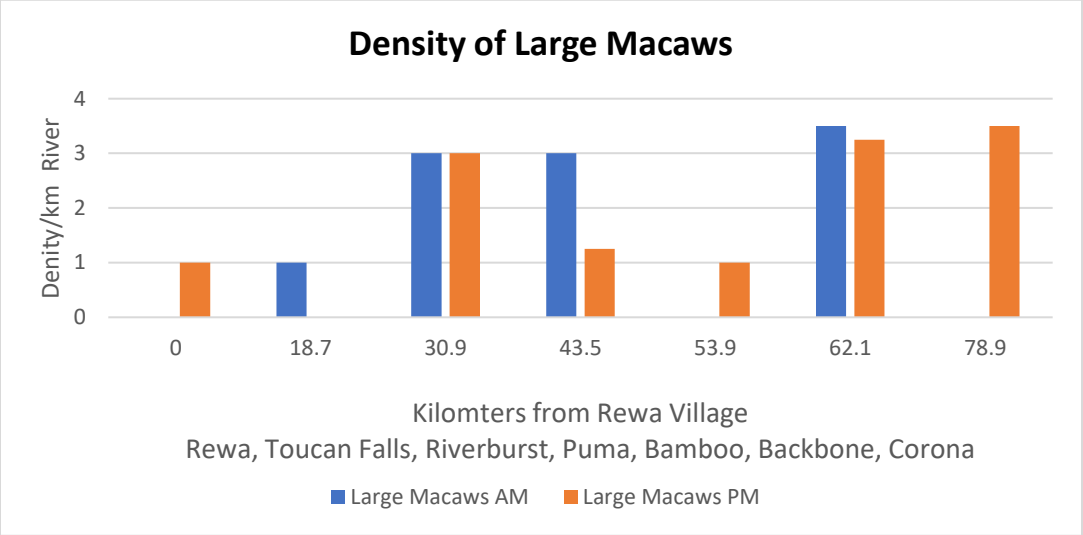


Figure 20: Density of amazons per kilometer of river as measured from distance from Rewa village. There were no morning counts at 53.9 and 78.9 kilometers.

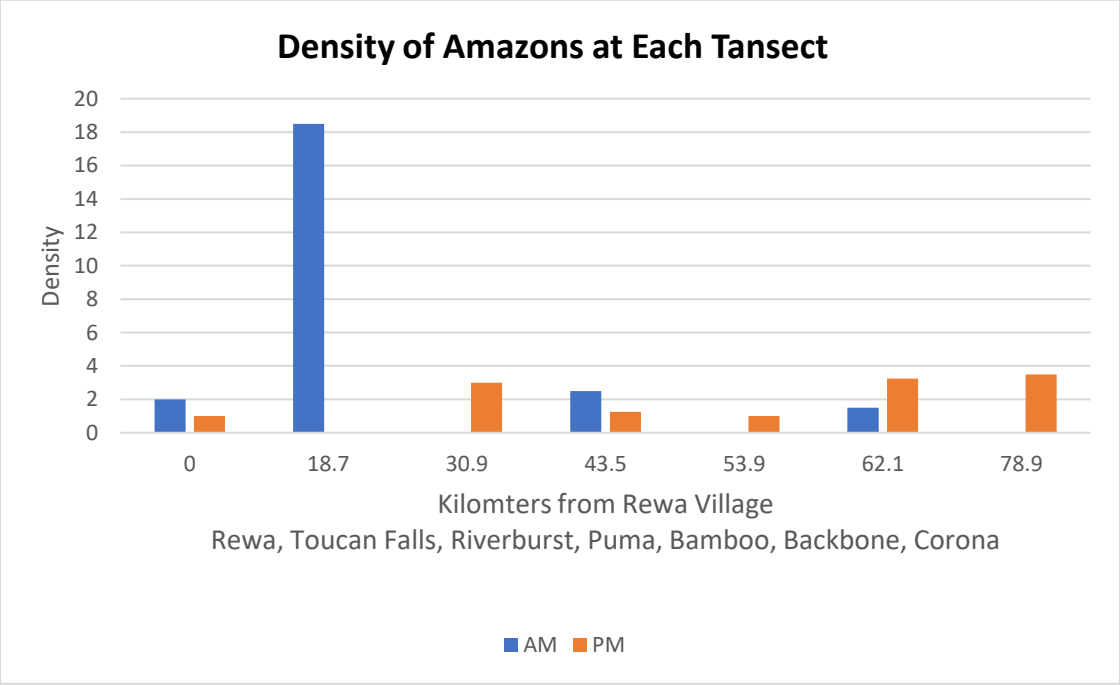


Figure 21: Density of parrots per kilometer of river as measured from distance from Rewa village. There were no morning counts at 53.9 and 78.9 kilometers.

