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A Multi-indicator Assessment of Conservation Success across a Populated Forest Anthrome

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A Multi-indicator Assessment of Conservation Success across a Populated Forest Anthrome

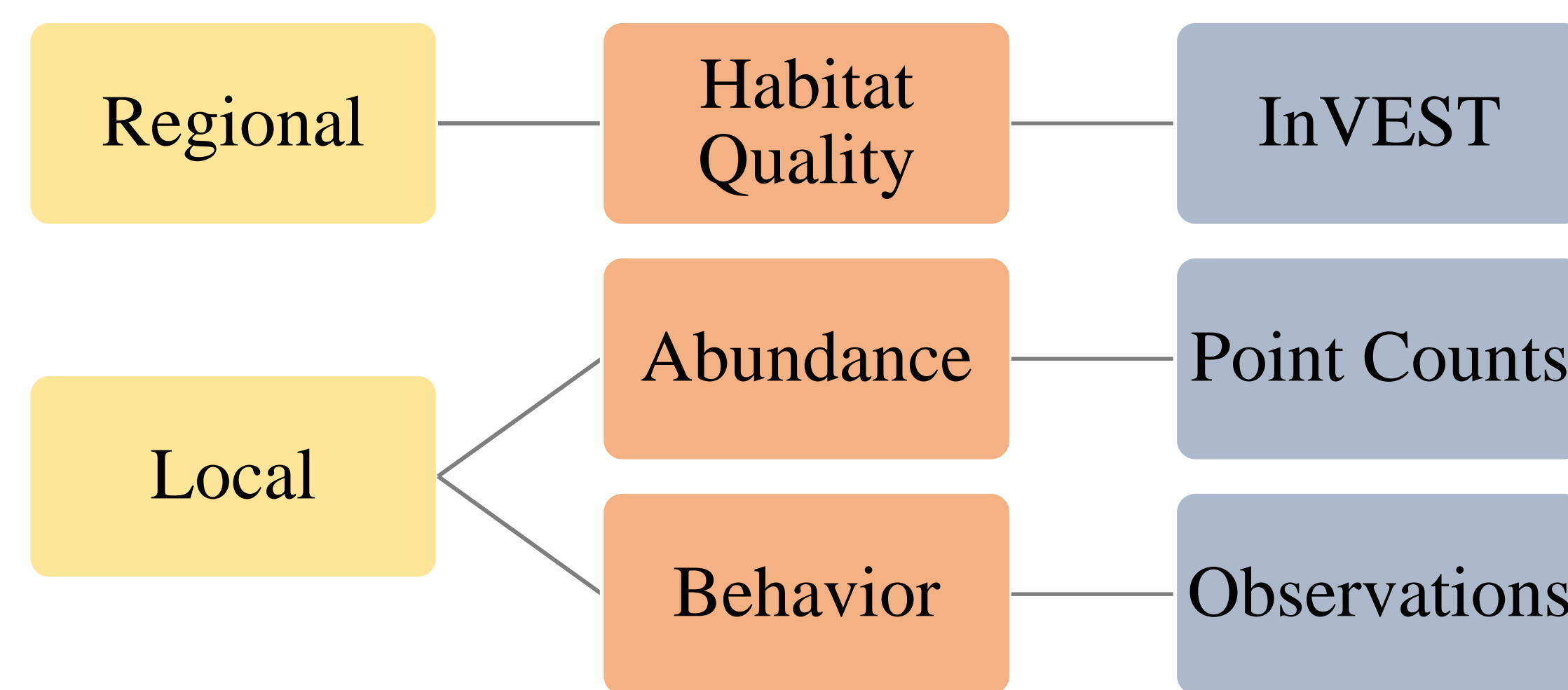
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Introduction

- Forest loss, particularly associated with increased urbanization, results in a shift from contiguous forest biomes to heterogeneous populated forest anthromes.
- Data are needed to understand how common and rare species respond to these changes and if ecological models from forest biomes can be applied to forest anthromes.
- Conservation action in anthromes should reflect multiple types of data, using local abundance and behavior to ground-truth and support regional models of habitat quality.
- In this project we link results from regional models, abundance estimates, and behavioral observations to evaluate and optimize conservation efforts.

Methods

- We modeled and spatially analyzed habitat quality using the Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) software developed by the Natural Capital Project.
- We investigated abundance of woodland birds in contiguous forest patches as a factor of patch size, patch matrix (surrounding LC) and land management.
- To further evaluate habitat quality and the effects of the aforementioned LC changes on birds we collected behavioral data on two species of generalists: Carolina Chickadees and Tufted Titmice.



