Biodiversity and Landscape Structure within the Chiquibul Forest Reserve

A Summary Report of Research Activities in 2006

Ref No. CD/60/3/06 (09)

Feb 2007

Trina. M. Fitzgerald
Acadia University
Wolfville, NS
B4P 2R6, Canada

The following report summarises research activities carried out at Las Cuevas, Cayo District under Permit # CD/60/3/06 (09) issued to Dr. Phil Taylor and the following additional individuals: Trina Fitzgerald, Sam vanderKloet and Joe Nocera.

Table of Contents

Broadly, our research focuses on examining the demographic characteristics of common tropical species of plants and animals in the Chiquibul Forest Reserve.

Research is conducted in conjunction with a two-week field course offered yearly through Acadia University. Students are introduced to particular aspects of tropical biodiversity and landscape ecology research, by designing and implementing long-term modular studies that focus on the following:

1) Long-term monitoring and demography of tropical forest passerines
2) Predator detection by tropical forest passerines
3) Long-term demography of fishtail palm

MODULAR PROJECT: BIRD MONITORING & DEMOGRAPHY

Project: Bird communities in two habitat-types within the Maya Mountains, Chiquibul Forest Reserve: Comparison of species abundance and richness

Principal Investigator: Trina M. Fitzgerald, Acadia University
Collaborators: Dr. Philip Taylor, Acadia University

1.0 INTRODUCTION

Knowledge about the use of the interior forested regions of Belize by resident and migrant bird populations is limited and we lack basic information about habitat requirements of the species known to occupy this region. Therefore, long-term monitoring is required to have a better understanding of bird populations in this region and their habitat needs to formulate conservation strategies.

We are interested in investigating demographic patterns of resident birds within the Maya Mountains, Chiquibul Forest Reserve. Specifically, we focus on determining species-specific habitat associations, and overall relative occurrences of bird species within this region. Our research also focuses on determining species-specific migratory stop-over patterns (e.g. habitat associations, temporal patterns) of neo-tropical migrants.

This study compared the bird community within two types of forest habitat. We describe general patterns in species richness and abundance considering the following questions: What bird species occur in each type of habitat? Are there differences in species richness and abundance of birds among sites? The following report summarises our efforts, to date, to document species-specific habitat relationships between resident and migrant bird species within the Maya Mountains, Chiquibul Forest Reserve.

2.0 METHODS

We selected four study locations within the Chiquibul Forest, near Las Cuevas, to monitor populations of resident and migratory birds. To assess species occurrence, richness and habitat associations, we used mist-nets (fine filamentous nets designed to capture birds) to sample two different habitat types. We established four net-arrays in forested habitat: two arrays of 12 nets in secondary forest habitat, and two arrays of 12 nets in mature broadleaved forest habitat (Figure 1 and 2a and 2b).

At each of these sites, nets were placed in natural openings to limit habitat disturbance. Two net arrays, located perpendicular to each other (e.g., Net Array # 1 and # 4 or # 2 and # 3) were operated daily, for approximately 6 hours, starting 15 minutes before sunrise. We alternated which sets of nets were operated daily. Nets were monitored every 30 minutes. All neotropical migrants were banded with a uniquely numbered U.S. Fish and Wildlife Service (USFWS) aluminum band. Resident birds were banded with a unique 4-number non-USFWS band. We assessed the amount of visible subcutaneous fat each bird had and assigned a score from 0 (no fat) to 7 (copious fat). Details on capture date, time, and net were also collected. These data allow inter-year comparisons of migration timing, physiology, and habitat associations. If a bird could not be identified, it was not banded.

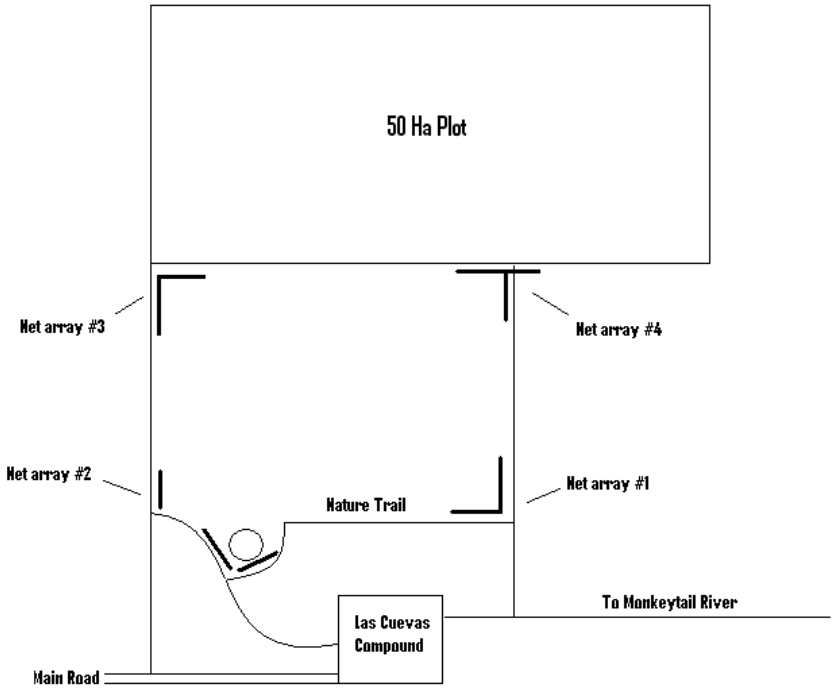
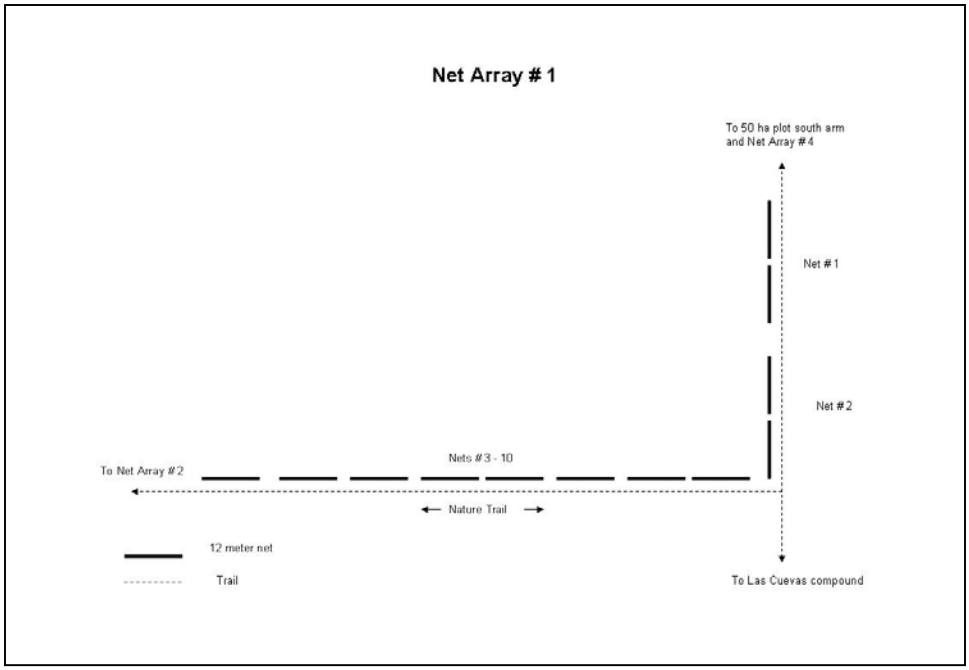


Figure 1. Location of Net Arrays at Las Cuevas Research Station.



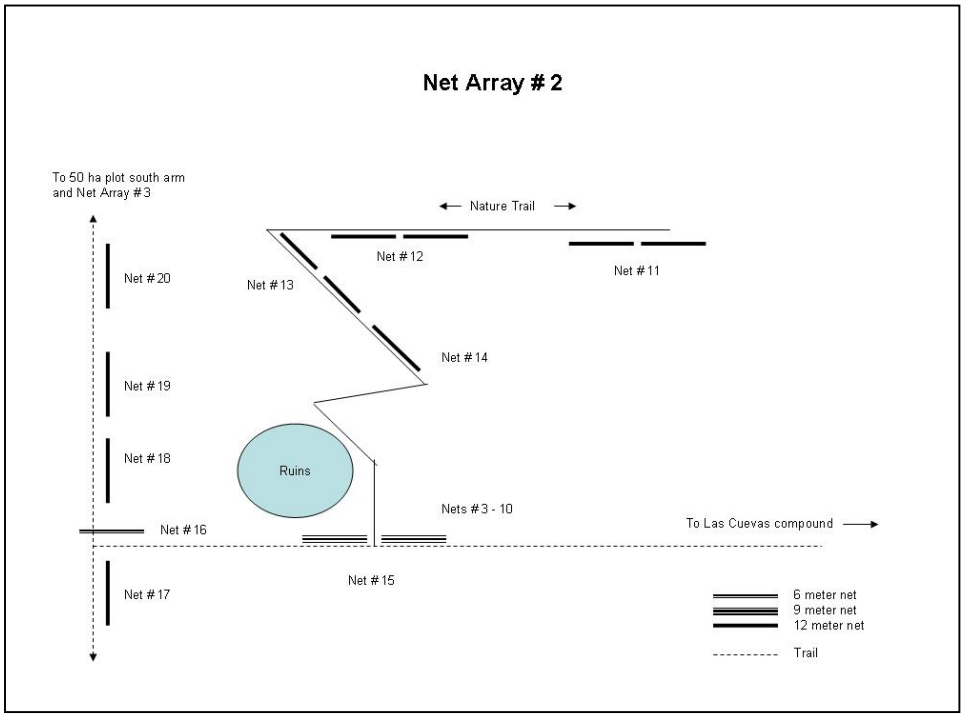
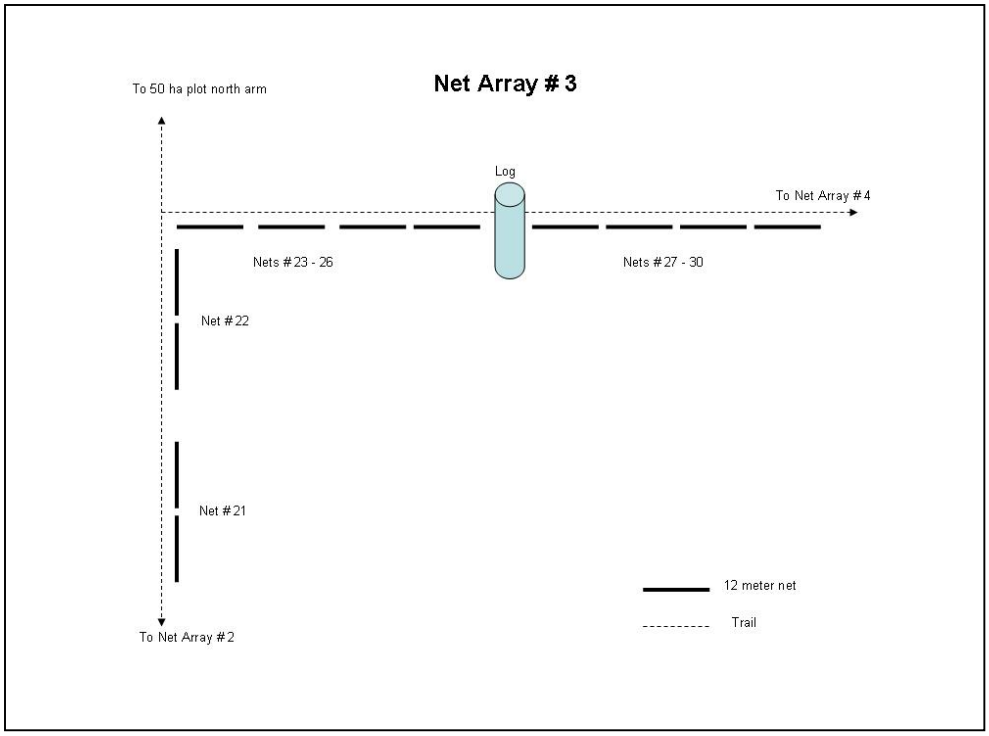


Figure 2a. Mist-net length, number, and placement at Net Arrays # 1 and # 2 (also see Figure 1).



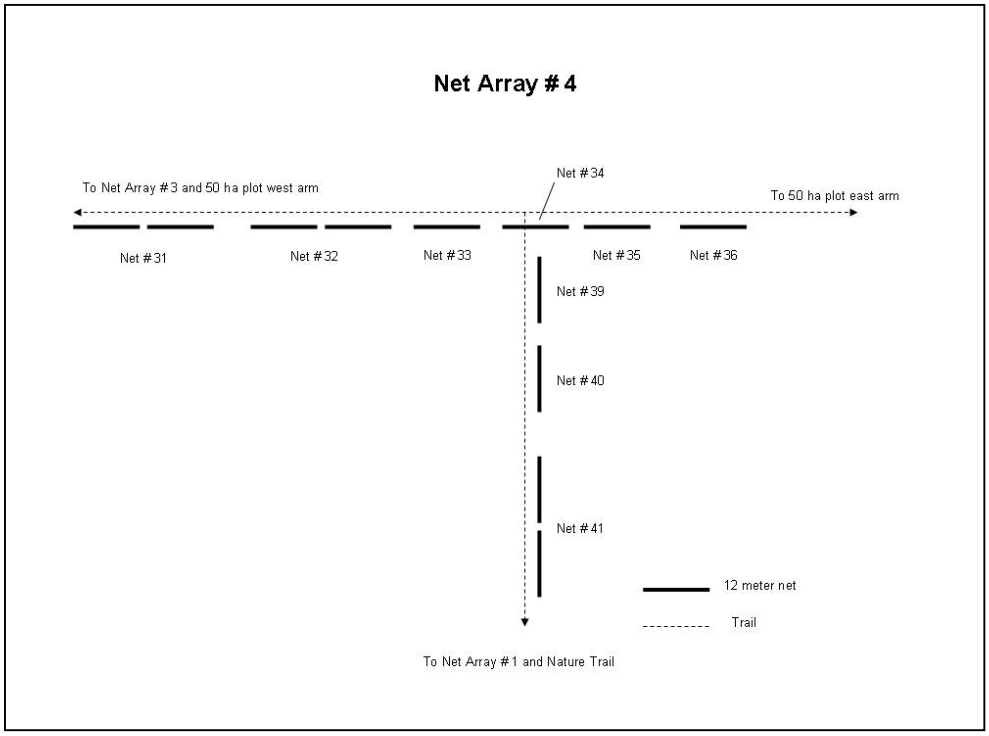


Figure 2b. Mist-net length, number, and placement at Net Arrays # 3 and # 4 (also see Figure 1).

