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## **Species diversity, winter-site fidelity, & ecology of winter resident ‘landbirds’ in Costa Rican mangroves**

### **Abstract**

Data from the North American Breeding Bird Survey indicate that populations of many species of neo-tropical migrant birds have declined over the past three decades. Processes operating during the non-breeding season may be particularly important in driving declines, yet data linking wintering and breeding populations are currently few. The scarcity of data on the winter ecology of neo-tropical migrants is especially alarming because most natural habitats in Central America (where most of these species over-winter) are currently considered “vulnerable, threatened, or endangered” due to direct human impacts. Wetland habitats, such as mangrove and riparian forests along the Pacific Flyway are particularly important for over-wintering bird species that breed in North America. Development and ranching is severely impacting these habitats; thus, information that leads to the conservation of important areas for birds and other wildlife is critically needed. Here we report on the results and observations of four winters banding in Costa Rican mangroves.

Populations of landbirds were sampled at 4 sites in Guanacaste, Costa Rica using constant-effort mist-netting and banding (Baillie et al 1986), mid-November through mid-March 2003/2007. The total effort was 20,269 mist-net hours. We participated in and followed the protocol of the MoSI (Monitoreo de Sobrevivencia Invernal) program (DeSante et al 2004). Three of the study sites were located in areas of mangrove swamps dominated by Black Mangroves *Avicennia germinans* in the Southern Dry Pacific Coast Mangroves ecoregion; a fourth site was sampled in the Central American Dry Forest ecoregion.

A total of 3,980 individual birds were captured, 3,015 of these birds were banded with numbered US F&W bands, and 965 resident ‘tropical’ birds were captured but released unbanded; selected species were however marked with unique combinations of color bands. Approximately 84% (2,502) of all the birds captured were neo-tropical migrants, 50% of these were migratory warblers (9 species) and 20% of all the birds captured were Prothonotary Warblers (*Protonotaria citrea*).

There were 1,744 recapture events involving 1,199 individual birds. Among-year site fidelity was documented for 441 birds of 34 species. Within year site fidelity was documented for 758 birds of 29 species. Warblers accounted for over 80% of all recaptures, 31% were Prothonotary Warblers and 23% were Northern Waterthrush (*Seiurus noveboracensis*).

Sixty-three birds of 7 species were recaptured after moving between mangrove and dry forest habitats about a kilometer apart: Brown-crested Flycatcher, Great Kiskadee, Northern Waterthrush, Prothonotary Warbler, Tennessee Warbler, and Yellow Warbler.

A foreign recovery was made of a Tennessee Warbler banded at Delta Marsh Bird Observatory, Manitoba, Canada.

Banding results show that mangrove swamps in Costa Rica provide important wintering habitat for migratory Passerines from North America and that individual birds show strong site

fidelity. Results also show that some Passerines use the mangrove swamps mostly for roosting at night and leave the swamps in early morning to spend much of the day foraging in adjacent 'Central American Dry Forest'.

## Study Areas

Three of the study sites were located in parts of mangrove swamps dominated by Black Mangrove *Avicennia germinans* in the Southern Dry Pacific Coast Mangroves ecoregion, along the north Pacific coast of Costa Rica at:

(1) **Estero Naranjo** (MoSI Station **ESNA**) Área de Conservación Guanacaste, sector Naranjo - 10° 46' 56" N, 085° 39' 52" W

(2) **Estero Iguanita** (MoSI Station **ESIG**) Área de Conservación Tempisque, Refugio Nacional de Vida Silvestre Iguanita - 10° 37' 47" N, 085° 37' 42" W.

(3) **Estero Tamarindo** (MoSI Station **ESTA**) Área de Conservación Tempisque, Parque Nacional Marino las Baulas de Guanacaste - 10° 19' 49" N, 085° 50' 24.5" W, and

We sampled a Costa Rican Central American Dry Forest site at:

(4) **Playa Grande** (MoSI Station **PLGR**), adjacent to the Estero Tamarindo site, Parque Nacional Marino las Baulas de Guanacaste - 10° 19' 40" N, 085° 50' 39" W.