Point Counts:

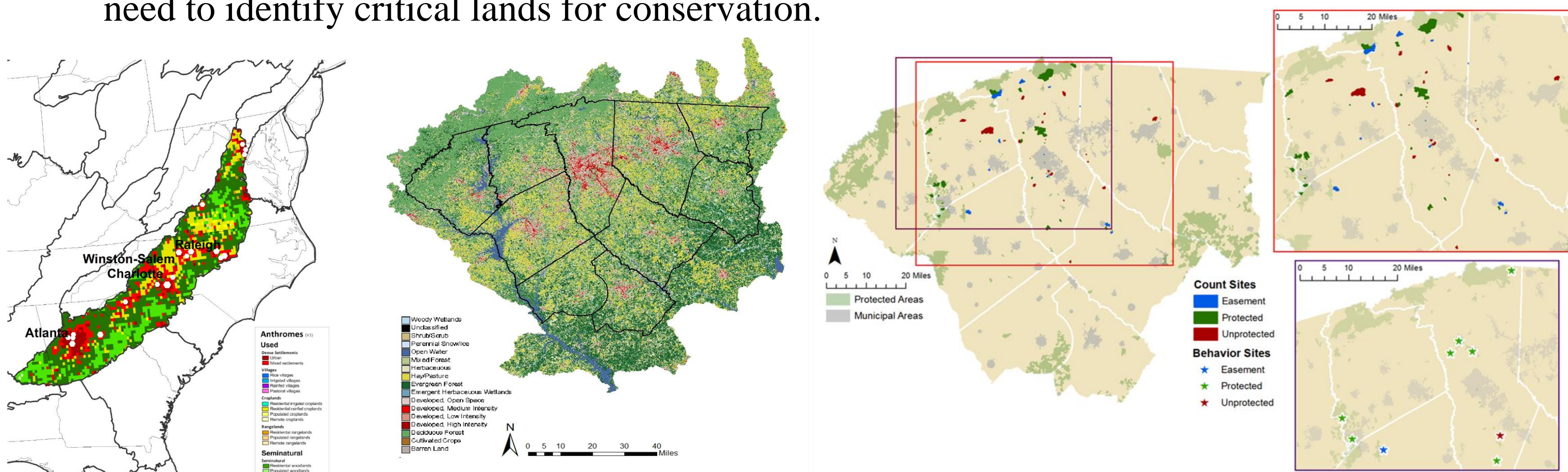
- 10-minute fixed-radius point counts (3 per patch)
- Analyzed data using Binomial-Poisson N-mixture models to predict abundance as a factor of 3 variables ('unmarked' package in program R)

Behavioral Observations:

- Recorded behavioral observations focusing on frequency of 8 behaviors categorized into: Active Foraging, Neutral, and Food Handling
- Analyzed data using Chi Square tests for independence (program R)

Study Region

- In the last four decades, the southeastern U.S. has experienced a regional land-cover transformation driven by urban development and multiple land-use demands.
 - Forests of the Piedmont region have experienced the greatest net loss.
- This region has shifted from a temperate forest biome to a heterogeneous mix of urban development, best described as a populated forest anthrome.
- These rapid LULC changes, along with the projected growth for the region, have created a need to identify critical lands for conservation.



Figures 1-3. (1) Map indicating frequency of anthromes in the southeast U.S. (2) Land cover (NLCD) map for Upstate South Carolina. (3) Map of Upstate SC, marking protected and municipal areas. Sub-maps indicate point count sites (top) and behavior sites (bottom). All sites classified by management category: conservation easement, protected land and unprotected (public) land.

- Point counts conducted at 57 forest patches across 6 counties in Upstate South Carolina: 13 easements, 25 protected patches, 19 unprotected patches
- Behavior data recorded at 9 of 57 forest patches: 2 Easements, 5 Protected Patches, and 2 Unprotected patches