3.0 RESULTS

Constant-effort mist-netting was conducted on 18 days (16 April – 8 May). We captured 428 individuals (332 residents and 96 migrants), comprising 64 species (50 residents and 14 migrants; Table 1; raw data presented in Appendix 1). White-breasted Wood-wren was the most commonly captured resident species and Swainson's Thrush the most commonly captured migrant species. Overall, 13 species comprised 75% of all resident captures and five species comprised 83% of all migrant captures.

Species Richness and Abundance: More resident individuals were caught at Net Array # 2 (113 individuals comprising 23 species) and this site had the greatest species richness (Table 1). Net Array # 4 had the fewest number of resident individuals captured and species richness was the lowest (58 and 20 respectively; Table 1). A similar pattern was observed for migrant species. More individuals were captured at Net Array # 2. However, similar numbers occurred at Net Array # 1 and 4 (Table 2). Species richness was similar across net arrays for migrants.

Overall, the total number of migrant species was similar between the two habitat types (Table 3). However, total number of resident species observed in secondary-forest habitat was 45 (captures from Net Array # 1 and # 2 combined), whereas 27 where observed in broadleaf habitat (captures from Net Array # 3 and # 4 combined; Table 4) suggesting that species richness was higher in secondary-forest habitat. In general, of the species that contributed the most to the overall total number of individuals captured (e.g., total captures ≥ 10), similar numbers occurred within each habitat type (Table 4). There were some exceptions. For instance, we captured more Buff-throated Foliage Gleaners (83.3%), Sulphur-rumped Flycatchers (60%) and Golden-crowned Warbler (66.7%) within secondary-forest habitat. More Red-capped Manakins (72.7%) and Black-faced Ant thrush (85.7) were captured within broadleaf-forest habitat (Table 4). Additionally, Gray-throated Chats were captured within the secondary-forest habitat only.

Temporal Patterns: Temporal patterns of the top four migrants species captured during this study are presented in Figure 2. Overall, Ovenbird, Kentucky Warbler, and Wood Thrush tended to be captured more often during the early part of our sampling period (16 – 20 April). However, more Swainson's Thrush tended to be captured during the later part of the sampling period (> 22 April).

Table 1. Number of individuals banded for all resident species captured at each net array. Total number of individuals and species captured per net array, and overall grand totals are also provided.

RESIDENTS

Species	NET ARRAY # 1	NET ARRAY # 2	NET ARRAY # 3	NET ARRAY # 4	TOTAL
White-breasted Wood-Wren	8	12	9	5	34
Red-throated Ant-Tanager	4	11	8	5	28
Ruddy Woodcreeper	9	1	4	8	22
Golden-crowned Warbler	8	6	4	3	21
Thrush-like Mourner	6	4	8	3	21
Tawny-crowned Greenlet	3	8	7	1	19
Red-crowned Ant-Tanager	3	5	7	3	18
Tawny-winged Woodcreeper	3	4	6	2	15
Ochre-bellied Flycatcher	1	6	4	2	13
Plain Antvireo	2	6	5		13
Buff-throated Foliage-gleaner	4	6	2		12
Red-capped Manakin	1	2	3	5	11
Sulphur-rumped Flycatcher	2	4		4	10
Black-faced Antthrush	1		2	4	7
Orange-billed Sparrow	1	3	1	2	7
Scaly-throated Leaftosser	2	1	2	2	7
Sepia-capped Flycatcher		2	1	3	6
Gray-throated Chat	1	4			5
Ivory-billed Woodcreeper		3		2	5
Olivaceous Woodcreeper	2	2			4
Blue-black Grosbeak	1	1	1		3
Green-backed Sparrow		3			3
Lesser Greenlet		2		1	3
Plain Xenops	1	1		1	3
Stub-tailed Spadebill			2	1	3
Yellow-olive Flycatcher	3				3
Yellow-throated Euphonia		3			3
Barred Forest-Falcon	2				2
Blue Bunting	1	1			2
Bright-rumped Attila	1	1			2
Gray-headed Tanager		2			2
Long-billed Gnatwren			2		2
Northern-Barred Woodcreeper	1		1		2
Olive-backed Euphonia			1	1	2
Ruddy Quail-Dove	1	1			2

RESIDENTS cont'd

Species	NET ARRAY # 1	NET ARRAY # 2	NET ARRAY # 3	NET ARRAY # 4	TOTAL
Bananaquit		1			1
Black-faced Grosbeak	1				1
Blue Seedeater		1			1
Spot-breasted Wren	1	1			2
Wedge-billed Woodcreeper			2		2
Clay-coloured Robin		1			1
Collared Trogon	1				1
Dusky Antbird		1			1
Dusky-capped Flycatcher		1			1
Eye-ringed Flatbill	1				1
Green Honeycreeper			1		1
Ridgway's Rough-winged Swallow		1			1
Royal Flycatcher	1				1
Smoky-brown Woodpecker	1				1
Strong-billed Woodcreeper		1			1
Grand Total Per Site	**78**	**113**	**83**	**58**	**332**
Total Number of Species	**32**	**36**	**23**	**20**	**50**

Table 2. Number of individuals banded for all migrant species captured at each net array. Total number of individuals and species captured per net array, and overall grand totals are also provided.

MIGRANTS

Species	NET ARRAY # 1	NET ARRAY # 2	NET ARRAY # 3	NET ARRAY # 4	TOTAL
Swainson's Thrush	9	10	5	6	30
Ovenbird	2	7	4	1	14
Wood Thrush	4	4	3	2	13
Kentucky Warbler	2	3	2	5	12
Gray-cheeked Thrush	1	2	1	7	11
Black-and-white Warbler	1	2			3
Traill's Flycatcher	3				3
Chestnut-sided Warbler		2			2
Hooded Warbler		1		1	2
Worm-eating Warbler	1	1			2
Acadian Flycatcher				1	1
Gray Catbird			1		1
Indigo Bunting		1			1
Magnolia Warbler			1		1
Grand Total Per Site	**23**	**33**	**17**	**23**	**96**
Total Number of Species	**8**	**10**	**7**	**7**	**14**

Table 3. Number of individuals banded for all migrant species captured within each habitat type. Total number of individuals and species captured per habitat, and grant totals are also provided.

	Secondary Forest		Broadleaf Forest		
Species	Total	%	Total	%	Grand Total
Swainson's Thrush	19	63.3	11	36.7	30
Ovenbird	9	64.3	5	35.7	14
Wood Thrush	8	61.5	5	38.5	13
Kentucky Warbler	5	41.7	7	58.3	12
Gray-cheeked Thrush	3	27.3	8	72.7	11
Black-and-white Warbler	3	100.0	0	0.0	3
Traill's Flycatcher	3	100.0	0	0.0	3
Chestnut-sided Warbler	2	100.0	0	0.0	2
Hooded Warbler	1	50.0	1	50.0	2
Worm-eating Warbler	2	100.0	0	0.0	2
Acadian Flycatcher	0	0.0	1	100.0	1
Gray Catbird	0	0.0	1	100.0	1
Indigo Bunting	1	100.0	0	0.0	1
Magnolia Warbler	0	0.0	1	100.0	1
Total Number of Individuals	56	58.3	40	41.7	96
Number of Species	11	78.6	9	64.3	14

Table 4. Number of individuals banded for all resident species captured within each habitat type. Total number of individuals and species captured per habitat, and grant totals are also provided.

Species	Secondary Forest		Broadleaf Forest		Grand Total
	Total	%	Total	%	
White-breasted Wood-Wren	20	58.8	14	41.2	34
Red-throated Ant-Tanager	15	53.6	13	46.4	28
Ruddy Woodcreeper	10	45.5	12	54.5	22
Thrush-like Mourner	10	47.6	11	52.4	21
Golden-crowned Warbler	14	66.7	7	33.3	21
Tawny-crowned Greenlet	11	57.9	8	42.1	19
Red-crowned Ant-Tanager	8	44.4	10	55.6	18
Tawny-winged Woodcreeper	7	46.7	8	53.3	15
Ochre-bellied Flycatcher	7	53.8	6	46.2	13
Plain Antvireo	8	61.5	5	38.5	13
Buff-throated Foliage-gleaner	10	83.3	2	16.7	12
Red-capped Manakin	3	27.3	8	72.7	11
Sulphur-rumped Flycatcher	6	60.0	4	40.0	10
Black-faced Antthrush	1	14.3	6	85.7	7
Scaly-throated Leaftosser	3	42.9	4	57.1	7
Orange-billed Sparrow	4	57.1	3	42.9	7
Sepia-capped Flycatcher	2	33.3	4	66.7	6
Ivory-billed Woodcreeper	3	60.0	2	40.0	5
Gray-throated Chat	5	100.0	0	0.0	5
Olivaceous Woodcreeper	4	100.0	0	0.0	4
Stub-tailed Spadebill	0	0.0	3	100.0	3
Blue-black Grosbeak	2	66.7	1	33.3	3
Lesser Greenlet	2	66.7	1	33.3	3
Plain Xenops	2	66.7	1	33.3	3
Green-backed Sparrow	3	100.0	0	0.0	3
Yellow-olive Flycatcher	3	100.0	0	0.0	3
Yellow-throated Euphonia	3	100.0	0	0.0	3
Long-billed Gnatwren	0	0.0	2	100.0	2
Olive-backed Euphonia	0	0.0	2	100.0	2
Wedge-billed Woodcreeper	0	0.0	2	100.0	2
Northern-Barred Woodcreeper	1	50.0	1	50.0	2
Barred Forest-Falcon	2	100.0	0	0.0	2
Blue Bunting	2	100.0	0	0.0	2
Bright-rumped Attila	2	100.0	0	0.0	2
Gray-headed Tanager	2	100.0	0	0.0	2
Ruddy Quail-Dove	2	100.0	0	0.0	2
Spot-breasted Wren	2	100.0	0	0.0	2
Green Honeycreeper	0	0.0	1	100.0	1

Residents cont'd

Species	Secondary Forest Total	Secondary Forest %	Broadleaf Forest Total	Broadleaf Forest %	Grand Total
Bananaquit	1	100.0	0	0.0	1
Black-faced Grosbeak	1	100.0	0	0.0	1
Blue Seedeater	1	100.0	0	0.0	1
Clay-coloured Robin	1	100.0	0	0.0	1
Collared Trogon	1	100.0	0	0.0	1
Dusky Antbird	1	100.0	0	0.0	1
Dusky-capped Flycatcher	1	100.0	0	0.0	1
Eye-ringed Flatbill	1	100.0	0	0.0	1
Ridgway's Rough-winged Swallow	1	100.0	0	0.0	1
Royal Flycatcher	1	100.0	0	0.0	1
Smoky-brown Woodpecker	1	100.0	0	0.0	1
Strong-billed Woodcreeper	1	100.0	0	0.0	1
Total Number of Individuals	191	57.5	141	42.5	332
Number of Species	45	90	27	54	50

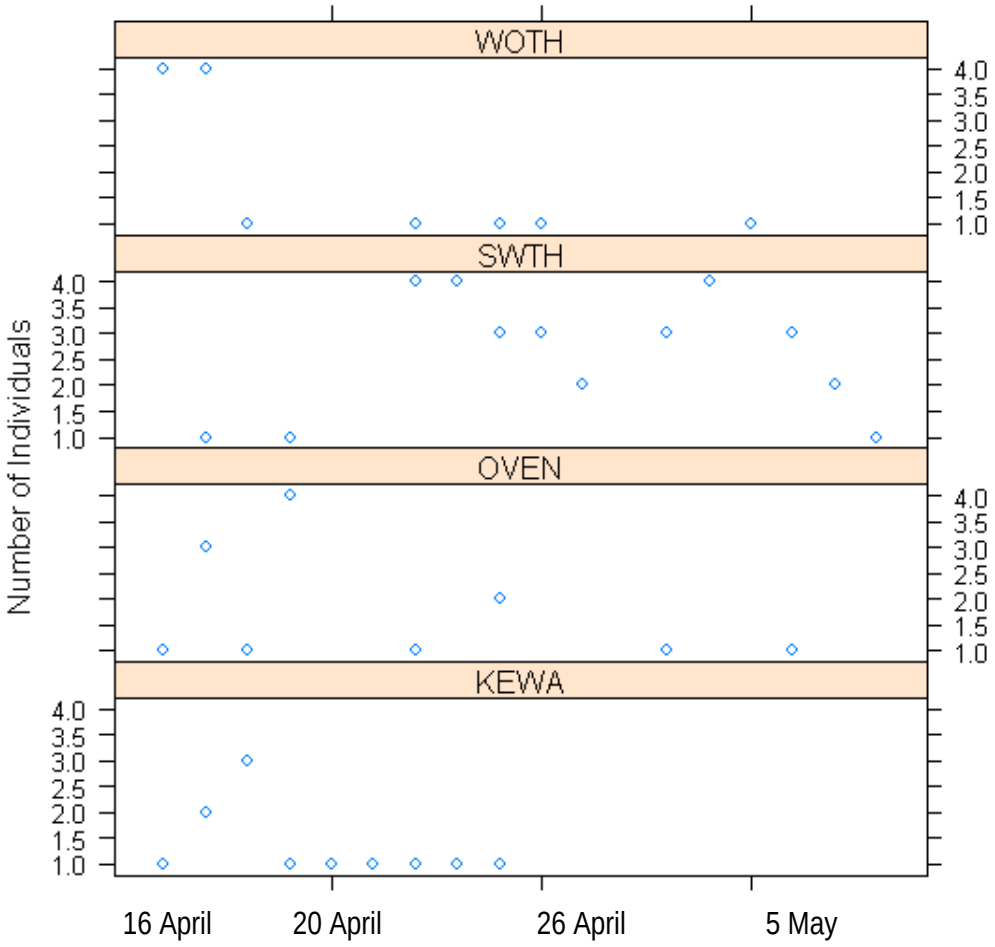


Figure 3. Number of individuals captured daily across study period for 4 migrant species. KEWA = Kentucky Warbler, OVEN = Ovenbird, SWTH = Swainson's Thrush, WOTH = Wood Thrush.