Straight line distances between sites were as follows: ESIG was 17.4 km S of ESNA. ESTA was 40.5 km SW of ESIG and 50.3 km SSW of ESNA. PLGR was 1 km W of ESTA.

This southern dry Pacific coast ecoregion marks the transition zone from dry to moist on the Central American Pacific coast (Spalding et al. 1997). There was little to no rain throughout the study period and daily high temperatures were commonly between 30 and 35°C. Strong, persistent, gusty winds commencing mid- to late-morning were encountered most days necessitating the closure of nets at those times.

## Vegetation

The three mangrove study sites were dominated by 'black mangrove' *Avicennia germinans*, a mangrove species that grows within the estuary zone that is periodically flooded and subjected to regular dry periods. Mixed with the *Avicennia* were occasional *Laguncularia racemosa*, *Conocarpus erectus*, and *Rhizophora racemosa*, mangrove species that are typically more abundant in deeper estuary waters. Very little ground vegetation was present on the mud substrate apart from the numerous ptenophores and seedlings of the *Avicennia*. The edge between the mangroves and the dry forest was often sharply defined; with dense patches of the succulents *Acanthocerus pentagonus*, *Opuntia stricta*, and/or *Bromelia penguin*.

The mean percent cover of leafy vegetation below 3m at Estero Iguanita was lower than at the other mangrove sites, the swamp was smaller in area (24 ha) and most of the trees in the netting area were taller. At Estero Naranjo and Estero Tamarindo the forested estuaries cover areas of approximately 400ha (Table 1).

Table 1 Mean percent cover of leafy vegetation (based on visual estimates in a 12m diameter circle centered on the middle of the mist-net)

Station	under 1m	1 to 2m	2 to 3m	over 3m	mean canopy height
ESIG	29	39	31	33	7m
ESNA	29	53	60	36	4.6m
ESTA	55	54	41	33	4m
PLGR	38	21	21	69	8.2m

At Playa Grande the forest where mist netting was conducted was dominated for the first 20 m in from the beach/forest edge by *Gliricidia sepium*, a tree species (up to 15m) often associated with pioneer vegetation. Mixed with this species (up to about a 20% mix) were *Haematoxylum brasiletto*, *Simaruba glauca*, *Tabebuia ochracea*, *Tabebuia ochracea*, *Caesalpinia eriosta* and *Bombacopsis quinata*, all tree species reaching a maximum height of 20m. The mean maximum height of trees within the mist-netting area was 8.2 m. Very little ground vegetation was present on the sand/leaf litter substrate. Ground vegetation consisted mainly of scattered patches of *Asteraceae* and *Passiflora* sp. Patches of *Lianas* occasionally reached into the canopy.

## Methods

Five monthly (Nov. – Mar. 2003 – 2007), 3 day ‘pulses’ of mist-netting and banding were conducted at 3 of the sites with the following exceptions; ESNA was visited only 4 times per season, except in 2004/2005, and ESIG was not sampled during the 2003/2004 season. Sixteen mist-nets (12m x 2m x 30mm mesh) were used at each site and their locations remained constant throughout the study period. Nets were opened approximately one half hour before sunrise and were kept open until sunset when wind conditions permitted. Effort varied among sites: ESIG 5,488.4 mist-net hours (mnh), ESNA 4,867 mnh, ESTA 5,443.9 mnh, and PLGR 4,470 mnh. At ESNA and PLGR we experienced more wind and subsequently more frequent closures of nets. Nets were closed most days by mid-day, primarily due to excessive wind.

Data was submitted to the MoSI program from all 4 stations. Feather samples were collected from up to 30 individuals of newly banded migratory birds, for isotope analysis in collaboration with the Center for Tropical Research & Conservation Genetics.

## Results

A total of 3,980 individual birds were captured, 3,015 of these birds were banded with numbered US F&W bands (Table 1), and 965 resident ‘tropical’ birds were captured (Table 2) but released unbanded. Selected species of resident tropical birds were marked with unique combinations of color bands.