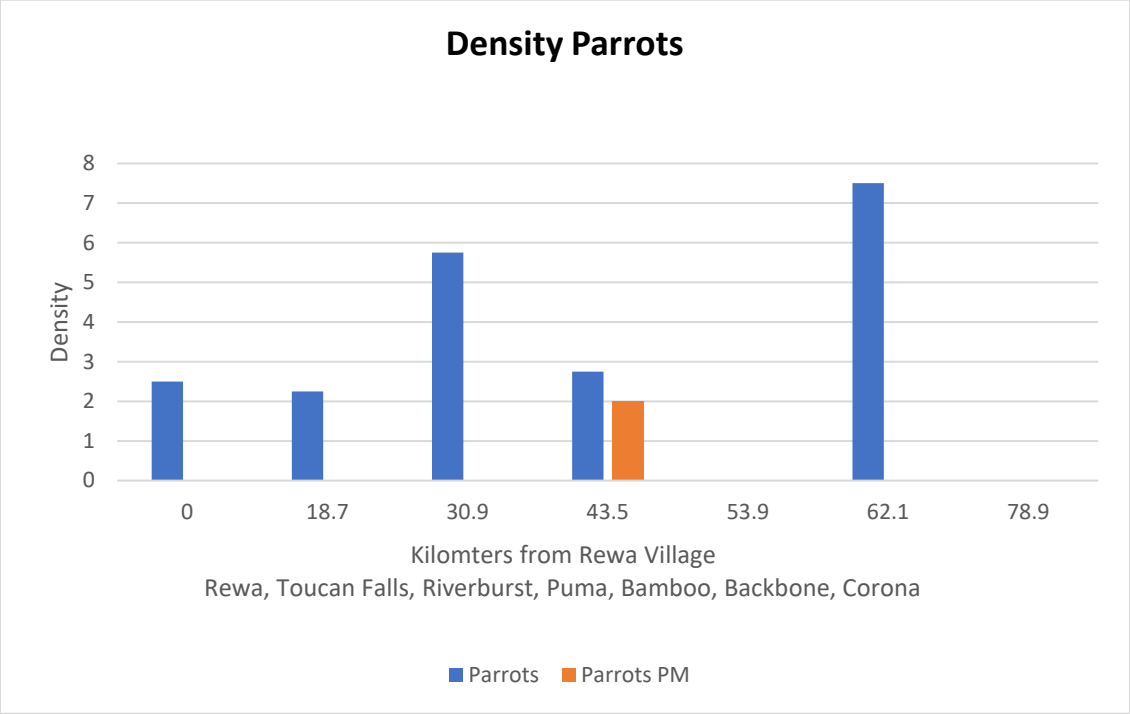


Figure 22: Density of parakeets per kilometer of river as measured from distance from Rewa village. There were no morning counts at 53.9 and 78.9 kilometers. At mile 43.5 there was one parakeet seen.