4.0 DISCUSSION

Our banding efforts show great promise to monitor migration adequately and begin a rigorous inventory of the local avifauna and their habitats. In addition, it has led to observations of several interesting patterns that, if we are to better understand birds in the Belizean interior, warrant further investigation. We present the following examples.

i. Our monitoring efforts continue to document large numbers of Swainson's Thrush migrating through the area, demonstrating the potential importance of this region to migratory passerines. This region of Belize is an important site to study because migration patterns in this area are poorly known (Mills and Rogers 1990, Miller and Miller 1998). The number of these migrants that we are detecting at Las Cuevas has not been documented from that region of Central America. If the Swainson's Thrush provides any indication, the Belizean interior (along the Maya Mountains) may be a very important, migration route. This possibility needs examination, and could prove to be a very important milestone in improving the conservation of migratory birds in Belize.

ii. Many of the species that we captured were common within both habitat types that we surveyed. However, there were some exceptions. For instance, we captured more Buff-throated Foliage Gleaners (83.3%), Sulphur-rumped Flycatchers (60%) and Golden-crowned Warbler (66.7%) within secondary-forest habitat. Red-capped Manakins (72.7%) and Black-faced Ant thrush (85.7) were captured within broadleaf-forest habitat (Table 3). Additionally, Gray-throated Chats were captured within the secondary-forest habitat only. These patterns may be due to habitat type or sampling biases within each area and therefore warrant further study before definite conclusions can be drawn.

Literature Cited.

Miller, B.W. and C.M. Miller. 1998. Ornithology in Belize since 1960. *Wilson Bulletin* 110: 544-558.

Mills, E.D. and D.T. Rogers. 1990. Nearctic passerine fall migration in central Belize. *Wilson Bulletin* 102: 146-150.

MODULAR PROJECT: PREDATOR DETECTION BY MIGRANTS

Project: Observational surveys to determine how migrants learn to recognize unfamiliar predators within the Maya Mountains, Chiquibul Forest Reserve.

Principal Investigator: Dr. Joseph Nocera, Queens University
Collaborators: Dr. Philip Taylor and Trina M. Fitzgerald, Acadia University

1.0 INTRODUCTION

Migration is the riskiest portion of a migratory animal's life cycle (Lindström 1989; Anthony & Blumstein 2000); the risks of starvation, predation, or inaccurate navigation accumulate as migratory distance increases (Dierschke & Delingat 2001; Drent *et al.* 2003). Long-distance migrants encounter a diverse and potentially novel array of habitat types, which present some unique risks to survival. For instance, a long-distance migrant will encounter numerous unfamiliar predators that use a range of hunting strategies; these risks strongly affect aspects of bird migration such as foraging behaviour and migratory timing (Lind & Cresswell 2006). Although many animals recognize predators innately (Veen *et al.* 2000), some may also use social cues from other animals and/or information from predator inspection (Conover 1987; McLean & Rhodes 1991; Deecke *et al.* 2002; Caro 2005). During migration, such behaviours have the potential to increase survival greatly. The most successful migrants will recognise novel and variable predation hazards en route, and respond to them appropriately.

Animals that detect potential predators may respond by avoiding or approaching them. An approach is either an inspection or confrontation, either of which may *seem* maladaptive because mortality risk can increase if the approach is too close (Fishman 1999). However, inspection and confrontation can be advantageous (see review by Dugatkin & Godin 1992) if they provide prey with reliable information about the threat (e.g., predator size, position, activity). Here, I differentiate between inspection and confrontation on the basis of physical interaction between predator and prey.

Inspection behaviour involves an approach toward the predator to gain an unobstructed view, which does not result in a physical interaction. Using this definition, inspection is not an attempt to harass the predator. However, it can signal to the predator that it has been detected and that it should divert its hunting attention elsewhere. Predator inspection has been documented in several taxa (e.g., gazelles (Fitzgibbon 1994) and lizards (Leal & Rodriguez-Robles 1997)), but predominantly in fish (Dugatkin & Godin 1992; Godin & Davis 1995; Brown 2003). To my knowledge, direct predator inspection has not been documented in animals engaged in migration, particularly birds.

Confrontation, on the other hand, is an attempt to forcibly drive the predator away (Curio's (1978) "move-on hypothesis"). A confrontation is more likely to evict a predator successfully if others are recruited to form a "mob". Mobbing is seen in many taxa, such as primates (Srivastava 1991), rodents (Owings & Coss 1977) and fish (Ishihara 1987). There is little

evidence to suggest the behaviour is associated with increased mortality (Caro 2005), although more study is needed. Mobbing is observed most commonly in passerines (songbirds), where individuals converge on a potential predator, rapidly change position around its location, perform restless wing and tail movements, and emit loud broad-frequency calls (Curio 1978). These calls are easily recognizable to both conspecifics (Templeton *et al.* 2005) and heterospecifics (Marler 1957; Hurd 1996) and act as honest signals of threat (Lind *et al.* 2005). In temperate habitats, the individuals most likely to participate in mobs are established territory holders and breeding birds (Betts *et al.* 2005), followed by non-migratory winter residents (Turcotte & Desrochers 2002). Migrating individuals seldom participate in mobbing, opting instead to approach predators silently or avoid them altogether (Shedd 1982).

This presents an unresolved paradox. To avoid a predator, an individual must recognise that one is present, and possess information on the expected threat level. If migrating birds rarely participate in mobs, and approach to inspect predators is undocumented, how do birds acquire information on unfamiliar predators? One hypothesis is that migrants acquire additional information on predatory hazard from birds that are resident within areas they are passing through. These residents should be reliable information sources because they have a vested interest to drive away predators by engaging in mobs. Therefore, responding by inspecting a mob (hereafter "mob-inspection"), but not participating in it, may be an important low-cost way to gain predator information (a form of cultural transmission; Curio *et al.* 1978); We call this the 'mob-inspection hypothesis'.

We tested the mob-inspection hypothesis using mob-call playback experiments during spring migration in Belize, Central America. We provided mob-call playbacks of a nearctic resident, the black-capped chickadee (*Poecile atricapillus*), and a neotropical resident, the blue-gray tanager (*Thraupis episcopus*).

Black-capped chickadees are non-migratory and distributed coast-to-coast in North America, reaching their northern limit in the Northwest Territories (Canada) and their southern limit in Kansas and Colorado (USA). We chose black-capped chickadees for my experiments because their calls would be novel to neotropical residents, but familiar to most nearctic-neotropical migrants (hereafter "neotropical migrants"). In addition, black-capped chickadees often act as "nuclear species" that instigate community flocking behaviour (Dolby & Grubb 1998), the acoustic structure of their mob-call has been well described (Ficken *et al.* 1978) and can convey contextual information (Templeton *et al.* 2005).

We chose to use playbacks of blue-gray tanager mob-calls for similar reasons. They are non-migratory and abundant across their range from the Amazon Basin to the Atlantic coast of Mexico (Brawn *et al.* 1996; DaSilva *et al.* 1996). Blue-gray tanagers are often nuclear species in the neotropics (e.g., Hilty 1994, Latta &Wunderle 1996) and, during spring migration their calls should be familiar to both neotropical migrants and residents.

In testing the mob-inspection hypothesis, we seek to determine 1) if migrants inspect mob-calls, 2) the factors influencing responses to mob-call cues, and 3) if calls can be recognized when they are unfamiliar (black-capped chickadee calls are novel to neotropical residents) and/or clearly

out of context (migrants would not otherwise encounter black-capped chickadees within 2000 km of our study site).

2.0 MATERIAL AND METHODS

Study site: We conducted our study during a period of low seasonal rainfall (16 April – 9 May, 2006) in western Belize at Las Cuevas Research Station (16°44'N, 88°59'W), in the interior of the Chiquibul rainforest in the Maya Mountains. The Chiquibul is the largest intact tropical forest north of the Amazon. It is typical of diverse tropical broad-leafed rainforests dominated by mahogany (Meliaceae), bay cedar (Surianaceae) and ceiba trees (Bombacaceae). Numerous epiphytes and profuse vine tangles contribute to the foliage density.

Belize has a great diversity of predators and is also along a major migratory route; 83 passerine species migrate through the area (Jones 2003). Although many neotropical migrant species over-winter in Belize, the winter range of other migrant species is further south, which allowed me to sample birds in different migratory phases (i.e., over-wintering and actively migrating).

Bird capture and banding: We used data collected from constant-effort mist-netting in 2005 and 2006 (see project description above) to monitor the breeding status and abundance of residents and the passage and abundance of migrants.

Mobbing playback experiments: Experiments consisted of broadcasting one of four playback stimuli for 10 min and concurrently observing the number and behaviour of responding individuals. The stimuli were: (i) a control with no playback, (ii) playback of a neutral sound to control for sound stimulus, (iii) playback of black-capped chickadee mob-calls, and (iv) playback of blue-gray tanager mob-calls. We wanted to quantify responses to the information provided only by mob-calls (and not any visual cues), so we did not use any predator model during experiments. We used continuous AM radio static (range 530-610 KHz) as a neutral sound treatment. We repeatedly played a track of black-capped chickadee mob-calls recorded from wild-caught birds in Montana (USA) that were presented with a live great-horned owl (*Bubo virginianus*) in a semi-natural aviary (Templeton *et al.* 2005). Likewise, we repeatedly played a track of blue-gray tanager calls recorded while mobbing a common black hawk (*Buteogallus anthracinus*) at Manuel Antonio National Park in Costa Rica (D. Von Gausig, Sennheiser shotgun microphone recording system).

Playback experiments were conducted in five 40 m wide circular plots within 1 km of the banding stations described above. Each plot was sampled six times per treatment type, so that each 10 min treatment was performed twice during the first, middle and last third of daylight hours (0600-1000, 1001-1400, and 1401-1800 h, respectively). A plot that received a sound stimulus trial was not visited again for at least 6 h. Trials were conducted only on days when wind was < 25 kph with no precipitation. A total of 120 trials was conducted.

Playbacks were carried out using a portable compact disc player (Sony DEJ1010B) broadcasting (75 ± 5 dB at 1 m) through two amplifier-speakers (Nexxtech SXM/11 Multimedia). In the centre of each plot, speakers were oriented back-to-back on a small platform positioned in tree

limbs 1-2 m from the ground. Short pieces of flagging tape were used to indicate 20 m radii from the speakers.

Two observers were positioned opposite each other at vantage points beyond 20 m from the playback. One observer, using continuous sampling, recorded (*i*) all species and individuals detected in the plot and (*ii*) the time each bird was first detected. The other observer used focal-switch sampling (Losito *et al.* 1989) to monitor behaviour of birds in the plot. When more than one bird simultaneously entered a plot, the behavioural observer haphazardly selected a focal bird to follow. The behavioural observer also surveyed for signs of passive (foraging, singing, perching, preening) or agitated behavioural responses (frequently approaching the plot/playback and retreating, calling repeatedly, wing fluttering, tail flicking / display, frequent hop, bowing) (modified after Krams & Krama 2002).

Statistical analyses: We built logistic regression models, using *R* v. 2.1.1 (R Development Core Team 2005), to determine factors influencing presence/absence of migrant and resident species in a plot, and whether they showed passive/agitated behaviour. In all cases, the importance of a term in the model was initially assessed by evaluating the parameter estimates followed by an analysis of deviance (using an α-level of 0.05) to justify removing terms from the model (Dalgaard 2002).

We used receiver operating characteristic (ROC) curves to estimate the predictive value of all final models (Hanley & McNeil 1982). The area under the ROC curve (AUC) reflects the probability that a model will discriminate between positive and negative observations correctly. AUC values of 0.5 represent no discrimination (i.e., a very poor model). In general, models with AUC <0.7 have low predictive accuracy, between 0.7-0.8 have acceptable accuracy, and >8 have high accuracy (Hosmer & Lemeshow 2000).

Prior to analysis, we eliminated trials during which we observed brown jays (*Cyanocorax morio*; 10 trials), mealy parrots (*Amazona farinose*; 1 trial), or red-lored parrots (*A. autumnalis*; 2 trials). These resident species occasionally passed through in noisy foraging flocks that prevented detailed observation and may have unduly influenced the response of passerines. We also ignored any observations of unidentified species (n = 144, 30% of total observations).

Incidence. To ensure that birds were not simply attracted to playbacks to investigate novel sounds, we assessed whether incidence (i.e., presence/absence) of all birds (migrants and residents pooled) differed between control and static treatments. We found a negative relationship between incidence and static playback ($t = -2.01$, $p = 0.002$) relative to controls. This indicated that playback of static was actually an aversive stimulus. We therefore removed the static treatment from all further analyses.

Our second step was to determine whether there were detectable differences in responses to the remaining treatments. To do this, we pooled all migrant species ("all-migrant" model) and all resident species ("all-resident" model) and modelled their incidence with chickadee, tanager and control treatments as main effects.

Most respondents were from a small number of species, so we did not generate all-migrant or all-resident models with further factors. Instead, our third step was to build species-specific models for the most commonly detected migrant and residents. In addition to treatment type, we included four other predictor variables in the full model: time-of-day, date (Julian) of the trial, observer, and the interaction between date and treatment type (to account for any change in perceived stimulus value over time).

To control for the daily changing abundance of migrant birds available in the study area (determined from the bird banding data), we included a sixth variable in the full model (for migrant species only): an abundance index for each day, derived from the daily capture rate per meter-net-hour for each species. For migrant species not captured in adequate numbers to develop a species-specific index, we used all migrants to calculate a daily 'migratory activity' index.