Table 1 Numbers of birds banded

English Common Name	Scientific Name	Iguanita			Naranjo				Tamarindo				Playa Grande				Totals
		2004/5	2005/6	2006/7	2003/4	2004/5	2005/6	2006/7	2003/4	2004/5	2005/6	2006/7	2003/4	2004/5	2005/6	2006/7	
Spotted Sandpiper	<i>Actitis macularia</i>		1	1	1			2	4	7	4	4					24
Least Sandpiper	<i>Calidris minutilla</i>										1						1
White-winged Dove	<i>Zenaida asiatica</i>		1	3				2		2	1						9
Inca Dove	<i>Columbina inca</i>	7	6	4	1	1	2	3	8	2	5	2	2	1	1		45
Common Ground-Dove	<i>Columbina passerina</i>	21	6	30		1			23	27	17	17				6	148
White-tipped Dove	<i>Leptotila verreauxi</i>		7	4			1	2			1					1	16
Mangrove Cuckoo	<i>Coccyzus minor</i>	2		1			1										4
Ferruginous Pygmy-Owl	<i>Glaucidium brasilianum</i>	2	1	1													4
Lesser Nighthawk	<i>Chordeiles acutipennis</i>		2								1						3
Pauraque	<i>Nyctidromus albicollis</i>	1		2		1	1		1								6
Green Kingfisher	<i>Chloroceryle americana</i>	1	2	2	1	2	2	6	3	2		5				1	27
Northern Beardless Tyrannulet	<i>Camptostoma imberbe</i>							1				3					4
Trail's Flycatcher	<i>Empidonax alnorum/traillii</i>		2						1								3
Dusky-capped Flycatcher	<i>Myiarchus tuberculifer</i>	4	7	2	2	1			2	1							19
Great Crested Flycatcher	<i>Myiarchus crinitus</i>	6	4	4					2	1	2	1					20
Brown-crested Flycatcher	<i>Myiarchus tyrannulus</i>	4	4	3	28	19	10	7	15	12	18	11	2	2			135
Great Kiskadee	<i>Pitangus sulphuratus</i>	8	11	7		1	2	5	1	1	12	2	1	2		1	54
Sulphur-bellied Flycatcher	<i>Myiodynastes luteiventris</i>	1		1					5	1							8
Tropical Kingbird	<i>Tyrannus melancholicus</i>					1			12	2	5	5		1	2	3	31
Rose-throated Becard	<i>Pachyrhamphus aglaiae</i>		1	3								1					5
Yellow-throated Vireo	<i>Vireo flavifrons</i>	3	1	1					1	1	3	3					13
Philadelphia Vireo	<i>Vireo philadelphicus</i>	3	1	2	1	4						2					13
Swainson's Thrush	<i>Catharus ustulatus</i>				1		1		1			1					4
Wood Thrush	<i>Hylocichla mustelina</i>			1													1
Clay-colored Robin	<i>Turdus grayi</i>	1	1	3							2	1					8
Tennessee Warbler	<i>Vermivora peregrina</i>	17	63	172	24	9	15	6	23	35	56	60	3	8	4	21	516
Yellow Warbler	<i>Dendroica petechia</i>	30	34	37	11	28	9	9	17	32	49	37	5	7	4	2	311
Mangrove Yellow Warbler	<i>Dendroica petechia erithachorides</i>	3	3	6	3	4	5	3	21	18	18	14					98
Prairie Warbler	<i>Dendroica discolor</i>						2										2
Black-and-White Warbler	<i>Mniotilta varia</i>									1				1			2
American Redstart	<i>Setophaga ruticilla</i>		4	1			2	1									8
Prothonotary Warbler	<i>Protonotaria citrea</i>	24	15	21	61	61	66	61	59	112	82	135	20	30	5	44	796
Ovenbird	<i>Seiurus aurocapillus</i>											1					1
Northern Waterthrush	<i>Seiurus noveboracensis</i>	15	14	12	20	18	36	17	46	54	76	65			1	3	377
Hooded Warbler	<i>Wilsonia citrina</i>	1									3				1		5
Rufous-capped Warbler	<i>Basileuterus rufifrons</i>	1			1	3	2	3									10
Summer Tanager	<i>Piranga rubra</i>	2	2		1			3	2	3	8	3				1	25
Western Tanager	<i>Piranga ludoviciana</i>	4	5	4							1	1					15
White-collared Seedeater	<i>Sporophila torqueola</i>	1							2	4	17	4					28
Rose-breasted Grosbeak	<i>Pheucticus ludovicianus</i>		1				1										2
Blue Grosbeak	<i>Passerina caerulea</i>	2	2														4
Indigo Bunting	<i>Passerina cyanea</i>					1											1
Painted Bunting	<i>Passerina ciris</i>	36	28	17	1	5	1		13	41	29	17		1			189
Streak-backed Oriole	<i>Icterus pustulatus</i>				2	1			5	1	2			1			12
Baltimore Oriole	<i>Icterus galbula</i>			1		1			1	1	1	1		1	1		8
Total		200	229	346	159	162	159	131	268	361	414	396	33	55	19	83	3015