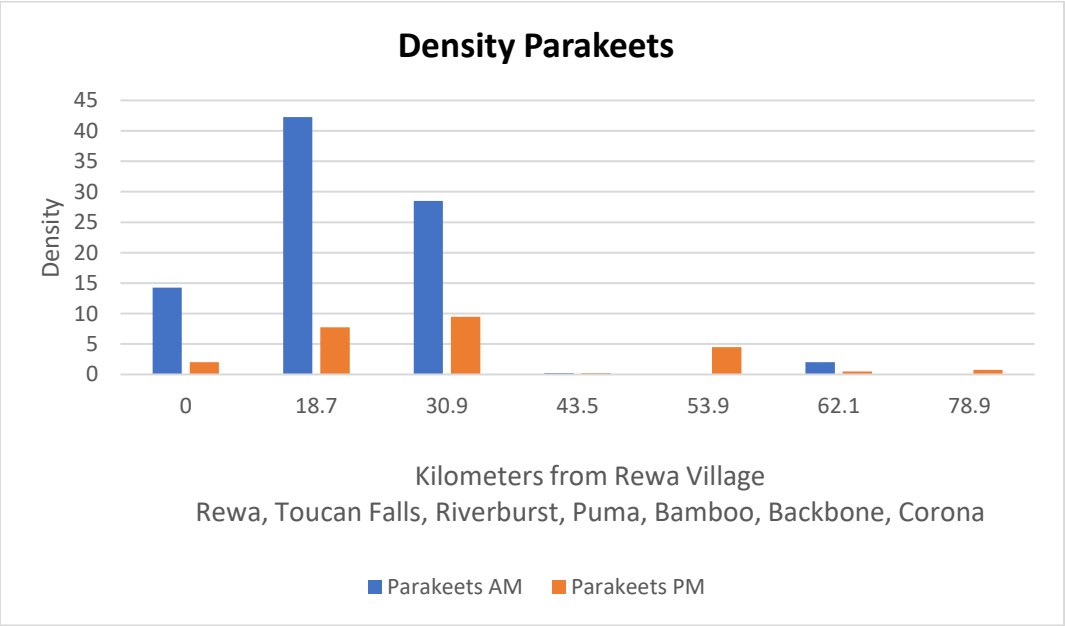


Figure 23: Density of all parrots, width of river, and height of the canopy on the right (R) and left (L) side of the river.

KM Upriver	Density PM	Density AM	R Canopy	L Canopy	Width
0	5.0	19.3	20.6	20.9	109.7
18.7	10.5	64.0	37.8	31.2	87.6
30.9	15.8	37.3	34.6	36.3	102.2
43.5	4.3	8.5	35.7	33.0	93.5
53.9	8.8	0.0	39.0	37.9	89.3
62.1	7.8	14.5	31.1	26.7	75.1
78.9	5.5	0.0	37.4	35.0	65.1
Average	8.2	20.5	33.7	31.6	88.9
Standard Deviation	4.0	23.1	6.3	6.0	15.2

Figures 24: Density all parrots versus width of river during moving counts.

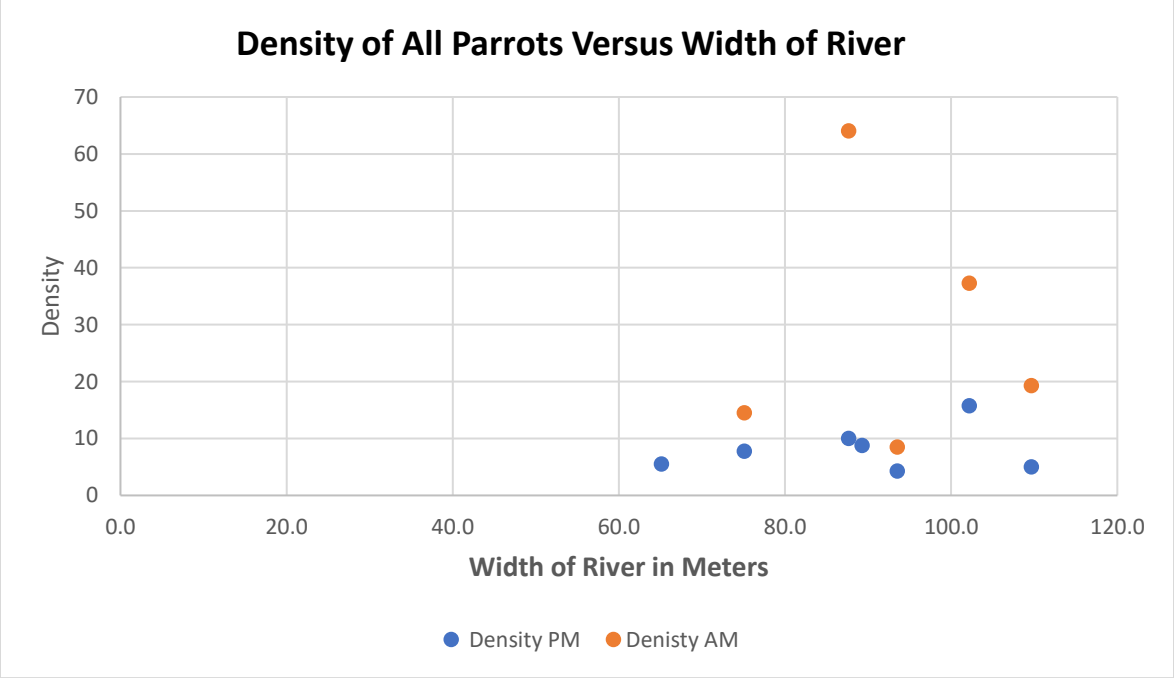


Figure 25: Canopy height versus density of birds in both morning and afternoon moving counts.