Behaviour. We built all-migrant and all-resident models of passive/agitated behaviour using the same predictive variables as above (with the exception of the abundance index for resident models). We also included three more predictive variables in the full models: latency to response (i.e., time first observed in relation to trial start), total-time-responding, and whether the individual was the first bird observed at the trial (to control for social effects). Because of small sample sizes for most species, we then constructed species-specific models only for the migrant Swainson's thrush (*Catharus ustulatus*), and the resident golden-crowned warbler (*Basileuterus culicivorus*) and red-throated ant-tanager (*Habia fuscicauda*).

3.0 RESULTS

Bird capture and banding: We accumulated 33,894 meter-net-hours of banding effort. We captured and banded 148 migrant passerines (see tables within Modular Project #1 above for 2006 data). Swainson's thrush was the most common migrant (41.9% of all migrants captured). The next most commonly captured migrant species were ovenbird (*Seiurus aurocapilla*; 12.8%), Kentucky warbler (*Oporornis formosus*; 9.5%), wood thrush (*Hylocichla mustelina*; 8.8%), and gray-cheeked thrush (*C. minimus*; 8.8%).

We captured and banded 413 neotropical resident passerines (see Supplementary Table II, page 17, for a complete list). White-breasted wood-wren (*Henicorhina leucosticta*) was the most common resident species (10% of all residents captured). The next most commonly captured residents were red-throated ant-tanager (7.8%), golden-crowned warbler (6.1%), ruddy woodcreeper (*Dendrocincla homochroa*; 5.8%), and thrushlike mourner (*Schiffornis turdinus*; 5.3%).

Mob-inspection by migrants: A total of 94 migrants were observed during trials (see Supplementary Table I for a complete list). The four species observed most commonly in playback trials were Swainson's thrush (42% of all observations), magnolia warbler (14%; *Dendroica magnolia*), black-and-white warbler (13%; *Mniotilta varia*), and red-eyed vireo (11%; *Vireo olivaceus*).

Best-fit models describing the response of these four migrant species to playbacks are shown in table 1. Not surprisingly, the abundance index was an important predictor in all best-fit models describing incidence, indicating that trials reflected the overall incidence of species in the area. Time of day was an important predictor in incidence models for all species except Swainson's thrush, with more activity being observed in earlier and latter parts of the day. However, only models for incidence of Swainson's thrush and red-eyed vireo showed a relationship with playback treatment types; both occurred more often in trials with chickadee and tanager playbacks relative to controls, but more often to chickadee than to tanager playbacks. The same pattern is seen among all species migrating at the time of the study (Figure 1).

The best-fit models of behavioural response to playbacks for both Swainson's thrush (AUC = 0.84) and all-migrants (AUC = 0.77) retained the same two variables: date and total-time-responding. As the season progressed, fewer agitated responses were observed for both Swainson's thrush ($t = -1.37$, $p = 0.12$) and all-migrants ($t = -2.14$, $p = 0.06$). However, as expected, the number of agitated responses increased as birds spent more time at the trial for both Swainson's thrush ($t = 1.15$, $p = 0.02$) and all-migrants ($t = 1.93$, $p = 0.03$).

Factors influencing response: Our results are consistent with the hypothesis that response by migrants to playbacks is linked to migratory status (Figure 1). The three most commonly detected species (Swainson's thrush, magnolia warbler, and red-eyed vireo) do not over-winter in the study area (Manomet Observatory 1996; Jones 2003), so we are confident they were actively migrating at the time of observation. In contrast, four of the five species captured in greatest abundance (ovenbird, Kentucky warbler, wood thrush, and gray-cheeked thrush) were hardly ever observed at playbacks (2 individuals only; Table 1, Figure 1). All these species over-winter in our study area (Manomet Observatory 1996; Jones 2003), so our observations of these species are comprised of an unknown ratio of non-migrating to actively migrating birds. The banding activity provides further support for the purported difference in migratory status of these species. Many ovenbirds, wood thrushes, and Kentucky warblers were recaptured on days following their banding, however, Swainson's thrushes were never recaptured.

Response by residents to playbacks was linked to breeding status. The majority of the most commonly observed residents responded positively to tanager playbacks (table 2, figure 1, see also next section), all of these species also showed signs of breeding during the study period. Golden-crowned warblers exhibited the greatest proportion of breeding individuals (30% of captured individuals). The lowest level of breeding activity was observed in the two species that did not show a difference in response between chickadee and tanager playbacks (table 2): ruddy woodcreeper (7% of individuals captured) and white-breasted wood-wren (none). For these two species, date was the only retained predictor in models of their incidence (table 2), where more individuals were observed at trials later in the season. A model lumping resident species into two groups (breeding/not) confirms this suggestion (breeding response; $t = 1.49$, $p = 0.04$).

Response to mob-call playbacks was not socially facilitated. In our analyses, the variable describing whether a bird was first to respond to our playbacks was not retained in the best-fit models for migrants or residents (tables 1 and 2).

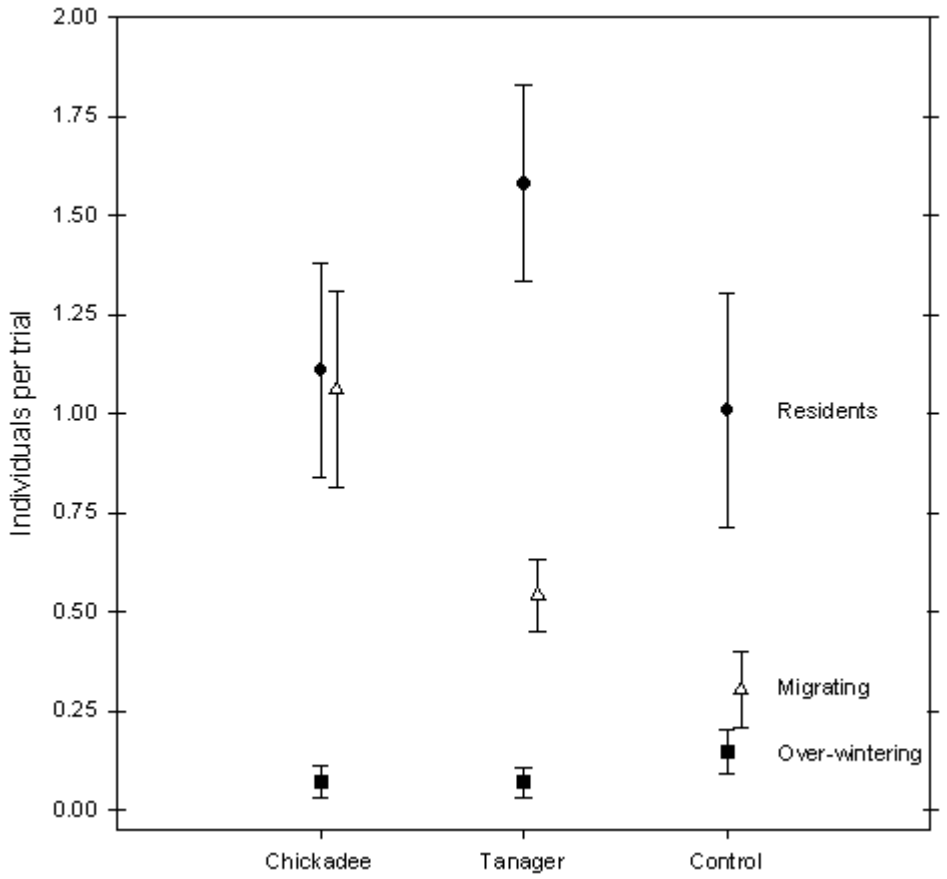


Figure 1. Effect of call playback treatments on migrating birds (open triangles), migrants still over-wintering (filled squares), and resident neotropical species (filled circles) in Belize. Values for migrating birds have been right-shifted to avoid overlap. Response is shown as the number of individuals observed per trial in relation to playbacks of mob-calls from black-capped chickadees (*Poecile atricapillus*; a nearctic resident), blue-gray tanagers (*Thraupis episcopus*; a neotropical resident), and no sound (control). Migrating birds responded significantly more to chickadee and tanager playbacks than to controls, although response to chickadee was stronger than to tanager. Over-wintering birds responded very little to any stimulus type. Neotropical residents responded significantly to tanager playbacks, but did not differ in response to chickadees and controls.

Table 1. Best-fit models describing the incidence of the four migrant bird species most commonly detected at playbacks of black-capped chickadee and blue-gray tanager mob-calls in Belize, Central America. (Variables retained in the best-fit model are indicated by provision of their parameter estimates (β coefficient ± standard error; deviance explained) within the model)

species	variables retained in best-fit model						residual deviance	null deviance	AUC
	treatment type		abundance index		time of day				
	β ± SE	deviance	β ± SE	deviance	β ± SE	deviance			
Swainson's thrush	-0.51 ± 0.3	3.39	86.92 ± 71.7	1.21			86.58	92.24	0.68
red-eyed vireo	-4.59 ± 12.0	8.11	-117.22 ± 96.4	0.33	-0.002 ± 0.0	3.73	38.38	49.98	0.84
magnolia warbler			-287.39 ± 160.1	4.77	-0.001 ± 0.0	0.85	42.60	44.76	0.70
black-and-white warbler			281.03 ± 106.0	7.01	0.003 ± 0.0	3.39	42.25	44.76	0.70

Table 2. Best-fit models describing the incidence of the five neotropical resident bird species most commonly detected at playbacks of black-capped chickadee and blue-gray tanager mob-calls in Belize, Central America. (Variables retained in the best-fit model are indicated by provision of their parameter estimates (β coefficient ± standard error; deviance explained) within the model)

species	variables retained in best-fit model				residual deviance	null deviance	AUC
	treatment type		date				
	β ± SE	deviance	β ± SE	deviance			
golden-crowned warbler	0.33 ± 0.3	1.52			86.69	88.21	0.58
red-throated ant-tanager	-0.29 ± 0.5	0.38			36.51	37.01	0.57
thrushlike mourner			0.51 ± 0.6	0.85	30.60	31.45	0.62
white-breasted wood-wren			0.10 ± 0.1	2.27	49.10	51.37	0.59
ruddy woodcreeper			-0.06 ± 0.06	0.87	42.11	44.76	0.67

Response to context and novelty: All-migrant models of incidence showed that birds responded more strongly to chickadee ($t = 2.31$, $p = 0.0002$), and tanager playbacks ($t = -1.14$, $p = 0.12$), relative to controls (figure 1). However, response was stronger to chickadee than to tanager playbacks (figure 1). Among the best-fit models for the most common migrant species (table 1), the response to black-capped chickadees was particularly evident for Swainson's thrush and red-eyed vireo.

Treatment type was the only retained predictor in incidence models for three resident species (table 2); their incidence was much greater at blue-gray tanager playbacks than at the novel black-capped chickadee playbacks (figure 1). Best-fit models describing the response to playbacks of each of the five resident species detected most commonly in trials are shown in table 2, although the precision of these models is generally low (i.e., AUC < 0.70).

The best-fit all-resident behavioural model retained the terms of time of day and total-time-responding (AUC = 0.65); residents were least active in the mid-day and more active as their time in the trial plot increased. The two species-specific models we generated retained only the term of total-time-responding for golden-crowned warbler (AUC = 0.98) and date for red-throated ant-tanager (AUC = 0.55). I did not observe a treatment effect in the all-resident best-fit models of behavioural response to playbacks, indicating that agitated/passive response to chickadees and tanagers was similar.

4.0 DISCUSSION

4.1 *Mob-inspection by migrants*: Our results reveal interesting variation in mob-inspection behaviour within a suite of migratory bird species at a neotropical site. Species migrating through the site responded more often to mob-call playbacks than to control (no sound) experiments. Previous studies have suggested that migrating birds do not participate in mobs (Shedd 1982) and rarely approach predators directly (see review in Caro 2005), despite ample evidence that birds gain fitness advantages by collecting information on predators (see review in Lind & Cresswell 2005). Our study reconciles these differences by suggesting that migrating birds may inspect mobs while migrating, *in lieu* of directly approaching the predator and/or participating in the mob. Our models also showed no difference in behavioural (agitated vs. passive) response to playbacks, further supporting the inference that inspectors tend to approach but not participate. Thus, mob-inspection may represent a low-cost learning opportunity for migrants.

4.2 *Factors influencing response*: Migratory phase seems to be linked to mob-inspection behaviour; among migrant birds, those that were actively migrating inspected mob-call playbacks more frequently than their non-migrating counterparts (figure 1). For example, Swainson's thrush and red-eyed vireos do not over-winter in the study area (so were migrating through the area at the time of our study), yet were observed most frequently at playbacks of black-capped chickadee mob-calls (see Supplementary Table I). Red-eyed vireos were not caught in mist-nets, and surprisingly, they were never observed at playbacks of blue-gray tanager mob-calls or static. In contrast, four of the five most commonly captured migrant species were

rarely detected at playbacks: ovenbird, Kentucky warbler, gray-cheeked thrush, and wood thrush. These four species are migrants that reside for the winter in this study area (Manomet Observatory 1996; Jones 2003) and all but the Kentucky warbler (M.V. Macdonald pers. com.) respond to chickadee stimuli on the temperate breeding grounds (Belisle & Desrochers 2002; Sieving *et al.* 2004; Hames *et al.* 2006). There are two possible explanations for the difference in mob-inspection by actively migrating and non-migrating birds: i) mob-calls associated with the breeding grounds might suddenly elicit response at the onset of migration, or ii) perhaps the responsive species are always attuned to breeding ground stimuli and would respond in the over-wintering period as well. These two possibilities have not been evaluated, so it would be worthwhile to investigate mob-inspection behaviour during the over-wintering period when migration is not occurring and compare it to results from experiments conducted during migration, such as the present study.

The response of neotropical residents to playbacks was generally weaker, but appeared to be associated with breeding activity. Golden-crowned warblers responded strongly to playbacks of blue-gray tanager mob-calls and also showed the highest proportion of breeding individuals among the species captured. Less responsive species, such as the white-breasted wood-wren, showed no sign of breeding. This relationship is expected; breeding birds are more likely to defend their parental investment. The breeding season for neotropical birds is generally year-round, and varies more between species and individuals than for temperate birds (Stutchbury & Morton 2001). Therefore, because only a comparatively small proportion of resident individuals were breeding at any one time, intra- and inter-specific variation in magnitude of their response to playback is to be expected.