Table 2 Numbers of birds 'unbanded'

English Common Name	Scientific Name	Iguanita			Naranjo				Tamarindo				Playa Grande				Totals
		2004/5	2005/6	2006/7	2003/4	2004/5	2005/6	2006/7	2003/4	2004/5	2005/6	2006/7	2003/4	2004/5	2005/6	2006/7	
Snowy Egret	<i>Egretta thula</i>						1										1
Little Blue Heron	<i>Egretta caerulea</i>		2			1											3
Green Heron	<i>Butorides virescens</i>		1		1		1				1	1					5
Yellow-crowned Night-heron	<i>Nyctanassa violacea</i>									1							1
White Ibis	<i>Eudocimus albus</i>						1										1
Roadside Hawk	<i>Buteo magnirostris</i>						1									2	3
Orange-fronted Parakeet	<i>Aratinga canicularis</i>		1							2		1					4
White-fronted Parrot	<i>Amazona albifrons</i>		1														1
Squirrel Cuckoo	<i>Piaya cayana</i>	1	1	1										1			4
Groove-billed Ani	<i>Crotophaga sulcirostris</i>								3	1			1				5
Pacific Screech-owl	<i>Otus cooperi</i>						1						1				1
Long-billed Hermit	<i>Phaethornis longirostris</i>			1													1
Green-breasted Mango	<i>Anthracothorax prevostii</i>							3			1	2			4	4	14
Canivet's Emerald	<i>Chlorostilbon canivetii</i>	2	4	2		3			2	3	2	2	2	3	1	5	31
Mangrove Hummingbird	<i>Amazilia boucardi</i>								1	2	3	2					8
Steely-vented Hummingbird	<i>Amazilia saucerrottei</i>	16	23	38	4	4	5	3	9	18	13	14	2	2	6	6	163
Rufous-tailed Hummingbird	<i>Amazilia tzacatl</i>										1						1
Cinnamon Hummingbird	<i>Amazilia rutila</i>	10	9	16	2	1	4	1	18	27	37	22	9	14	7	16	193
Plain-capped Starthroat	<i>Helimaster constantii</i>	2	1	2	5	3	1	4			1						19
Ruby-throated Hummingbird	<i>Archilocus colubris</i>	9	16	9		7	4	3	2	15	12	8	7	22	6	4	124
Black-headed Trogon	<i>Trogon melanocephalus</i>	4	1	2	1	1	1	3	1	3	1	4		1	3		26
Ringed Kingfisher	<i>Ceryle torquata</i>					1	2										3
White-necked Puffbird	<i>Notharchus macrorhynchos</i>			1													1
Hoffmann's Woodpecker	<i>Melanerpes hoffmannii</i>	4	4	5					3	2	1		1	2		3	25
Lineated Woodpecker	<i>Dryocopus lineatus</i>	1															1
Olivaceous Woodcreeper	<i>Sittasomus griseicapillus</i>	1	2	1	1												5
Streak-headed Woodcreeper	<i>Lepidocolaptes souleyetii</i>	3	3	1	3	3		1	5	8	1	2					30
Northern Beardless-tyrannulet	<i>Camptostoma imberbe</i>					2				1	1						4
Greenish Elaenia	<i>Myiopagis viridicata</i>	2															2
Slate-headed Tody-Flycatcher	<i>Poecilatriccus sylvia</i>			1													1
Yellow-olive Flycatcher	<i>Tolmomyias sulphureus</i>	6	9	11	1	2	2	2	5	7	4	2	2		1		54
Royal Flycatcher	<i>Onychorhynchus coronatus</i>						1										1
Tropical Pewee	<i>Contopus cinereus</i>			2													2
Nutting's Flycatcher	<i>Myiarchus nuttingi</i>	4		4	2				1		3	2		1	2	3	22
Boat-billed Flycatcher	<i>Megarynchus pitangua</i>	2	1						1	5	1			2	3	1	16
Social Flycatcher	<i>Myiozetetes similis</i>	1	1			1		1		2		2					8
Streaked Flycatcher	<i>Myiodynastes maculatus</i>		1								1	2					4
White-winged Becard	<i>Pachyrhamphus polychopterus</i>		2	2							1						5
Long-tailed Manakin	<i>Chiroxiphia linearis</i>	2		1	2	9	5	2									21
White-throated Magpie-Jay	<i>Calocitta formosa</i>									1					1		2
Rufous-naped Wren	<i>Campylorhynchus rufinucha</i>	1						1	3	2		4	10	10	3	9	43
Banded Wren	<i>Thryothorus pleurostictus</i>	3	3	4					6	2	4	4		2	1	2	31
White-lored Gnatcatcher	<i>Poliophtila albiloris</i>	1	4	6	8	5	1	2	8	5	2	1	9	11	5	4	72
Scrub Euphonia	<i>Euphonia affinis</i>				1						2						3
Total		75	90	110	31	43	31	26	68	107	93	75	43	72	44	57	965