Results: Regional Habitat Quality

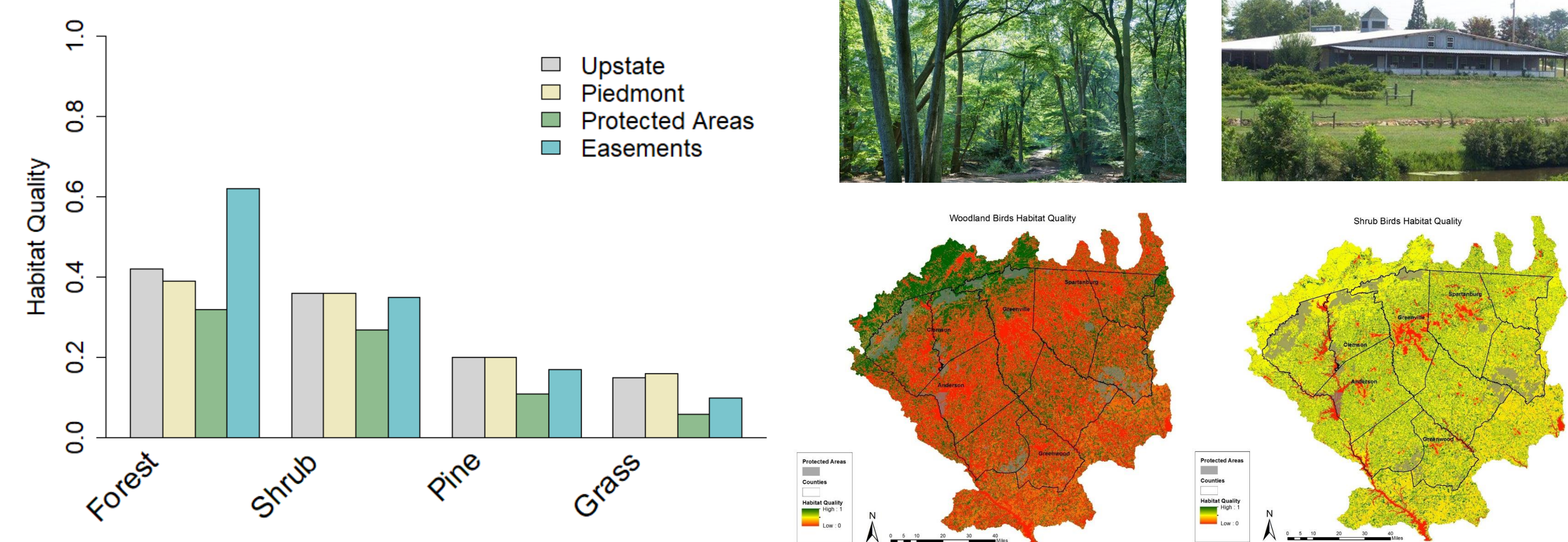


Figure 4. Relative habitat quality for four different habitat types across Upstate South Carolina, the Piedmont region, protected areas (PAD), and conservation easements.

Figure 5. Estimated habitat quality in the Upstate for Forest and Shrubland birds.

Results: Local Behavior

	Active Foraging					Neutral			Food Handling		
	PECK	PROBE	REACH	HANG	TOTAL	HOP	PERCH	TOTAL	GULP	JAB	TOTAL
Carolina Chickadee	8.4	11.4	7.8	9.6	37.3	27.1	28.9	56.0	0.9	5.7	6.6
Tufted Titmouse	3.8	9.7	8.6	3.2	25.4	35.1	37.3	72.4	0.5	1.6	2.2

Table 1. Eight behaviors (peck, probe, reach, hang, hop, perch, gulp, and jab) represented as percentage of total observed behaviors by Carolina Chickadees and Tufted Titmice across 2 Easements, 5 Protected patches, and 2 Unprotected patches. Behaviors are classified under three categories: active foraging, neutral and food handling (category totals are also included).