4.3 *Response to context and novelty*: Surprisingly, migrating birds responded strongly to the black-capped chickadee mob-call, in spite of the fact that the cue was clearly out of context; they are unlikely to encounter chickadees until mid-way through migration (> 2000 km to the north). Although migrating birds could have simply responded to any mob-call they encountered, their response to the blue-gray tanager mob-calls was weaker than to the chickadee call (figure 1). Neotropical residents such as the golden-crowned warbler responded strongly to tanagers (which also validates the blue-gray tanager call as a stimulating mob cue). There are two possible arguments to explain why migrating birds responded to chickadees: i) migrants perceive the importance of the chickadee call only on the breeding grounds and during migration, or ii) the call remains important to migrants throughout the year. Our results support the first possibility; among the migrant species we studied (most of which respond to chickadees on the breeding grounds), the only ones that responded to chickadee playbacks were those who were actively migrating, not overwintering species. Similar to our previous suggestion, this could be tested further by comparing mob-inspection behaviour during the over-wintering period to that during migration at various locations along the migratory route. If chickadee mob-calls lose their value on the wintering grounds, there should be a marked difference in mob-inspection behaviour between over-wintering and migrating birds, but little detectable difference in the strength of response in migrants at differing locations along the migratory path.

Typically, mobbing calls have a generic structure that makes them easily recognizable (Marler 1955); they are high-pitched with a narrow frequency range. Therefore, we expected that neotropical residents would respond equally to the familiar blue-gray tanager calls and the novel

black-capped chickadee calls. However, my results do not support this expectation; neotropical residents rarely responded to the novel black-capped chickadee calls. This contradicts a previous finding (Johnson *et al.* 2003) that birds innately recognize mob-calls of unfamiliar allopatric species. However, Johnson *et al*.'s (2003) study did not consider whether their study subjects were resident, short-distance migrants, or long-distance migrants. Our results suggest that long-distance migrants may respond to a broader repertoire of species, while resident species respond more to those calls with which they were most familiar. If this is the case, then the strength of response to unfamiliar calls should be positively related to migration length.

4.4 *Further considerations*: Our results have important implications for understanding the process of predator recognition; we show for the first time that migrating animals inspect the anti-predator behaviour of heterospecifics. Because migration is such a common life history trait, we suspect that inspection of heterospecific anti-predator behaviour is widespread; animals that move between environments will seek low-cost information sources over direct exposure to (e.g., inspection of) a predator.

Although this hypothesis has not been formally tested, numerous studies provide indirect support. For instance, brook sticklebacks (*Culaea inconstans*) migrate to shallow waters in the spring (Winn 1960) and respond to predator alarm signals of heterospecific fish (Mathis *et al.* 1996). Adult nymphs of the grazing mayfly (*Baetis rhodani*) disperse between streams and can react to variations in predation risk indicated by heterospecific chemical and visual cues (Tikkanen *et al.* 1996). Edelaar & Wright (2006) showed that Arabian babblers (*Turdoides squamiceps*) at a migratory stopover in Israel were efficient sentinels of varying predator threat levels. It seems reasonable that migrating heterospecifics would be aware of the babbler's proficiency as a risk indicator.

The use of low-cost cues need not be limited to intentionally produced signals; the fate of conspecifics can be monitored. Several examples have been documented: *Daphnia* migrate vertically in response to chemical cues produced by crushed conspecifics (Pijanowska 1997) and the presence of fish faeces (Slusarczyk & Rygielska 2004), while fathead minnows (*Pimephales promelas*) shift their locations in response to conspecific alarm pheromones (Chivers & Smith 1994). These examples suggest that the use of second-hand information as a low-cost alternative to direct predator inspection, particularly when coping with unfamiliar predators, is common in nature and therefore merits more detailed investigation.

5.0 REFERENCES

Anthony, L. L. & Blumstein, D. T. 2000 Integrating behaviour into wildlife conservation: the multiple ways that behaviour can reduce N_e. *Biol. Conserv*. **95**, 303-315.

Belisle, M. & Desrochers, A. 2002 Gap-crossing decisions by forest birds: an empirical basis for parameterizing spatially-explicit, individual-based models. *Landscape Ecol*. **17**, 219-231.

Betts, M. G., Hadley, A. S. & Doran, P. J. 2005 Avian mobbing response is restricted by territory boundaries: Experimental evidence from two species of forest warblers. *Ethology* **111**, 821-835.

Brawn, J. D., Collins, T. M., Medina, M. & Bermingham, E. 1996 Associations between physical isolation and geographical variation within three species of Neotropical birds. *Mol. Ecol*. **5**, 33-46.

Brown, G. E. 2003 Learning about danger: chemical alarm cues and local risk assessment in prey fishes. *Fish Fish.* **4**, 227-234.

Caro, T. M. 2005 *Antipredator defenses in birds and mammals*. Chicago, IL: University of Chicago Press.

Chivers, D. P. & Smith, R. J. F. 1994 Fathead minnows, *Pimephales promelas*, acquire predator recognition when alarm substance is associated with the sight of unfamiliar fish. *Anim. Behav.* **48**: 597-605.

Conover, M. R. 1987 Acquisition of predator information by active and passive mobbers in ring-billed gull colonies. *Behaviour* **102**, 41-57.

Curio, E. 1978 The adaptive significance of mobbing. I. Teleonomic hypotheses and predictions. *Z. Tierpsychol.* **48**, 175-183.

Curio, E., Ernst U. & Vieth, W. 1978 Cultural transmission of enemy recognition: one function of mobbing. *Science* **202**, 899-901.

Dalgaard, P. 2002 *Introductory statistics with R*. New York, NY: Springer-Verlag.

DaSilva, J. M. C., Uhl, C. & Murray, G. 1996 Plant succession, landscape management, and the ecology of frugivorous birds in abandoned Amazonian pastures. *Conserv. Biol.* **10**, 491-503.

Deecke, V. B., Slater, P. J. B. and Ford, J. K. B. 2002 Selective habituation shapes acoustic predator recognition in harbour seals. *Nature* **420**, 171-173.

Dierschke, V. & Delingat, J. 2001 Stopover behaviour and departure decision of northern wheatears, *Oenanthe oenanthe*, facing different onward non-stop flight distances. *Behav. Ecol. Sociobiol*. **50**, 535-545.

Dolby, A. S. & Grubb, T. C. 1998 Benefits to satellite members in mixed-species foraging groups: an experimental analysis. *Anim. Behav*. **56**, 501-509.

Drent, R., Both, C., Green, M., Madsen, J. & Piersma, T. 2003 Pay-offs and penalties of competing migratory schedules. *Oikos* **103**, 274-292.

Dugatkin, L. A. & Godin J-G. J. 1992 Prey approaching predators: a cost-benefit perspective. *Ann. Zool. Fenn.* **29**, 233-252.

Edelaar, P. & Wright, J. 2006 Potential prey make excellent ornithologists: adaptive, flexible responses towards avian predation threat by Arabian Babblers *Turdoides squamiceps* living at a migratory hotspot. *Ibis* **148**, 664-671.

Ficken, M. S., Ficken, R. W. & Witkin, S. R. 1978 Vocal repertoire of the Black-capped Chickadee. *Auk* **95**, 34-48.

Fishman, M. A. 1999 Predator inspection: Closer approach as a way to improve assessment of potential threats. *J. Theor. Biol.* **196**, 225-235.

Fitzgibbon, C. D. 1994 The costs and benefits of predator inspection behavior in Thomson gazelles. *Behav. Ecol. Sociobiol*. **34**, 139-148.

Godin, J-G.J. and S.A. Davis. 1995 Who dares, benefits – predator approach behavior in the guppy (*Poecilia reticulata*) deters predator pursuit. *Proc. R. Soc. B* **259**, 193-200.

Hames, R. S., Lowe, J. D., Barker Swarthout, S. & Rosenberg, K. V. 2006 Understanding the risk to neotropical migrant bird species of multiple human-caused stressors: elucidating

processes behind the patterns. *Ecol. Soc.* **11**, article 24. [online] URL: http://www.ecologyandsociety.org/vol11/iss1/art24/
Hanley, J. & McNeil, B. 1982 The meaning and use of the area under a receiver operating characteristic (ROC) curve. *Radiology* **143**, 29-36.
Hilty, S. 1994 *Birds of Tropical America*. Austin, TX: University of Texas Press.
Hosmer, D. & Lemeshow, S. 2000 *Applied Logistic Regression*. Hoboken, NJ: John Wiley and Sons.
Hurd, C. R. 1996 Interspecific attraction to the mobbing calls of black-capped chickadees (Parus atricapillus). *Behav. Ecol. Sociobiol* **38**, 287-292.
Ishihara, M. 1987 Effect of mobbing toward predators by the damselfish *Pomacentrus coelestis* (Pisces, Pomacentridae). *J. Ethol*. **5**, 43-52.
Johnson, F. R., McNaughton, E. J., Shelley, C. D. & Blumstein, D. T. 2003 Mechanisms of heterospecific recognition in avian mobbing calls. *Aust. J. Zool*. **51**, 577-585.
Jones, H. L. 2003 *Birds of Belize*. Austin, TX: University of Texas Press.
Krams, I. & Krama, T. 2002 Interspecific reciprocity explains mobbing behaviour of the breeding chaffinches, *Fringilla coelebs*. *Proc. R. Soc. B* **269**, 2345-2350.
Latta, S. C. & Wunderle, J. M. 1996 The composition and foraging ecology of mixed-species flocks in pine forests of Hispaniola. *Condor* **98**, 595-607.
Leal, M. & Rodriguez-Robles, J. A. 1997 Signalling displays during predator-prey interactions in a Puerto Rican anole, *Anolis cristatellus*. *Anim. Behav*. **54**, 1147-1154
Lind, J. & Cresswell, W. 2005 Determining the fitness consequences of antipredation behavior. *Behav. Ecol.* **16**, 945-956.
Lind, J. & Cresswell, W. 2006 Anti-predation behaviour during bird migration; the benefit of studying multiple behavioural dimensions. *J. Ornithol.* **147**, 310-316.
Lind, J., Jöngren, F., Nilsson, J., Alm, D. S. & Strandmark, A. 2005 Information, predation risk and foraging decisions during mobbing in Great Tits *Parus major*. *Ornis Fennica* **82**, 89-96.
Lindström, Å. 1989 Finch flock size and risk of hawk predation at a migratory stopover site. *Auk* **106**, 225-232.
Losito, M. P., Mirarchi R. E. & Baldassarre, G. A. 1989 New techniques for time-activity studies of avian flocks in view-restricted habitats. *J. Field Ornithol.* **60**, 388-396.
Manomet Observatory for Conservation Sciences 1996 Impacts of silvicultural trials on birds and tree regeneration in the Chiquibul Forest Reserve, Belize. Supplement: Birds banded and saplings tagged. Report to Ministry of Natural Resources, Belmopan, Belize.
Marler, P. 1955. Characteristics of some animal calls. *Nature* **176**, 6-8.
Marler, P. 1957. Specific distinctiveness in the communication signals of birds. *Behaviour* **11**, 13–39.
Mathis, A., Chivers, D. P. & Smith, R. J. F. 1996 Cultural transmission of predator recognition in fishes: intraspecific and interspecific learning. *Anim. Behav.* **51**, 185-201.
McLean, I. G. & Rhodes, G. 1991 Enemy recognition and response in birds. *Curr. Ornithol*. **8**, 173-211.
Owings, D. H. & Coss, R. G. 1977 Snake mobbing by California ground squirrels – adaptive variation and ontogeny. *Behaviour* **62**, 50-69.
Pijanowska, J. 1997 Alarm signals in *Daphnia*? *Oecologia* **112**, 12-16.
Pyle, P. 1997 *Identification Guide to North American Birds, Part 1*. Bolinas, CA: Slate Creek Press.

R Development Core Team 2005 *R: A language environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing.

Shedd, D. H. 1982 Seasonal variation and function of mobbing and related antipredator behaviors of the American Robin (*Turdus migratorius*). *Auk* **99**, 342-346.

Sieving, K. E., Contreras, T. A. & Maute, K. L. 2004 Heterospecific facilitation of forest-boundary crossing by mobbing understory birds in North-Central Florida. *Auk* **121**, 738-751.

Slusarczyk, M. & Rygielska, E. 2004 Fish faeces as the primary source of chemical cues inducing fish avoidance diapause in Daphnia magna. *Hydrobiologia* **526**, 231-234.

Srivastava, A. 1991 Cultural transmission of snake-mobbing in free-ranging Hanuman langurs. *Folia Primatol.* **56**, 117-120.

Stutchbury, B. J. M. & Morton, E. S. 2001 *Behavioral Ecology of Tropical Birds*. London, U.K.: Academic Press.

Templeton, C. N., Greene, E. & Davis, K. 2005 Allometry of alarm calls: black-capped chickadees encode information about predator size. *Science* **308**, 1934-1937.

Tikkanen, P., Muotka, T. & Huhta, A. 1996 Fishless-stream mayflies express behavioural flexibility in response to predatory fish. *Anim. Behav.* **51**, 1391-1399.

Turcotte, Y. & Desrochers, A. 2002 Playbacks of mobbing calls of Black-capped Chickadees help estimate the abundance of forest birds in winter. *J. Field Ornithol.* **73**, 303-307.

Veen, T., Richardson, D. S., Blaakmeer, K., & Komdeur, J. 2000 Experimental evidence for innate predator recognition in the Seychelles warbler. *Proc. R. Soc. B* **267**, 2253-2258.

Winn, H.E. Biology of the brook stickleback *Eucalia inconstans* (Kirtland). *Am. Midl. Nat.* **63**, 424-438.

MODULAR PROJECT: FISHTAIL PALM

Project: To determine the demography of the fishtail palm (*Chamaedorae ernest augustinii*) by establishing benchmark measurements at the two sites within the Chiquibul Forest Reserve.

Principal Investigator: Dr. Philip Taylor, Acadia University
Collaborators: Dr. Sam vanderKloet and Trina M. Fitzgerald, Acadia University

1.0 OVERVIEW

The demographic characteristics and population structure of fishtail palm was studied at two sites, in 2006, within the Chiquibul Forest Reserve. The population that was studied is situated in the 'old' and 'new' forest near the Las Cuevas field station.