There were 1,744 recapture events involving 1,199 individuals. 441 of these birds were returns from previous years (Table 3) and 758 birds were recaptured during the same season (Table 4).

Table 3 Number of recaptures of individual birds among years

English Common Name	ESIG		ESNA			ESTA			PLGR			Totals
	2005/6	2006/7	2004/5	2005/6	2006/7	2004/5	2005/6	2006/7	2004/5	2005/6	2006/7	
Spotted Sandpiper			1			1	2	1				5
Inca Dove		1				1	3	1				6
Common Ground-Dove	3					4	3					10
White-tipped Dove		2										2
Mangrove Cuckoo	1	1										2
Ferruginous Pygmy-Owl	1											1
Green Kingfisher			1	1								2
Streak-headed Woodcreeper	1	1		1			3	2				8
Northern Beardless Tyrannulet				1	1							2
Yellow-olive Flycatcher		3					1	1				5
Dusky-capped Flycatcher	2	2										4
Nutting's Flycatcher	1							1				2
Great Crested Flycatcher	2											2
Brown-crested Flycatcher	1		2	5	6	5	8	4	3			34
Great Kiskadee	1	2					1			1		5
Streaked Flycatcher		1										1
Sulphur-bellied Flycatcher						2						2
Tropical Kingbird									1			1
Long-tailed Manakin	1											1
Yellow-throated Vireo		1						1				2
Rufous-naped Wren											1	1
Banded Wren		1					1	1				3
White-lored Gnatcatcher		1			1					1	2	5
Tennessee Warbler		7				3	4	3	1		2	20
Yellow Warbler	6	3	1	2	1	4	9	9	2	1	1	39
Mangrove Yellow Warbler						6	8	6				20
American Redstart		1										1
Prothonotary Warbler	5	10	18	13	10	13	37	21	6	8	6	147
Northern Waterthrush	4	8	3	4	4	17	20	20	1			81
Summer Tanager		1				1	1	2				5
White-collared Seedeater							1					1
Blue Grosbeak	1											1
Painted Bunting	5	1					5	7				18
Streak-backed Oriole						1					1	2
Totals	35	47	26	27	23	58	107	80	14	11	13	441

