A Network for Inventory and Monitoring of Bird Populations on the Santa Cruz River Watershed.

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Abstract

The Santa Rita Experimental Range (SRER) hosts one of the two long term bird banding stations on the Santa Cruz River Drainage. The station in Florida Canyon (FLAC) has operated since 1999, the other at Tumacacori National Historical Park (TUMA) since 1997. The stations are part of the Monitoring Avian Productivity and Survivorship (MAPS) program. The analysis of data collected from observations and captures has produced an inventory of the natural history of the birds at FLAC and TUMA. Further, a baseline for monitoring the productivity and diversity of the bird community of the Upper Santa Cruz River now exists. As a part of the MAPS network, population trends and estimates of vital rates can be obtained.

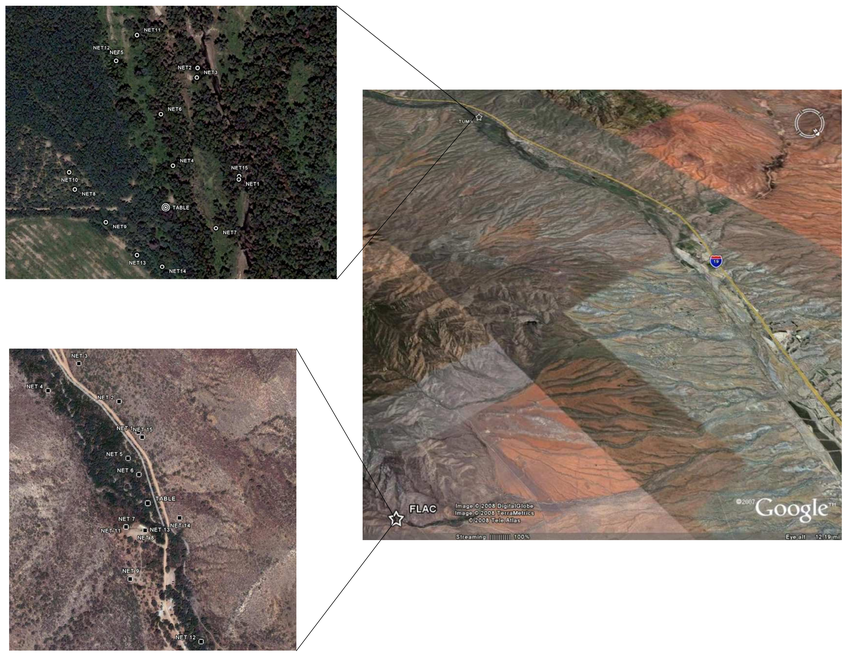
Findings

- TUMA and FLAC have similar breeding species diversity.
- FLAC contains higher diversity due to higher numbers of transient species.
- TUMA diversity contains higher numbers of passage migrants.
- TUMA's greater productive is due to one or two very abundant species.
- Habitiat driven diversity may depend on finely tuned preferences on species by species basis.
- Two stations can establish coarse community level characterization.
- Need many more stations to explain community level patterns driven by species level process.

Introduction

FLAC, situated at 4200 ft, is a roughly 10 ha section of Florida Canyon that extends for about 0.5 miles from the care-taker's residence at SRER. Nets are equally divided between the Oak/Mesquite gallery forest along the creek and also in the Mesquite/Grassland association on the hillside flanking the creek. TUMA, at 2500ft occupies 10 ha on the West banks of the Santa Cruz River in Tumacacori National Historical Park. Nets are divided between the Cottonwood/Willow gallery forest along the river and the Mesquite/Hackberry woodlands boardered by fallow agricultural fields. **Figure 1** shows the locations of the two stations.

Figure 1:
Station Locations Along the Santa Cruz River



Birds are categorized according to their breeding and migratory status as shown in **Table 1**.