Long-term monitoring of this population has occurred since 2002. The main focus for 2006 was to continue monitoring the marked population of *C. ernest augustinii* and document changes that had occurred within the population since 2002. The changes that have been monitored since 2002 will form the core of future estimates of key demographic parameters for the populations under study. To document yearly changes, we gathered morphological data on individual stems (new and previously marked) and re-assessed environmental variables that might be associated with the micro-scale distribution of the plants.

Specifically, the main objectives for 2006 were to:

A. Re-visit all plots that were established in 2002.

B. Obtain better estimates on age structure and sex ratio of *C. ernest augustinii* within the Chiquibul Forest Reserve.

C. For each quadrat determine:
    a. The number of palms per plot (new and previously marked)
    b. Assess whether palms were fruiting
    c. Count the number of leaves on each palm
    d. Count the number of leaves that had been harvested
    e. Quantify the relationship between sex and leaf ratio
    f. Count the number of nodes on each palm.

2.0 METHODS

We revisited all 5x5 meter plots established previously in 2002 to search for new palms. To obtain better estimates on age structure and sex ratio of *C. ernest augustinii* within Chiquibul Forest Reserve, we established 8 new 10x10 meter plots.

3.0 SUMMARY

We relocated 11/12 plots established previously in 2002. Overall, we detected 71 new juvenile palm plants within these plots. On average, there was 6.5 ± 4.7 new palms per plot. The number of new palms within a plot ranged from 0 to 15.

Eight new 10x10 meter plots were set up to obtain better estimates on age structure and sex ratio of *C. ernest augustinii* within the Chiquibul Forest Reserve. Overall, we detected 84 palms (10.5 ± 3.9 palms per plot). On average, each palm had 2.8 leaves present and 2.8 leaves that had been cut previously. In general, each palm had at least one new leaf. However, not all palms had a newly emerging leaf at the time of our survey.

Estimating key demographic parameters for any population of long-lived plants (such as fishtail palm) requires long-term data collection. Our previous years of monitoring has made large gains towards this objective, and we feel that our 2006 research will give us a greater degree of confidence in developing some initial estimates of demographic parameters. Therefore, we will draft a separate report to be sent to the Forest Department, which will summarize our monitoring efforts of fishtail palm at Las Cuevas. In addition, any scientific publications resulting from this work will be directed to the Forest Department Conservation Division.

Site	Number of Palms	Average Number of Leaves	Average Number of Cut Leaves	Average number of New Leaves	Average number of Emerging Leaves	Number of Female Palms	Number of Male Palms
1	7	3.8	2.6	NA	0.5	3	0
2	10	3	3.1	NA	0.7	3	0
3	9	2.7	3.3	1.0	0.63	0	1
4	9	2.4	3.8	0.89	0.75	7	0
5	8	2.3	1.9	0.88	0.63	0	3
6	15	2.5	3.2	0.73	0.4	7	1
7	18	2.6	2.4	1.1	0.88	7	2
8	8	3.9	2.3	0.89	0.56	2	4
Total	**84**						
Average	**10.5**	**2.8**	**2.8**	**0.9**	**0.63**	**3.6**	**1.4**

Appendix 1. Capture information for all individual birds caught in mist nets at Las Cuevas in 2006. Common names are shown. Local (resident birds) were banded with a unique 4-number band; all migrant birds were banded with a uniquely numbered U.S. Fish and Wildlife Service aluminum band. Trap refers to the specific net of capture at one of four net arrays (see Modular Project: Bird Monitoring and Demography; Figures 1 and 2).

Band Number	Species	Mig or Res	Day	Mo	Yr	Trap	SITE
001	Red-throated Ant-Tanager	R	16	04	2006	6	NET ARRAY #1
003	Red-crowned Ant-Tanager	R	16	04	2006	6	NET ARRAY #1
004	Red-throated Ant-Tanager	R	16	04	2006	6	NET ARRAY #1
005	Red-crowned Ant-Tanager	R	16	04	2006	1	NET ARRAY #1
006	Red-crowned Ant-Tanager	R	16	04	2006	7	NET ARRAY #1
007	Buff-throated Foliage-gleaner	R	17	04	2006	12	NET ARRAY #2
008	Red-throated Ant-Tanager	R	17	04	2006	13	NET ARRAY #2
009	Buff-throated Foliage-gleaner	R	17	04	2006	12	NET ARRAY #2
010	Red-throated Ant-Tanager	R	17	04	2006	13	NET ARRAY #2
011	Red-throated Ant-Tanager	R	17	04	2006	13	NET ARRAY #2
012	Thrush-like Mourner	R	17	04	2006	12	NET ARRAY #2
013	Buff-throated Foliage-gleaner	R	17	04	2006	12	NET ARRAY #2
014	Red-throated Ant-Tanager	R	17	04	2006	15	NET ARRAY #2
015	Red-crowned Ant-Tanager	R	17	04	2006	11	NET ARRAY #2
016	Red-crowned Ant-Tanager	R	17	04	2006	15	NET ARRAY #2
017	Buff-throated Foliage-gleaner	R	17	04	2006	17	NET ARRAY #2
018	Red-throated Ant-Tanager	R	17	04	2006	15	NET ARRAY #2
019	Buff-throated Foliage-gleaner	R	19	04	2006	11	NET ARRAY #2
020	Red-throated Ant-Tanager	R	21	04	2006	1	NET ARRAY #1
021	Blue-black Grosbeak	R	21	04	2006	7	NET ARRAY #1
022	Buff-throated Foliage-gleaner	R	21	04	2006	6	NET ARRAY #1
023	Orange-billed Sparrow	R	23	04	2006	19	NET ARRAY #2
024	Red-throated Ant-Tanager	R	25	04	2006	14	NET ARRAY #2
025	Ivory-billed Woodcreeper	R	25	04	2006	15	NET ARRAY #2
026	Ivory-billed Woodcreeper	R	25	04	2006	19	NET ARRAY #2
027	Ivory-billed Woodcreeper	R	25	04	2006	16	NET ARRAY #2
028	Orange-billed Sparrow	R	26	04	2006	3	NET ARRAY #1
029	Northern-Barred Woodcreeper	R	26	04	2006	10	NET ARRAY #1
030	Red-crowned Ant-Tanager	R	28	04	2006	11	NET ARRAY #2
031	Red-crowned Ant-Tanager	R	28	04	2006	11	NET ARRAY #2
032	Red-crowned Ant-Tanager	R	28	04	2006	11	NET ARRAY #2
034	Red-throated Ant-Tanager	R	29	04	2006	9	NET ARRAY #1
035	Scaly-throated Leaftosser	R	3	05	2006	15	NET ARRAY #2
036	Green-backed Sparrow	R	3	05	2006	17	NET ARRAY #2
037	Blue-black Grosbeak	R	3	05	2006	13	NET ARRAY #2
038	Bright-rumped Attila	R	3	05	2006	12	NET ARRAY #2
039	Buff-throated Foliage-gleaner	R	4	05	2006	3	NET ARRAY #1
040	Green-backed Sparrow	R	5	05	2006	17	NET ARRAY #2
041	Red-throated Ant-Tanager	R	7	05	2006	18	NET ARRAY #2
042	Red-throated Ant-Tanager	R	7	05	2006	18	NET ARRAY #2
043	Scaly-throated Leaftosser	R	9	05	2006	2	NET ARRAY #1
044	Buff-throated Foliage-gleaner	R	8	05	2006	4	NET ARRAY #1
0100	Sulphur-rumped Flycatcher	R	3	05	2006	NA	NET ARRAY #2
0101	Blue Bunting	R	3	05	2006	11	NET ARRAY #2
0106	White-breasted Wood-Wren	R	23	04	2006	25	NET ARRAY #3
0107	White-breasted Wood-Wren	R	17	04	2006	26	NET ARRAY #3
0108	Tawny-winged Woodcreeper	R	17	04	2006	21	NET ARRAY #3
0109	White-breasted Wood-Wren	R	19	04	2006	21	NET ARRAY #3

0111	White-breasted Wood-Wren	R	23	04	2006	26	NET ARRAY #3
0112	White-breasted Wood-Wren	R	28	04	2006	22	NET ARRAY #3
0113	White-breasted Wood-Wren	R	29	04	2006	32	NET ARRAY #4
0114	Red-capped Manakin	R	6	05	2006	31	NET ARRAY #4
0115	White-breasted Wood-Wren	R	7	05	2006	24	NET ARRAY #3
0151	White-breasted Wood-Wren	R	17	04	2006	17	NET ARRAY #2
0152	Eye-ringed Flatbill	R	21	04	2006	4	NET ARRAY #1
0153	Spot-breasted Wren	R	24	04	2006	8	NET ARRAY #1
0154	White-breasted Wood-Wren	R	25	04	2006	17	NET ARRAY #2
0155	White-breasted Wood-Wren	R	25	04	2006	12	NET ARRAY #2
0156	Spot-breasted Wren	R	25	04	2006	13	NET ARRAY #2
0157	White-breasted Wood-Wren	R	26	04	2006	4	NET ARRAY #1
0223	Ruddy Woodcreeper	R	16	04	2006	31	NET ARRAY #4
0224	Tawny-winged Woodcreeper	R	16	04	2006	31	NET ARRAY #4
0225	Ruddy Woodcreeper	R	16	04	2006	39	NET ARRAY #4
0226	Thrush-like Mourner	R	17	04	2006	28	NET ARRAY #3
0227	Ruddy Woodcreeper	R	17	04	2006	22	NET ARRAY #3
0228	Thrush-like Mourner	R	17	04	2006	28	NET ARRAY #3
0229	Tawny-winged Woodcreeper	R	19	04	2006	27	NET ARRAY #3
0230	Tawny-winged Woodcreeper	R	19	04	2006	24	NET ARRAY #3
0231	Thrush-like Mourner	R	20	04	2006	34	NET ARRAY #4
0232	Ruddy Woodcreeper	R	20	04	2006	41	NET ARRAY #4
0233	Thrush-like Mourner	R	23	04	2006	25	NET ARRAY #3
0234	Tawny-winged Woodcreeper	R	23	04	2006	22	NET ARRAY #3
0235	Thrush-like Mourner	R	23	04	2006	22	NET ARRAY #3
0236	Thrush-like Mourner	R	24	04	2006	39	NET ARRAY #3
0237	Red-crowned Ant-Tanager	R	25	04	2006	29	NET ARRAY #3
0238	Green Honeycreeper	R	25	04	2006	26	NET ARRAY #3
0239	Ruddy Woodcreeper	R	28	04	2006	27	NET ARRAY #3
0240	Thrush-like Mourner	R	28	04	2006	26	NET ARRAY #3
0241	Ruddy Woodcreeper	R	28	04	2006	26	NET ARRAY #3
0242	Tawny-winged Woodcreeper	R	28	04	2006	24	NET ARRAY #3
0243	Ruddy Woodcreeper	R	29	04	2006	34	NET ARRAY #4
0244	Ruddy Woodcreeper	R	29	04	2006	34	NET ARRAY #4
0245	Tawny-winged Woodcreeper	R	5	05	2006	25	NET ARRAY #3
0246	Thrush-like Mourner	R	7	05	2006	21	NET ARRAY #3
0251	Bright-rumped Attila	R	16	04	2006	4	NET ARRAY #1
0252	Thrush-like Mourner	R	16	04	2006	8	NET ARRAY #1
0253	Tawny-winged Woodcreeper	R	16	04	2006	6	NET ARRAY #1
0254	Thrush-like Mourner	R	16	04	2006	10	NET ARRAY #1
0255	Ruddy Woodcreeper	R	16	04	2006	10	NET ARRAY #1
0256	Thrush-like Mourner	R	16	04	2006	10	NET ARRAY #1
0257	Thrush-like Mourner	R	17	04	2006	19	NET ARRAY #2
0258	Tawny-winged Woodcreeper	R	17	04	2006	17	NET ARRAY #2
0259	Gray-headed Tanager	R	17	04	2006	15	NET ARRAY #2
0260	Orange-billed Sparrow	R	17	04	2006	19	NET ARRAY #2
0261	Tawny-winged Woodcreeper	R	17	04	2006	18	NET ARRAY #2
0262	Tawny-winged Woodcreeper	R	18	04	2006	5	NET ARRAY #2
0263	Ruddy Woodcreeper	R	18	04	2006	7	NET ARRAY #1
0264	Ruddy Woodcreeper	R	18	04	2006	6	NET ARRAY #1
0265	Thrush-like Mourner	R	19	04	2006	13	NET ARRAY #2
0266	Red-throated Ant-Tanager	R	19	04	2006	17	NET ARRAY #2
0267	Red-throated Ant-Tanager	R	19	04	2006	19	NET ARRAY #2
0268	Ruddy Woodcreeper	R	21	04	2006	4	NET ARRAY #1
0269	Smoky-brown Woodpecker	R	21	04	2006	10	NET ARRAY #1
0270	Collared Trogon	R	21	04	2006	10	NET ARRAY #1