Table 4 Number of recaptures of individual birds within years

English Common Name	ESIG			ESNA				ESTA				PLGR				Totals
	2004/5	2005/6	2006/7	2003/4	2004/5	2005/6	2006/7	2003/4	2004/5	2005/6	2006/7	2003/4	2004/5	2005/6	2006/7	
Spotted Sandpiper								1	5		1					7
Inca Dove	1	2						1		1						5
Common Ground-Dove	1		3					4	6	3	2					19
Ferruginous Pygmy-Owl	1															1
Green Kingfisher					1						2					3
Streak-headed Woodcreeper		1			1		1		3		1					7
Yellow-olive Flycatcher	3	2	3		1	1			1	1	1					13
Dusky-capped Flycatcher	1	3														4
Nutting's Flycatcher											1					1
Great Crested Flycatcher	2								1							3
Brown-crested Flycatcher	1	1		4	4	1	1	3	2	1	1	1	1			21
Great Kiskadee	2		1							1						4
Tropical Kingbird								1		1						2
White-winged Becard		1														1
Long-tailed Manakin					1											1
Yellow-throated Vireo	1								1	1						3
Philadelphia Vireo	1															1
Rufous-naped Wren													1	2		3
Banded Wren	1	1	1						1	3	1				1	9
White-lored Gnatcatcher		1	1		2		1		1	2			6		3	17
Tennessee Warbler		4	20	5			1	3	4	2	9				3	51
Yellow Warbler	8	7	6	2		1	2	2	1	10	7	1	2	2		51
Mangrove Yellow Warbler	1	2	3		2	2	1	11	2	11	9					44
Prairie Warbler						1										1
American Redstart		1														1
Prothonotary Warbler	14	8	7	19	21	20	10	20	40	30	47	13	15	1	22	287
Northern Waterthrush	5	4	7	8	10	15	10	26	23	42	27				3	180
Summer Tanager										1						1
Painted Bunting	4							1	2	6	4					17
Totals	47	38	52	38	43	41	27	73	93	116	113	15	25	5	32	758

Twenty-nine individuals of 6 species were recaptured after moving between the mangroves at ESTA and the dry forest at PLGR (Table 5).

Table 5 Numbers of birds banded at ESTA and recaptured at PLGR

Species	Number recaptured
Brown-crested Flycatcher	2
Great Kiskadee	1
Northern Waterthrush	2
Prothonotary Warbler	22
Tennessee Warbler	1
Yellow Warbler	1

Thirty-four birds of 4 species were recaptured after moving between the dry forest at PLGR and the mangroves at ESTA (Table 6).

Table 6 Numbers of birds banded at PLGR and recaptured at ESTA

Species	Number recaptured
Tennessee Warbler	1
Yellow Warbler	2
Prothonotary Warbler	30
Painted Bunting	1

There were no other recaptures of birds among sites.

There was one foreign recovery; a Tennessee Warbler banded on August 8 2006 at Delta Marsh Bird Observatory (24 km N of Portage la Prairie, Manitoba, Canada) was recaptured at Playa Grande (3 km N of Tamarindo, Guanacaste, Costa Rica) on November 23 2006. This 8.1 g. hatch year bird covered a straight line distance of over 4,300 km in 107 days, averaging at least 40 km per day.

Table 7 Age/sex classes of Prothonotary Warblers

	adults		young	
	male AHY/ASY	female AHY/ASY	male HY/SY	female HY/SY
ESIG	20 - 74%	7 - 26%	23 - 70%	10 - 30%
ESNA	53 - 67%	26 - 33%	99 - 58%	71 - 42%
ESNA	89 - 70%	42 - 30%	138 - 53%	119 - 47%
PLGR	21 - 75%	7 - 25%	29 - 41%	42 - 59%

## Discussion

A greater diversity of birds was captured in the mangroves than in the adjacent dry forest: 66 species were captured at ESIG, 54 at ESNA, 63 at ESTA, and only 35 at PLGR. This difference was likely due, in part at least, to a higher canopy at PLGR resulting in a lesser likelihood of birds encountering nets there. The number of species observed, but not captured, was also higher in the mangroves than in the dry forest. There were 54 species at ESIG that were observed, but not captured, 57 species at ESNA, 48 at ESTA, and 34 at PLGR. This difference can in part be attributed to many 'wetland' species that did not use the dry forest habitat and many dry forest species that did use the mangroves.