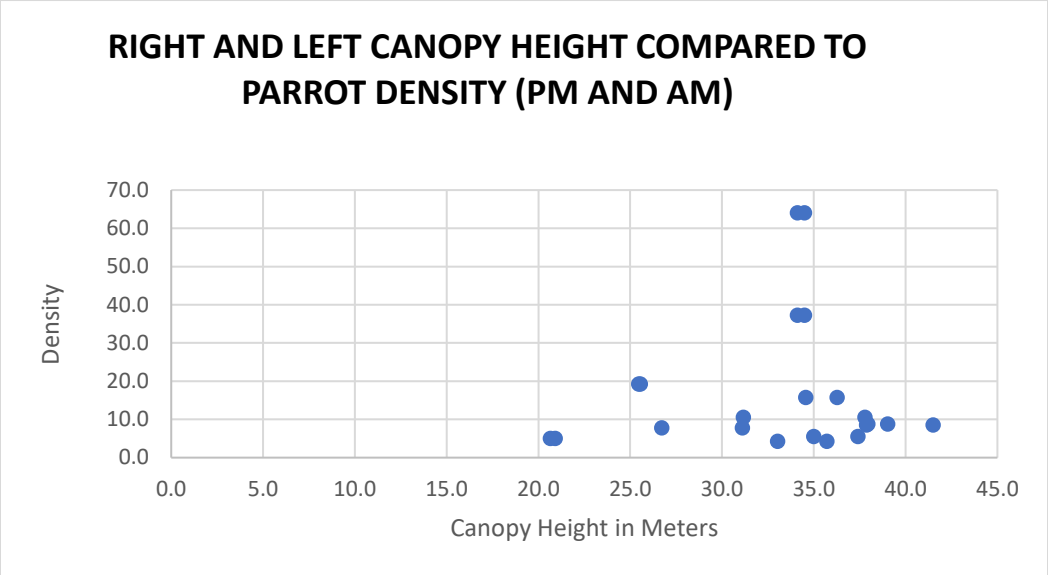


Figure 26: Percentage of total numbers of each species occurring as single birds, in family groups (3,4,5, or 6 birds) or as chicks. Species include those most observable to fly in family-size groups (macaws, amazons, and parrots)

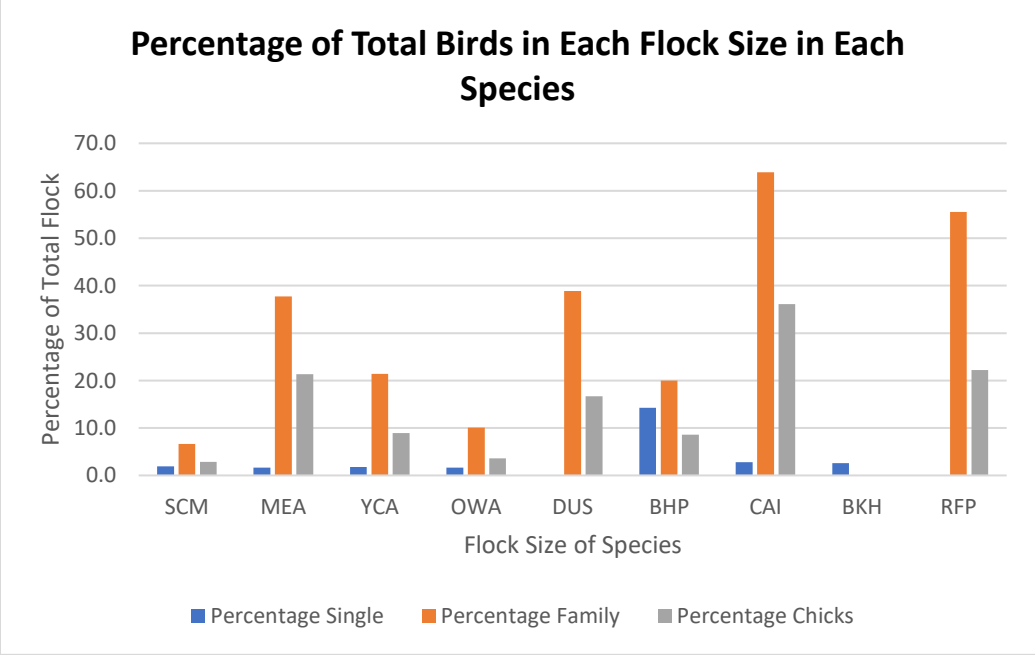


Figure 27: Numbers of minutes stopped at 500-meter marks during evening counts.