Table 1: Definition of Breeding and Migratory Status

Breeding Status

CODE	CLASS	DEFINTION
B	Breeder	Recorded as breeding in all years
U	Usual Breeder	Recorded as breeding in > 50% of years
O	Occasional Breeder	Recorded as breeding in < 50% of years
T	Transient	Station is in breeding range but has not bred within station boundary
N	Non-breeder	Station is not within breeding range

Migratory Status

M	Migrant	Station is within at most either the breeding or non-breeding range
A	Altitudinal Migrant	Station is within either breeding/non-breeding range depending on altitude
S	Sedentary	Species is year round station resident

Methods

- Constant effort mist netting follow MAPS protocol (DeSante et al, 2005)
- Area searches to document status follow (DeSante et al, 2005)
- Population Density Estimates computed according to Huggins et al. (2003)
- Species Richness Curves (SRC) estimated using variant of Chao et al. (2001)
- Species Abundance Distribution (SAD) estimated using Wand & Jones (1995)

Habitat Structure Assessment

FLAC and TUMA have similar local habitat structural diversity. Both comprise two main habitat types dominated by gallery forest with a 15-20m canopy surrounded by a secondary habitat dominated by mesquite. The Sycamore/Oak/Hackberry gallery forest at FLAC is set in a mid-elevation canyon surrounded by rolling hills whose understory is a mixed grassland/octotillo/opuntia association. The Cottonwood/Willow/Hackberry gallery forest at TUMA is embedded in fallow agricultural lands at lower elevation that are in the early stages of succession. Moving beyond the 100m station boundaries, birds at FLAC can reach pine forests and low elevation semi-desert grasslands by travelling a mile or less. TUMA has rather lower β diversity having mostly agricultural and urban habitats within a 1 mile radius.

Productivity

The total number of individuals occurring in an area is a measure of productivity. **Figure 2**, shows fluctuations in productivity for both FLAC and TUMA. TUMA has been in operation for 2 years longer than FLAC so the first few years at FLAC show no productivity. The correlations between widely separated sites implies large-scale environmental effects. **Figure 2** contains curves from 103 species. The large increase at TUMA in 2005 and 2006 is due primarily to Yellow-breasted Chat. This species occurs very rarely at FLAC. **Table 2** lists the top 21 for each site species by average density. The species are classified by breeding and migratory status as defined in **Table 1**.

Figure 2:
Total Population Sizes for FLAC and TUMA

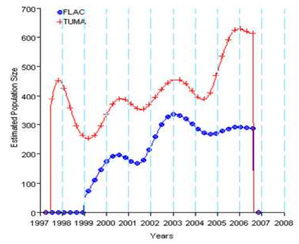


Table 2: Status of most abundant species at FLAC and TUMA ranked by average density.

Florida Canyon

STATUS	COMMON NAME	AVERAGE DENSITY
N,M	Wilson's Warbler	15.9
B,M	Black-headed Grosbeak	12.8
B,S	Canyon Towhee	9.8
B,M	Blue Grosbeak	9.2
B,S	Black-throated Sparrow	9
B,M	Varied Bunting	9
B,S	Northern Cardinal	8.9
T,M	Western Flycatcher	8.6
B,S	Rufous-crowned Sparrow	8.3
N,M	Swainson's Thrush	7
N,M	Hammond's Flycatcher	7
T,M	Western Tanager	6.8
B,S	House Finch	6.8
B,S	Bewick's Wren	6.3
B,M	Summer Tanager	6.2
B,S	Verdin	6
T,M	Warbling Vireo	5
B,M	Lucy's Warbler	5
B,M	Ash-throated Flycatcher	4.9
B,S	Lesser Goldfinch	4.7
N,M	Dusky Flycatcher	4.7