Approximately 84% (2,502) of the birds captured were neo-tropical migrants of 25 species. 50% of all birds captured were migratory warblers of four species: Prothonotary Warbler (796) 20% of the total captured, Tennessee Warbler (516) 13%, Northern Waterthrush (377) 9.5%, and Yellow Warbler (311) 7.8%. LeFebvre et al 1992 report different proportions in Venezuelan black mangroves with captures of 75% Northern Waterthrush and 20% Prothonotary Warbler. Observations by LeFebvre & Poulin (1996) in Panamanian mangroves show similar high proportions of Prothonotary Warblers and Northern Waterthrush but far fewer Yellow Warblers and Tennessee Warblers.



Two patterns of dispersal were noted. On a daily basis Prothonotary Warblers were observed leaving the mangroves in the early morning, to forage in adjacent dry forest habitat and return to the mangroves later in the day for, presumably, cover and roosting. Banding data supports this observation with high proportions of the daily catch of Prothonotary Warblers being made in the first hour after dawn and in the last hours of daylight. There were many recaptures of Prothonotary Warblers that had moved between mangroves and dry forest, and vice versa. Many of the warblers captured in the dry forest and the mangroves were dusted with pollen from flowering trees and vines in the dry forest where they were often observed feeding. There were small numbers of Brown-crested Flycatchers, Great Kiskadee, Northern Waterthrush, Tennessee Warbler, and Yellow Warbler recaptured after moving between the two habitats. Many other species were observed leaving the mangroves in the early morning: Orange-fronted Parakeet, Orange-chinned Parakeet, White-fronted Parrot, Yellow-naped Parrot, Brown-crested Flycatcher, Great Kiskadee, Tropical Kingbird, Scissor-tailed Flycatcher, and Great-tailed Grackle. There were high numbers of Tennessee Warblers captured around mid-day in the mangroves but this was an exception to the rule. This species was often observed foraging in the mangroves in mixed flocks with Streak-headed Woodcreepers, Yellow-olive Flycatchers, Yellow Warblers, and Prothonotary Warblers.

Over the longer term, the numbers of Prothonotary Warblers using the mangroves decreased between a November high and a February low with numbers resurging in March. Similar patterns were observed by LeFebvre et al 1992. The February low coincides with the flowering of many dry forest trees. Prothonotary Warblers were observed feeding in and around the flowers of leafless trees (*Haematoxylum brasiletto*, *Bombacopsis quinata*, *Tabebuia ochracea*, and *Gliricidia sepium*) in the dry forest at Playa Grande.

This scarcity in February was most pronounced at Estero Naranjo where very few Prothonotary Warblers were encountered in February and was least pronounced at Estero Tamarindo where the number of captures did not fall off quite so dramatically in February. Perhaps this difference is due to varying climatic conditions between these two locations. Estero Naranjo tends to be hotter and drier than Estero Tamarindo. In addition, Estero Tamarindo has more extensive areas of early successional mangroves favored by the warblers and is more fragmented by small bodies of water, creating not only more edge habitat but also isolating interior regions and thus making access for land dwelling predators more difficult. All these factors combine to make Estero Tamarindo a more favorable habitat throughout the winter obviating the need to depart during the harshest part of the winter. A fairly large number of new Prothonotary Warblers were banded in March and these were likely migrants on their way north. Many of these birds had significant fat deposits.

Recapture data of Prothonotary Warblers lends support to the theory that two behavioral strategies may exist in wintering populations of songbirds: a transient strategy in which individuals roam over a large area and a resident strategy with movements limited to a small area (Cattry et al 2003, Belda et al 2007). Many Prothonotary Warblers were recaptured only one time and these were likely birds exhibiting the transient strategy. Other individuals were recaptured many times each season and these were likely resident birds.