0271	Ruddy Woodcreeper	R	21	04	2006	4	NET ARRAY #1
0272	Ruddy Woodcreeper	R	21	04	2006	5	NET ARRAY #1
0273	Orange-billed Sparrow	R	23	04	2006	18	NET ARRAY #2
0274	Tawny-winged Woodcreeper	R	25	04	2006	17	NET ARRAY #1
0275	Thrush-like Mourner	R	25	04	2006	13	NET ARRAY #1
0276	Ruddy Woodcreeper	R	28	04	2006	17	NET ARRAY #2
0277	Tawny-winged Woodcreeper	R	29	04	2006	10	NET ARRAY #1
0278	Thrush-like Mourner	R	3	05	2006	11	NET ARRAY #2
0279	Tawny-winged Woodcreeper	R	3	05	2006	19	NET ARRAY #2
0280	Red-throated Ant-Tanager	R	3	05	2006	18	NET ARRAY #2
0281	Ruddy Woodcreeper	R	4	05	2006	6	NET ARRAY #1
0282	Thrush-like Mourner	R	4	05	2006	5	NET ARRAY #1
0283	Ruddy Woodcreeper	R	4	05	2006	3	NET ARRAY #1
0284	Ruddy Woodcreeper	R	4	05	2006	5	NET ARRAY #1
0285	Green-backed Sparrow	R	5	05	2006	17	NET ARRAY #2
0286	Thrush-like Mourner	R	6	05	2006	8	NET ARRAY #1
0287	Scaly-throated Leaftosser	R	8	05	2006	2	NET ARRAY #1
335	Black-faced Antthrush	R	16	04	2006	41	NET ARRAY #4
336	Black-faced Antthrush	R	16	04	2006	39	NET ARRAY #4
337	Orange-billed Sparrow	R	16	04	2006	39	NET ARRAY #4
338	Red-throated Ant-Tanager	R	17	04	2006	30	NET ARRAY #3
339	Orange-billed Sparrow	R	17	04	2006	21	NET ARRAY #3
340	Buff-throated Foliage-gleaner	R	17	04	2006	29	NET ARRAY #3
344	Red-throated Ant-Tanager	R	17	04	2006	29	NET ARRAY #3
345	Buff-throated Foliage-gleaner	R	17	04	2006	29	NET ARRAY #3
346	Red-throated Ant-Tanager	R	17	04	2006	23	NET ARRAY #3
347	Red-throated Ant-Tanager	R	17	04	2006	23	NET ARRAY #3
348	Orange-billed Sparrow	R	18	04	2006	41	NET ARRAY #4
349	Red-throated Ant-Tanager	R	18	04	2006	41	NET ARRAY #4
350	Red-throated Ant-Tanager	R	18	04	2006	41	NET ARRAY #4
351	Red-throated Ant-Tanager	R	18	04	2006	41	NET ARRAY #4
352	Red-crowned Ant-Tanager	R	18	04	2006	32	NET ARRAY #4
353	Ruddy Woodcreeper	R	18	04	2006	39	NET ARRAY #4
354	Ruddy Woodcreeper	R	18	04	2006	39	NET ARRAY #4
355	Scaly-throated Leaftosser	R	19	04	2006	22	NET ARRAY #3
356	Red-throated Ant-Tanager	R	19	04	2006	27	NET ARRAY #3
357	Ruddy Woodcreeper	R	19	04	2006	28	NET ARRAY #3
358	Red-crowned Ant-Tanager	R	20	04	2006	41	NET ARRAY #4
359	Red-crowned Ant-Tanager	R	20	04	2006	41	NET ARRAY #4
360	Thrush-like Mourner	R	21	04	2006	32	NET ARRAY #4
361	Ruddy Woodcreeper	R	21	04	2006	39	NET ARRAY #4
362	Red-throated Ant-Tanager	R	23	04	2006	30	NET ARRAY #3
363	Red-throated Ant-Tanager	R	23	04	2006	30	NET ARRAY #3
364	Red-throated Ant-Tanager	R	24	04	2006	41	NET ARRAY #4
365	Ivory-billed Woodcreeper	R	24	04	2006	41	NET ARRAY #4
366	Red-throated Ant-Tanager	R	25	04	2006	21	NET ARRAY #3
367	Thrush-like Mourner	R	25	04	2006	24	NET ARRAY #3
368	Blue-black Grosbeak	R	25	04	2006	22	NET ARRAY #3
369	Red-throated Ant-Tanager	R	26	04	2006	41	NET ARRAY #4
370	Red-crowned Ant-Tanager	R	28	04	2006	22	NET ARRAY #3
371	Red-crowned Ant-Tanager	R	28	04	2006	27	NET ARRAY #3
372	Red-crowned Ant-Tanager	R	28	04	2006	27	NET ARRAY #3
373	Red-crowned Ant-Tanager	R	28	04	2006	25	NET ARRAY #3
374	Scaly-throated Leaftosser	R	29	04	2006	33	NET ARRAY #4
375	Red-crowned Ant-Tanager	R	3	05	2006	25	NET ARRAY #3
376	Scaly-throated Leaftosser	R	4	05	2006	34	NET ARRAY #4

377	Thrush-like Mourner	R	4	05	2006	41	NET ARRAY #4
378	Ivory-billed Woodcreeper	R	4	05	2006	31	NET ARRAY #4
379	Scaly-throated Leaftosser	R	5	05	2006	28	NET ARRAY #3
380	Red-crowned Ant-Tanager	R	5	05	2006	26	NET ARRAY #3
381	Tawny-winged Woodcreeper	R	8	05	2006	35	NET ARRAY #4
0401	White-breasted Wood-Wren	R	18	04	2006	41	NET ARRAY #4
0402	White-breasted Wood-Wren	R	16	04	2006	31	NET ARRAY #4
0403	White-breasted Wood-Wren	R	19	04	2006	30	NET ARRAY #3
0404	White-breasted Wood-Wren	R	19	04	2006	30	NET ARRAY #3
0405	Red-capped Manakin	R	20	04	2006	41	NET ARRAY #4
0406	White-breasted Wood-Wren	R	20	04	2006	36	NET ARRAY #4
406	Ruddy Quail-Dove	R	25	04	2006	13	NET ARRAY #2
0407	White-breasted Wood-Wren	R	20	04	2006	36	NET ARRAY #4
0408	Plain Antvireo	R	28	04	2006	28	NET ARRAY #3
0409	Red-capped Manakin	R	28	04	2006	21	NET ARRAY #3
0410	Red-capped Manakin	R	4	05	2006	36	NET ARRAY #4
0412	White-breasted Wood-Wren	R	16	05	2006	6	NET ARRAY #1
0413	White-breasted Wood-Wren	R	16	04	2006	6	NET ARRAY #1
0414	Gray-headed Tanager	R	17	04	2006	15	NET ARRAY #2
0415	White-breasted Wood-Wren	R	17	04	2006	11	NET ARRAY #2
0416	White-breasted Wood-Wren	R	19	04	2006	15	NET ARRAY #2
0417	White-breasted Wood-Wren	R	19	04	2006	19	NET ARRAY #2
0418	White-breasted Wood-Wren	R	19	04	2006	11	NET ARRAY #2
0419	White-breasted Wood-Wren	R	19	04	2006	18	NET ARRAY #2
0420	White-breasted Wood-Wren	R	19	04	2006	11	NET ARRAY #2
0421	Dusky-capped Flycatcher	R	19	04	2006	17	NET ARRAY #2
0422	White-breasted Wood-Wren	R	21	04	2006	3	NET ARRAY #1
0423	White-breasted Wood-Wren	R	21	04	2006	9	NET ARRAY #1
0424	Royal Flycatcher	R	26	04	2006	4	NET ARRAY #1
0425	White-breasted Wood-Wren	R	28	04	2006	17	NET ARRAY #2
0426	White-breasted Wood-Wren	R	4	05	2006	5	NET ARRAY #1
0427	White-breasted Wood-Wren	R	5	05	2006	12	NET ARRAY #2
506	Black-faced Antthrush	R	19	04	2006	22	NET ARRAY #3
507	Black-faced Antthrush	R	19	04	2006	22	NET ARRAY #3
508	Black-faced Antthrush	R	21	04	2006	33	NET ARRAY #4
509	Black-faced Antthrush	R	21	04	2006	33	NET ARRAY #4
510	Northern-Barred Woodcreeper	R	28	04	2006	22	NET ARRAY #3
546	Clay-coloured Robin	R	25	04	2006	NA	EDGE NETS
547	Buff-throated Foliage-gleaner	R	28	04	2006	13	NET ARRAY #2
548	Buff-throated Foliage-gleaner	R	29	04	2006	10	NET ARRAY #1
549	Black-faced Antthrush	R	29	04	2006	9	NET ARRAY #1
550	Clay-coloured Robin	R	5	05	2006	18	NET ARRAY #2
551	Black-faced Grosbeak	R	6	05	2006	2	NET ARRAY #1
0602	Stub-tailed Spadebill	R	17	04	2006	22	NET ARRAY #3
0603	Ochre-bellied Flycatcher	R	17	04	2006	21	NET ARRAY #3
0604	Golden-crowned Warbler	R	17	04	2006	24	NET ARRAY #3
0605	Tawny-crowned Greenlet	R	17	04	2006	23	NET ARRAY #3
605	Barred Forest-Falcon	R	18	04	2006	10	NET ARRAY #1
0606	Tawny-crowned Greenlet	R	17	04	2006	23	NET ARRAY #3
606	Barred Forest-Falcon	R	26	04	2006	9	NET ARRAY #1
0607	Golden-crowned Warbler	R	18	04	2006	34	NET ARRAY #4
607	Ruddy Quail-Dove	R	4	05	2006	NA	NET ARRAY #1
0608	Olive-backed Euphonia	R	18	04	2006	32	NET ARRAY #4
0609	Tawny-crowned Greenlet	R	19	04	2006	22	NET ARRAY #3
0610	Sepia-capped Flycatcher	R	19	04	2006	27	NET ARRAY #3
0611	Tawny-crowned Greenlet	R	19	04	2006	21	NET ARRAY #3

0612	Ochre-bellied Flycatcher	R	19	04	2006	24	NET ARRAY #3
0613	Golden-crowned Warbler	R	21	04	2006	32	NET ARRAY #4
0614	Golden-crowned Warbler	R	23	04	2006	29	NET ARRAY #3
0615	Ochre-bellied Flycatcher	R	23	04	2006	28	NET ARRAY #3
0616	Wedge-billed Woodcreeper	R	23	04	2006	28	NET ARRAY #3
0617	Sepia-capped Flycatcher	R	24	04	2006	35	NET ARRAY #4
0618	Sepia-capped Flycatcher	R	24	04	2006	35	NET ARRAY #4
0619	Ochre-bellied Flycatcher	R	24	04	2006	31	NET ARRAY #4
0620	Long-billed Gnatwren	R	25	04	2006	22	NET ARRAY #3
0621	Long-billed Gnatwren	R	25	04	2006	22	NET ARRAY #3
0622	Tawny-crowned Greenlet	R	25	04	2006	22	NET ARRAY #3
0623	Stub-tailed Spadebill	R	25	04	2006	28	NET ARRAY #3
0624	Lesser Greenlet	R	26	04	2006	35	NET ARRAY #4
0625	Golden-crowned Warbler	R	28	04	2006	26	NET ARRAY #3
0626	Golden-crowned Warbler	R	28	04	2006	22	NET ARRAY #3
0627	Plain Xenops	R	29	04	2006	32	NET ARRAY #4
0628	Stub-tailed Spadebill	R	29	04	2006	32	NET ARRAY #4
0629	Tawny-crowned Greenlet	R	29	04	2006	39	NET ARRAY #4
0631	Sepia-capped Flycatcher	R	6	05	2006	39	NET ARRAY #4
0632	Golden-crowned Warbler	R	6	05	2006	41	NET ARRAY #4
0633	Tawny-crowned Greenlet	R	7	05	2006	27	NET ARRAY #3
0651	Tawny-crowned Greenlet	R	16	04	2006	1	NET ARRAY #1
0652	Tawny-crowned Greenlet	R	16	04	2006	1	NET ARRAY #1
0653	Tawny-crowned Greenlet	R	16	04	2006	1	NET ARRAY #1
0654	Golden-crowned Warbler	R	16	04	2006	4	NET ARRAY #1
0655	Ochre-bellied Flycatcher	R	16	04	2006	10	NET ARRAY #1
0656	Gray-throated Chat	R	17	04	2006	12	NET ARRAY #2
0657	Gray-throated Chat	R	17	04	2006	11	NET ARRAY #2
0658	Golden-crowned Warbler	R	17	04	2006	18	NET ARRAY #2
0659	Golden-crowned Warbler	R	17	04	2006	19	NET ARRAY #2
0660	Golden-crowned Warbler	R	17	04	2006	19	NET ARRAY #2
0661	Sepia-capped Flycatcher	R	17	04	2006	11	NET ARRAY #2
0662	Plain Antvireo	R	17	04	2006	17	NET ARRAY #2
0663	Sepia-capped Flycatcher	R	17	04	2006	15	NET ARRAY #2
0664	Gray-throated Chat	R	18	04	2006	10	NET ARRAY #1
0665	Plain Antvireo	R	18	04	2006	2	NET ARRAY #1
0666	Golden-crowned Warbler	R	18	04	2006	7	NET ARRAY #1
0667	Golden-crowned Warbler	R	18	04	2006	6	NET ARRAY #1
0668	Sulphur-rumped Flycatcher	R	19	04	2006	13	NET ARRAY #2
0669	Ochre-bellied Flycatcher	R	19	04	2006	11	NET ARRAY #2
0670	Tawny-crowned Greenlet	R	19	04	2006	12	NET ARRAY #2
0671	Tawny-crowned Greenlet	R	19	04	2006	12	NET ARRAY #2
0672	Tawny-crowned Greenlet	R	21	04	2006	7	NET ARRAY #2
0673	Sulphur-rumped Flycatcher	R	21	04	2006	1	NET ARRAY #2
0674	Golden-crowned Warbler	R	21	04	2006	7	NET ARRAY #1
0675	Gray-throated Chat	R	23	04	2006	11	NET ARRAY #2
0676	Plain Antvireo	R	23	04	2006	20	NET ARRAY #2
0677	Tawny-crowned Greenlet	R	23	04	2006	12	NET ARRAY #2
0678	Ochre-bellied Flycatcher	R	23	04	2006	15	NET ARRAY #2
0679	Plain Xenops	R	23	04	2006	13	NET ARRAY #2
0680	Olivaceous Woodcreeper	R	23	04	2006	13	NET ARRAY #2
0681	Gray-throated Chat	R	23	04	2006	17	NET ARRAY #2
0682	Ridgway's Rough-winged Swallow	R	23	04	2006	11	NET ARRAY #2
0683	White-collared Seedeater	R	23	04	2006	S	EDGE NETS
0684	White-collared Seedeater	R	23	04	2006	S	EDGE NETS
0685	Golden-crowned Warbler	R	25	04	2006	15	NET ARRAY #2