Tumacacori National Historical Park

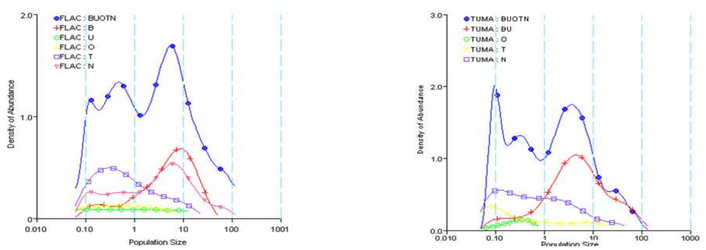
STATUS	COMMON NAME	AVERAGE DENSITY
B,M	Yellow-breasted Chat	80.7
B,M	Lucy's Warbler	45.5
B,M	Summer Tanager	35.4
B,S	Bewick's Wren	33.3
B,S	Song Sparrow	24.7
B,S	Abert's Towhee	22.2
N,M	Swainson's Thrush	17.8
N,M	Wilson's Warbler	14.3
B,M	Yellow Warbler	9.3
B,S	Northern Cardinal	9
B,M	Bell's Vireo	8.5
U,M	Varied Bunting	7.3
B,M	Brown-crested Flycatcher	6.8
B,M	Blue Grosbeak	6.6
N,M	MacGillivray's Warbler	6.5
B,M	Brown-headed Cowbird	6.3
B,S	Bridled Titmouse	5.8
U,M	Common Yellowthroat	5.7
T,M	Western Flycatcher	5
B,M	Phainopepla	4.4
U,M	Black-headed Grosbeak	3.7

Most of the abundant species found at both stations are migrant breeders. The non-breeding migrants may be either passage migrants or winter residents, however, this list includes just two passage migrants, WIWA – the most abundant species at FLAC - and WEFL. A quick scan of the list doesn't reveal the relative importance of breeding status and migratory status in the community composition of the two sites. The Species Abundance Distribution (SAD), presented below, provides a more graphical presentation of these results.

Species Abundance Distribution

The SAD plots density of species versus abundance and provides a measure of diversity by showing a relationship between population size and species richness. The SADs in **Figure 3** show that the most abundant species account for only a small fraction of the diversity while breeders, transients and migrants share in the dominance of diversity at both stations. Breeders and non-breeders each account for roughly one quarter of the diversity. The SADs reveal that transients are more important at FLAC and migrants at TUMA. This probably reflects the geography of the two stations – FLAC has higher β habitat diversity and TUMA is located on a corridor.

Figure 3:
SAD at FLAC and TUMA According to Breeding Status

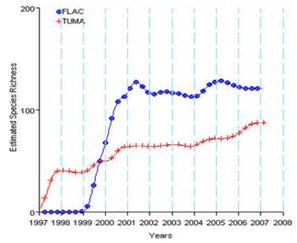


At FLAC, transient species, which typically have large home ranges and low density, account for another quarter with the rest made up by the irregular breeders. TUMA replaces the transients with non-breeders which must be long-distance migrants.

Species Richness Curves

The raw count of species captured under-estimates the true species richness so methods used for population estimation are used to correct for sampling effort. As seen in **Figure 3**, detection probabilities differ between species so Chao's (2001) Abundance-based Coverage Estimator (ACE) is used to correct for these effects. **Figure 4** shows the results of the ACE method. Note that the estimator requires about two years of data to arrive at roughly 122 species. In both stations, the breeding components have converged rapidly and stations evidently have similar local diversity because both support similar numbers of breeding and over-wintering species. However, FLAC is located on a steep elevation gradient providing relatively higher regional, or beta, habitat diversity.

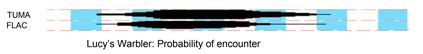
Figure 4:
SRC of FLAC and TUMA



Initial Network Results

The community level patterns observed above are generalizations taken across space, time and entire species assemblies. Drilling down to the data on individual species reveals a much finer grained, more mechanistic, picture of the avian ecology. It also shows that a more detailed, process oriented understanding requires a finer grained, more intensively sampled data set.

Figure 5: Lucy's Warbler at FLAC and TUMA

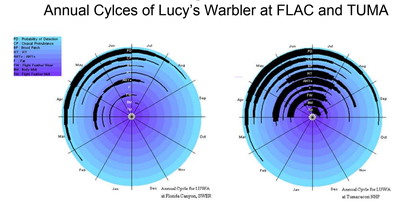


Molt Migration in Lucy's Warbler

Lucy's Warbler is a common breeding species at both TUMA and FLAC. It occurs in the gallery forest and mesquite bosques at both sites where its persistent singing make it easily detectable. As can be seen in Figure 5, Lucy's Warbler density plummets at FLAC towards the end of July. The drop off in Lucy's detections coincides with the fledging period when capture rates for other species usually increase due to the presence of juveniles and family groups. However, TUMA shows a completely different pattern. At TUMA, Lucy's Warbler persists for an additional two months. Comparing the data from only sites reveals a curious difference in molt and migration for Lucy's Warbler between the two sites.