More males than females of all age/sex classes were captured at all sites with the following exception: more HY/SY females than males were captured at PLGR. There was a higher male/female ratio in the AHY/ASY age class than in the HY/SY ages class. This is likely an adaptive response to higher predation rates that AHY/ASY birds experienced in previous breeding season(s), a selective pressure not yet encountered by the HY/SY birds.

Recaptures among and within years demonstrate site fidelity.

The percent cover of leafy vegetation below 3m in height was greatest at the 2 most productive sites, Estero Tamarindo and Estero Naranjo suggesting that Prothonotary Warblers have a preference for early successional habitat.

'Mangrove' Yellow Warblers *Dendroica petechia erithachorides* were present at all the mangrove sites contrary to Styles & Skutch 1986 report that they were absent from the north Pacific coast of Costa Rica. They were definite permanent residents, often heard singing in Nov. and March, and frequently recaptured, but only at Estero Tamarindo. Transient individuals were captured in the other two mangrove swamps and none were encountered in the dry forest.

The Mangrove Hummingbird *Amazilia boucardi*, also previously thought to absent from the north Pacific coast, was also captured at Estero Tamarindo, though in small numbers (2 adult females in Nov. 2006, 2 hatch year males: one in Feb. 2006 & one in March 2006, one hatch year female & a female of undetermined age in Jan. 2005, and an adult female in Feb. 2004). We suspect they were permanent residents.

These results indicate that the mangrove swamps and adjacent dry forest provide important wintering habitat for significant numbers of migratory songbirds. Not previously well documented is the strong site fidelity that Prothonotary Warblers and many other species of migratory birds have for these wintering grounds.

The dry forests surrounding Estero Tamarindo are currently under threat of development, particularly those forests adjacent to the beach at Playa Grande. To assure continued survival of the 'landbirds' that use the mangroves, the dry forests surrounding the mangroves need to be protected.

## References

Baillie, S. R., R. E. Green, M. Boddy, and S. T. Buckland. 1986. An evaluation of the constant effort sites scheme. Unpublished report to the British Trust for Ornithology.

Belda, E.J., E. Barba & J.S. Monrós. 2007. Resident and transient dynamics, site fidelity and survival in wintering Blackcaps *Sylvia atricapilla*: evidence from capture-recapture analyses. *Ibis* 149:396-404.

Catry, P., T. Catry & T. Martins. 2003. Within and between-year winter-site fidelity of Chiffchaffs *Phylloscopus collybita*. *Ardea* 91(2):213-220.

David F. DeSante, James F. Saracco, Claudia Romo de Vivar Alvarez & Salvadora Morales. 2004. 2004-05 MoSI Manual, Instructions for establishing and operating bird-banding stations as part of the MoSI (Monitoreo de Sobrevivencia Invernal) program. Contribution Number 214 of The Institute for Bird Populations, PO Box 1346 Pt. Reyes Station, CA 94956 USA.

LeFebvre, Gaëtan and Brigitte Poulin. 1996. Seasonal abundance of migrant birds and food resources in Panamanian mangrove forests. *Wilson Bulletin* 108(4):748-759.

LeFebvre, Gaëtan, Brigitte Poulin, & Raymond McNeil. 1992. Abundance, feeding behavior, and body condition of nearctic warblers wintering in Venezuelan Mangroves. *Wilson Bulletin* 104(3):400-412.

Polanía J. 1993. Mangroves of Costa Rica. In: Lacerda, L. D., editor. Conservation and sustainable utilization of Mangrove Forests in Latin America and Africa Regions. Part 1; Volume 2:

Spalding, Mark, Francois Blasco, and Colin Field., editors. 1997. World mangrove atlas. Chapter 7: The Americas: Costa Rica and Panama. Okinawa, Japan: The International Society for Mangrove Ecosystems.

worldwildlife.org<sup>a</sup> worldwildlife.org/wildworld/profiles/terrestrial\_nt.html#mangroves **Southern Pacific Coast Mangroves**, an unreviewed document

worldwildlife.org<sup>b</sup> worldwildlife.org/wildworld/profiles/terrestrial\_nt.html#drybroad **Central American dry forests**, a reviewed document

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