Place	**Average**	**Range**
Toucan Falls	6.5	4-8
Rupununi	5	3-8
Backbone	5.6	4-8
Corona	3.5	0-6
Riverburst	3.9	0-6
Puma	6.8	6-8
Total	5.2	0-8

Photographs

Collecting Data

Top – LoraKim Joyner using rangefinder and marking coordinates 500-meter marks
Bottom left – Andrew Albert at a stopped 500-meter mark
Bottom right – Cain Edwards, David Edwards, Andrew Albert moving slow at the first morning 500-meter section

Camps

Top to bottom – Riverburst, Backbone, and Corona camps

On the River

Top left – Franklin Paul motoring to reach next point along the slow Rupununi river
Top right – Davis Edwards grabbing a branch to stop forward motion of boat along fast Rewa River
Bottom left – Davis grabbing more branches, always looking for birds along with Andrew Albert
Bottom right –Franklin captaining during river transect along the Essequibo river with Danika Oriol-Moray of Foster Parrots

Off and on the River

Left – James (captain at Karasabai) getting rock to use as anchor before the count
Right – Dexter Dasilva (elder from Nappi village) summarizing the data after the count
Bottom – Cain Edwards and Dexter Dasilva conducting point count at Toucan Falls camp

Acknowledgements

Thanks to Rewa Ecolodge for providing our meals while at the lodge, lodgings , boats, a cook, a kitchen, guides, a captain, and camping supplies, as well as packing up the food for the trip. There have been many cooks and captains, and we give thanks to them and their families who supported them while they were on the river. Most of all, I thank them for their collaborative spirit and the work they do to provide river experiences to tourists and scientists from all over the world so that their people and ecosystem can thrive.

Thanks to the Rewa Village who staffs the Ecolodge and not only gave permission for this work to happen, but continue it with zeal and commitment.

Thanks to Karasabai village and the many parrot rangers there who helped us develop the ability to count along rivers in Guyana.

Thanks to Nappi Village and elder, Derek Dasilva, for being a counter and data collector.

Thanks to our lead parrot conservationist in Rewa, Davis Edwards, who began the work with Rudy Edwards and now continues with Cain Edwards. Without them, there would be no parrot project in Rewa. They made it possible to begin a river transect study that could be part of the saving of the parrots in this region.

Thanks to Foster Parrots which worked with Rewa Ecolodge years ago and supported this effort by paying stipends for counters. They were the leaders upon which the project was built.

Darin J. McNeil, Jr. was super helpful in helping us think about how to conduct counts on rivers. Thank you!

Thanks, One Earth Conservation Program Assistants, Soledad Diaz and Amanda Puitiza, for their editorial and scientific input, and to Allie for her editorial contributions.

About the Authors

LoraKim Joyner combines her experience as a wildlife veterinarian, Unitarian Universalist minister, and Certified Trainer in Nonviolent Communication to address the importance of both human and nonhuman well-being in living a deeply meaningful and vibrant life, as well as caring for self, family, relationships, organizations, and life all around. She serves as a Community Minister affiliated with the Community Unitarian Universalist Congregation at White Plains, NY and Co-Director of One Earth Conservation. She is an inspiring speaker, leading workshops and webinars all over the country in Compassionate Communication and Nurturing Nature. With over 34 years of experience working with parrot conservation in the Americas, she currently leads projects in Guatemala, Honduras, Nicaragua, Guyana, and Paraguay, and hopes to support parrot conservation projects in Suriname, and French Guiana. You can read about her life and work in her memoirs, "Conservation in Time of War." She looks up to the great people who made this work possible (see co-authors and photo below

Davis Edwards is a river fishing, bird, and wildlife guide at Rewa Ecolodge and co-leads the Rewa Wildlife Club. He is one of the best parrot observers that the lead author has ever met.

Cain Edwards is a fishing, bird, and wildlife guide at Rewa Ecolodge and co-leads the Rewa Wildlife Club. He is one of the best parrot observers that the lead author has ever met, and together with Davis they are a team without comparison.

Rudy Edwards is the Toshao of Rewa Village who with Davis Edwards began the parrot conservation project in Rewa. It was his enthusiasm and commitment that allowed the project to prosper.

Andrew Albert is Deputy Toshao of Karasabai village, and leads the ecotourism and parrot conservation efforts there. His leadership and commitment helped us develop river counting along river banks and during moving transects in Rewa.