0686	Ochre-bellied Flycatcher	R	25	04	2006	12	NET ARRAY #2
0687	Lesser Greenlet	R	25	04	2006	11	NET ARRAY #2
0688	Golden-crowned Warbler	R	25	04	2006	13	NET ARRAY #2
0689	Golden-crowned Warbler	R	26	04	2006	1	NET ARRAY #1
0690	Golden-crowned Warbler	R	26	04	2006	1	NET ARRAY #1
0691	Golden-crowned Warbler	R	26	04	2006	6	NET ARRAY #1
0692	Red-capped Manakin	R	26	04	2006	1	NET ARRAY #1
0693	Yellow-throated Euphonia	R	28	04	2006	15	NET ARRAY #2
0694	Yellow-throated Euphonia	R	28	04	2006	15	NET ARRAY #2
0695	Tawny-crowned Greenlet	R	28	04	2006	18	NET ARRAY #2
0696	Tawny-crowned Greenlet	R	28	04	2006	18	NET ARRAY #2
0697	Ochre-bellied Flycatcher	R	28	04	2006	12	NET ARRAY #2
0699	Golden-crowned Warbler	R	29	04	2006	3	NET ARRAY #1
0700	Tawny-crowned Greenlet	R	3	05	2006	16	NET ARRAY #2
0701	Sulphur-rumped Flycatcher	R	4	05	2006	4	NET ARRAY #1
0702	Yellow-olive Flycatcher	R	4	05	2006	2	NET ARRAY #1
0703	Plain Antvireo	R	4	05	2006	6	NET ARRAY #1
0704	Plain Xenops	R	4	05	2006	6	NET ARRAY #1
705	Strong-billed Woodcreeper	R	25	04	2006	13	NET ARRAY #2
0705	Sulphur-rumped Flycatcher	R	5	05	2006	11	NET ARRAY #2
0706	Ochre-bellied Flycatcher	R	5	05	2006	13	NET ARRAY #2
0707	Ochre-bellied Flycatcher	R	5	05	2006	12	NET ARRAY #2
0708	Olivaceous Woodcreeper	R	6	05	2006	8	NET ARRAY #1
0709	Olivaceous Woodcreeper	R	6	05	2006	6	NET ARRAY #1
0710	Sulphur-rumped Flycatcher	R	6	05	2006	3	NET ARRAY #1
0711	Plain Antvireo	R	7	05	2006	11	NET ARRAY #2
0712	Lesser Greenlet	R	7	05	2006	15	NET ARRAY #2
0713	Yellow-olive Flycatcher	R	8	05	2006	5	NET ARRAY #1
1409	White-breasted Wood-Wren	R	17	04	2006	25	NET ARRAY #3
1410	Plain Antvireo	R	17	04	2006	26	NET ARRAY #3
1411	Red-capped Manakin	R	17	04	2006	25	NET ARRAY #3
1412	Sulphur-rumped Flycatcher	R	20	04	2006	34	NET ARRAY #4
1413	Plain Antvireo	R	23	04	2006	27	NET ARRAY #3
1414	Tawny-crowned Greenlet	R	23	04	2006	30	NET ARRAY #3
1415	Ochre-bellied Flycatcher	R	24	04	2006	41	NET ARRAY #4
1416	Wedge-billed Woodcreeper	R	25	04	2006	22	NET ARRAY #3
1417	Red-capped Manakin	R	26	04	2006	31	NET ARRAY #4
1418	Red-capped Manakin	R	26	04	2006	41	NET ARRAY #4
1419	Plain Antvireo	R	28	04	2006	26	NET ARRAY #3
1420	Sulphur-rumped Flycatcher	R	29	04	2006	41	NET ARRAY #4
1421	Ochre-bellied Flycatcher	R	3	05	2006	22	NET ARRAY #3
1422	Olive-backed Euphonia	R	5	05	2006	24	NET ARRAY #3
1423	Plain Antvireo	R	5	05	2006	25	NET ARRAY #3
1424	Sulphur-rumped Flycatcher	R	6	05	2006	35	NET ARRAY #4
1425	Sulphur-rumped Flycatcher	R	6	05	2006	33	NET ARRAY #4
1426	Red-capped Manakin	R	7	05	2006	27	NET ARRAY #3
1451	White-breasted Wood-Wren	R	17	04	2006	11	NET ARRAY #2
1452	Blue Seedeater	R	17	04	2006	12	NET ARRAY #2
1453	White-breasted Wood-Wren	R	18	04	2006	5	NET ARRAY #1
1454	Yellow-olive Flycatcher	R	18	04	2006	2	NET ARRAY #1
1455	Dusky Antbird	R	19	04	2006	12	NET ARRAY #2
1456	Blue Bunting	R	24	04	2006	2	NET ARRAY #1
1457	Red-capped Manakin	R	25	04	2006	17	NET ARRAY #2
1459	Plain Antvireo	R	25	04	2006	14	NET ARRAY #2
1460	White-breasted Wood-Wren	R	26	04	2006	4	NET ARRAY #1
1461	Yellow-throated Euphonia	R	28	04	2006	14	NET ARRAY #2

1462	Bananaquit	R	5	05	2006	12	NET ARRAY #2
1463	Golden-crowned Warbler	R	5	05	2006	17	NET ARRAY #2
1464	Plain Antvireo	R	7	05	2006	11	NET ARRAY #2
1465	Red-capped Manakin	R	7	05	2006	13	NET ARRAY #2
0097	Tawny-crowned Greenlet	R	3	05	2006	12	NET ARRAY #2
0098	Plain Antvireo	R	3	05	2006	19	NET ARRAY #2
0099	Olivaceous Woodcreeper	R	3	05	2006	11	NET ARRAY #2
1751-36004	Wood Thrush	M	16	04	2006	39	NET ARRAY #4
1751-36005	Wood Thrush	M	16	04	2006	35	NET ARRAY #4
1751-36006	Wood Thrush	M	17	04	2006	21	NET ARRAY #3
1751-36007	Wood Thrush	M	17	04	2006	22	NET ARRAY #3
1751-36008	Gray Catbird	M	19	04	2006	24	NET ARRAY #3
1751-36009	Wood Thrush	M	5	05	2006	24	NET ARRAY #3
1751-36031	Wood Thrush	M	16	04	2006	8	NET ARRAY #1
1751-36032	Wood Thrush	M	16	04	2006	10	NET ARRAY #1
1751-36033	Wood Thrush	M	17	04	2006	12	NET ARRAY #2
1751-36034	Wood Thrush	M	17	04	2006	12	NET ARRAY #2
1751-36035	Wood Thrush	M	18	04	2006	10	NET ARRAY #1
1751-36036	Wood Thrush	M	23	04	2006	19	NET ARRAY #2
1751-36038	Gray Catbird	M	23	04	2006	5	EDGE NETS
1751-36039	Wood Thrush	M	25	04	2006	11	NET ARRAY #2
1751-36040	Wood Thrush	M	26	04	2006	10	NET ARRAY #1
1771-63117	Kentucky Warbler	M	18	04	2006	32	NET ARRAY #4
1771-63118	Kentucky Warbler	M	18	04	2006	32	NET ARRAY #4
1771-63119	Kentucky Warbler	M	18	04	2006	41	NET ARRAY #4
1771-63120	Ovenbird	M	19	04	2006	27	NET ARRAY #3
1771-63121	Kentucky Warbler	M	19	04	2006	26	NET ARRAY #3
1771-63122	Kentucky Warbler	M	20	04	2006	34	NET ARRAY #4
1771-63123	Kentucky Warbler	M	23	04	2006	27	NET ARRAY #3
1771-63124	Ovenbird	M	3	05	2006	22	NET ARRAY #3
1771-63141	Worm-eating Warbler	M	16	04	2006	9	NET ARRAY #1
1771-63142	Ovenbird	M	17	04	2006	19	NET ARRAY #2
1771-63143	Kentucky Warbler	M	17	04	2006	20	NET ARRAY #2
1771-63144	Kentucky Warbler	M	17	04	2006	12	NET ARRAY #2
1771-63145	Ovenbird	M	19	04	2006	18	NET ARRAY #2
1771-63146	Ovenbird	M	19	04	2006	19	NET ARRAY #2
1771-63148	Kentucky Warbler	M	21	04	2006	2	NET ARRAY #1
1771-63149	Ovenbird	M	23	04	2006	17	NET ARRAY #2
1771-63150	Kentucky Warbler	M	24	04	2006	2	NET ARRAY #1
1771-63151	Kentucky Warbler	M	25	04	2006	16	NET ARRAY #2
1771-63152	Indigo Bunting	M	25	04	2006	15	NET ARRAY #2
1771-63153	Ovenbird	M	19	04	2006	11	NET ARRAY #2
1771-63154	Ovenbird	M	6	05	2006	8	NET ARRAY #1
1861-31050	Gray-cheeked Thrush	M	17	04	2006	29	NET ARRAY #3
1861-31052	Gray-cheeked Thrush	M	20	04	2006	34	NET ARRAY #4
1861-31053	Swainson's Thrush	M	23	04	2006	29	NET ARRAY #3
1861-31054	Swainson's Thrush	M	23	04	2006	30	NET ARRAY #3
1861-31055	Swainson's Thrush	M	24	04	2006	35	NET ARRAY #4
1861-31056	Swainson's Thrush	M	25	04	2006	25	NET ARRAY #3
1861-31060	Swainson's Thrush	M	25	04	2006	22	NET ARRAY #3
1861-31061	Swainson's Thrush	M	26	04	2006	31	NET ARRAY #4
1861-31062	Gray-cheeked Thrush	M	29	04	2006	41	NET ARRAY #4
1861-31063	Swainson's Thrush	M	4	05	2006	35	NET ARRAY #4
1861-31064	Gray-cheeked Thrush	M	4	05	2006	35	NET ARRAY #4
1861-31065	Gray-cheeked Thrush	M	4	05	2006	39	NET ARRAY #4
1861-31066	Swainson's Thrush	M	6	05	2006	33	NET ARRAY #4

1861-31067	Swainson's Thrush	M	6	05	2006	41	NET ARRAY #4
1861-31068	Swainson's Thrush	M	6	05	2006	36	NET ARRAY #4
1861-31069	Swainson's Thrush	M	7	05	2006	28	NET ARRAY #3
1861-31070	Gray-cheeked Thrush	M	8	05	2006	34	NET ARRAY #4
1861-31071	Gray-cheeked Thrush	M	8	05	2006	31	NET ARRAY #4
1861-31072	Gray-cheeked Thrush	M	8	05	2006	33	NET ARRAY #4
1861-31101	Swainson's Thrush	M	17	04	2006	11	NET ARRAY #2
1861-31102	Gray-cheeked Thrush	M	18	04	2006	1	NET ARRAY #1
1861-31103	Swainson's Thrush	M	19	04	2006	14	NET ARRAY #2
1861-31104	Swainson's Thrush	M	23	04	2006	11	NET ARRAY #2
1861-31105	Swainson's Thrush	M	23	04	2006	NA	EDGE NETS
1861-31106	Swainson's Thrush	M	24	04	2006	1	NET ARRAY #1
1861-31107	Swainson's Thrush	M	24	04	2006	9	NET ARRAY #1
1861-31108	Swainson's Thrush	M	24	04	2006	9	NET ARRAY #1
1861-31109	Swainson's Thrush	M	25	04	2006	17	NET ARRAY #2
1861-31110	Swainson's Thrush	M	26	04	2006	7	NET ARRAY #1
1861-31111	Swainson's Thrush	M	26	04	2006	4	NET ARRAY #1
1861-31112	Swainson's Thrush	M	28	04	2006	13	NET ARRAY #2
1861-31113	Swainson's Thrush	M	28	04	2006	12	NET ARRAY #2
1861-31114	Gray-cheeked Thrush	M	3	05	2006	17	NET ARRAY #2
1861-31115	Swainson's Thrush	M	3	05	2006	17	NET ARRAY #2
1861-31116	Swainson's Thrush	M	3	05	2006	16	NET ARRAY #2
1861-31117	Gray-cheeked Thrush	M	3	05	2006	16	NET ARRAY #2
1861-31118	Swainson's Thrush	M	3	05	2006	18	NET ARRAY #2
1861-31119	Swainson's Thrush	M	4	05	2006	7	NET ARRAY #2
1861-31120	Swainson's Thrush	M	4	05	2006	6	NET ARRAY #1
1861-31121	Swainson's Thrush	M	4	05	2006	2	NET ARRAY #1
1861-31122	Swainson's Thrush	M	7	05	2006	14	NET ARRAY #1
1861-31123	Swainson's Thrush	M	8	05	2006	4	NET ARRAY #1
2260-91003	Magnolia Warbler	M	28	04	2006	21	NET ARRAY #3
2260-91029	Hooded Warbler	M	17	04	2006	11	NET ARRAY #2
2260-91030	Chestnut-sided Warbler	M	23	04	2006	14	NET ARRAY #2
2260-91031	Chestnut-sided Warbler	M	28	04	2006	17	NET ARRAY #2
2290-34006	Hooded Warbler	M	16	04	2006	31	NET ARRAY #4
2290-34007	Kentucky Warbler	M	16	04	2006	32	NET ARRAY #4
2290-34008	Ovenbird	M	16	04	2006	41	NET ARRAY #4
2290-34009	Acadian Flycatcher	M	16	04	2006	34	NET ARRAY #4
2290-34010	Ovenbird	M	17	04	2006	23	NET ARRAY #3
2290-34013	Ovenbird	M	17	04	2006	25	NET ARRAY #3
2290-34022	Worm-eating Warbler	M	17	04	2006	12	NET ARRAY #2
2290-34023	Ovenbird	M	18	04	2006	6	NET ARRAY #1
2290-34024	Traill's Flycatcher	M	24	04	2006	10	NET ARRAY #1
2290-34025	Traill's Flycatcher	M	24	04	2006	5	NET ARRAY #1
2290-34026	Traill's Flycatcher	M	24	04	2006	2	NET ARRAY #1
2290-34027	Black-and-white Warbler	M	25	04	2006	14	NET ARRAY #2
2290-34028	Ovenbird	M	25	04	2006	18	NET ARRAY #2
2290-34029	Ovenbird	M	25	04	2006	13	NET ARRAY #2
2290-34030	Black-and-white Warbler	M	3	05	2006	15	NET ARRAY #2
2290-34031	Black-and-white Warbler	M	8	05	2006	5	NET ARRAY #1