Figure 6 shows the same strip charts displayed in Figure 5 but displayed as a wheel to emphasize the annual cycle. The rim of the wheel shows the probability of detection, as in Figure 6. The left wheel shows Lucy's Warbler at FLAC, the right, TUMA. The second and third rings show the progression of breeding condition for males in the second ring and females in the third. By mid-July, birds at both sites are showing the termination of breeding condition with the fourth ring showing a corresponding emergence of juveniles. The third ring from the center shows that feather wear reaches a maximum by the end of July. The first and second inner rings show that most birds are in heavy molt and many have finished molt before they migrate south.

Figure 6:
Annual Cylces of Lucy's Warbler at FLAC and TUMA



The wear chart also indicates that the birds are already worn when they arrive in the spring. Other migrants that molt on the wintering grounds typically show much less wear in the spring.

Molting birds at TUMA comprise both local and birds from more northerly locations because retrap data show birds that have bred at TUMA have lingered even into November. Remarkably, only 1000 ft of elevation change separates the sites and the Santa Cruz River is a short 18 miles from FLAC. Migratory behavior typically involves much larger distances and often large swings in habitat selection.The relatively short distance migrated coupled with the rather precise timing indicate that, at least for Lucy's Warbler, selection of molting habitats may be fairly finely tuned. Unfortunately, no Lucy's banded at FLAC have ever been retrapped at TUMA. This is probably because FLAC is on the very edge of acceptable breeding habitat. In order to try to establish the boundaries of favored breeding and molting habitats requires more data for sites between TUMA and FLAC.

Future Work and Plans

Community level patterns can be obtained from a single site. Comparisons between sites can reveal intriguing patterns but only permit fairly general conclusions. In this case, the lower elevation site, TUMA, is more productive but less species rich that the higher elevation site, FLAC. Addressing the processes behind the pattern requires looking at individual species. As can be seen from the example of Lucy's Warbler, when we drill down to the details of individual species ecology, we discover that diversity carries over even to the strategies used for molt and migration. For each breeding species, and many of the migrants, analyses similar to the one presented here have been performed. Not surprisingly, each species presents a unique life history with a corresponding set of questions. The most basic data on dispersal and site fidelity are required in nearly every case. Only a finer scale network, in both space and time, can collect this data.

Unfortunately, two sites don't make a network. Establishing a network requires

- Suitable long term sites
- Trained and Certified Banders
- Trained Volunteers and Field Assistants
- Database management and analysis systems.

The two long term sites, TUMA and FLAC, generously funded by the National Park Service through the Desert Southwest Cooperative Ecosystem Study Unit, will continue to function as MAPS stations. Sister stations on the San Pedro River, operated for the Bureau of Reclamation, and in the Huachuca Mountains are also in operation to provide larger scale comparisons. Current plans call for the establishment of a non-profit research institute to coordinate the addition of new stations, manage staff and volunteers and procure funding. More than this, the new institute will facilitate the transfer of technologies like the database management, analysis and data entry programs to the bird banding community. With luck, other technologies that could, for example, facilitate real time tracking, enhance marking techniques or provide more accurate aging, will be developed.

Citations:

A.Chao, P.S.F. Yip, S.M. Lee, and W.T. Chu. Population size estimation based on estimating functions for closed capture-recapture models. Journal Of Statistical Planning And Inference, 213--232, January 2001.

D.F. DeSante, K.M. Burton, P.Velez, and D.Froehlich. Maps Manual: 2005 Protocol. Institute for Bird Populations. Point Reyes Station, CA, USA., 2005.

Huggins, R.; Yang, H.C.; Chao, A. & Yip, P.S.F. Population size estimation using local sample coverage for open populations. Journal Of Statistical Planning And Inference, 2003, 113, 699-714.

M.P. Wand and M.C. Jones. Kernel Smoothing. Chapman & Hall/CRC, 1995.