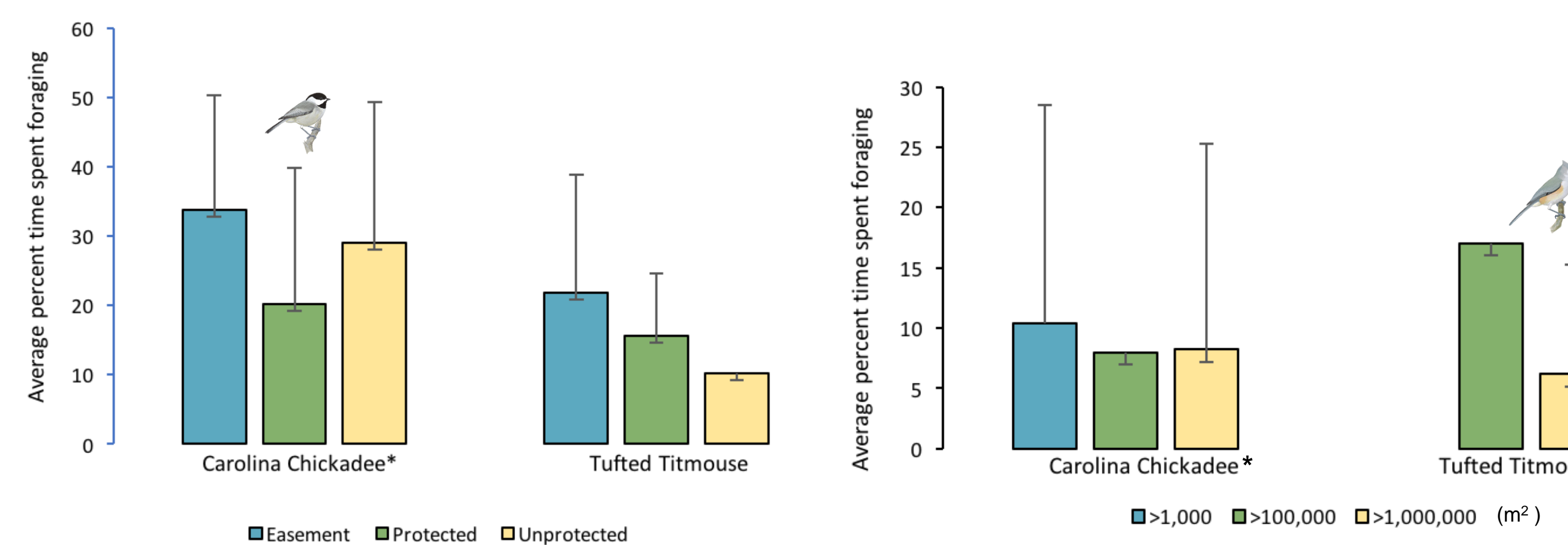


Figure 6. Average percent time of total observation time spent in active foraging of Carolina Chickadees and Tufted Titmice in Easements, Protected patches, and Unprotected patches (* indicates $P > 0.05$).

Figure 7. Average percent time of total observation time spent in active foraging for Carolina Chickadees and Tufted Titmice in forest patches with areas $>1,000$, $>100,000$, and $>1,000,000$ square meters (* indicates $P > 0.05$).

Results: Local Abundance

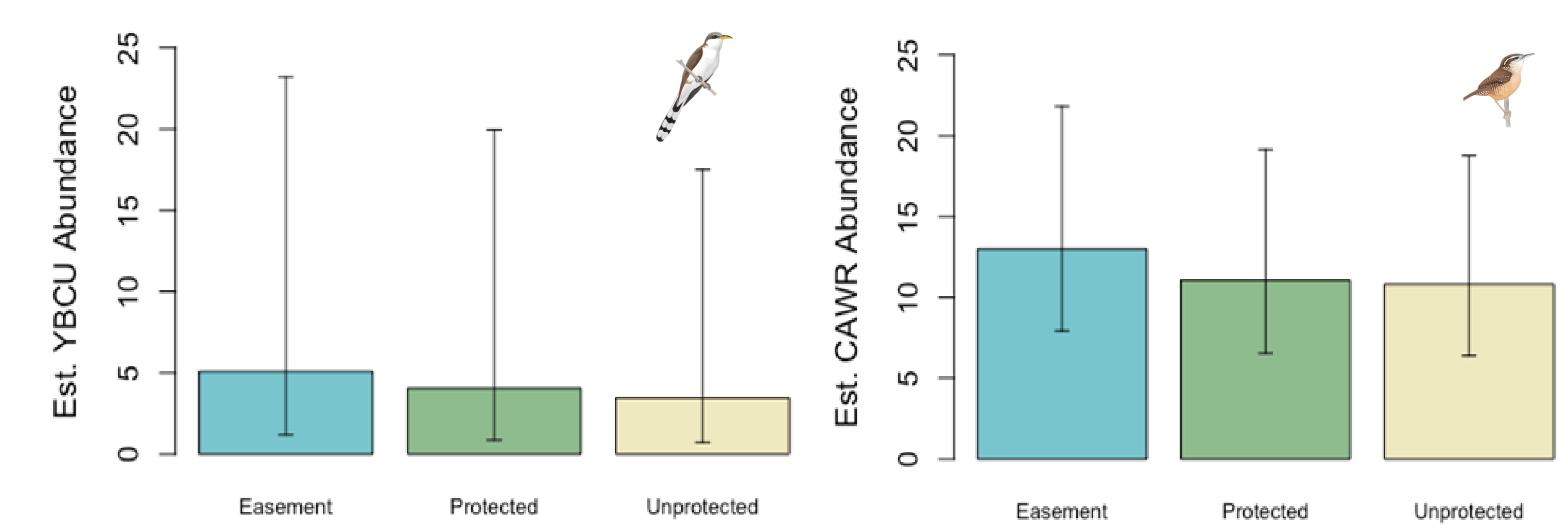


Figure 8 and 9. Estimated abundance of Yellow-billed Cuckoos and Carolina Wrens, respectively, in three different land management categories: Conservation Easement, Protected Area (i.e. state parks, county parks, WMAs, Heritage Preserves, etc.) and Unprotected Areas (public lands).

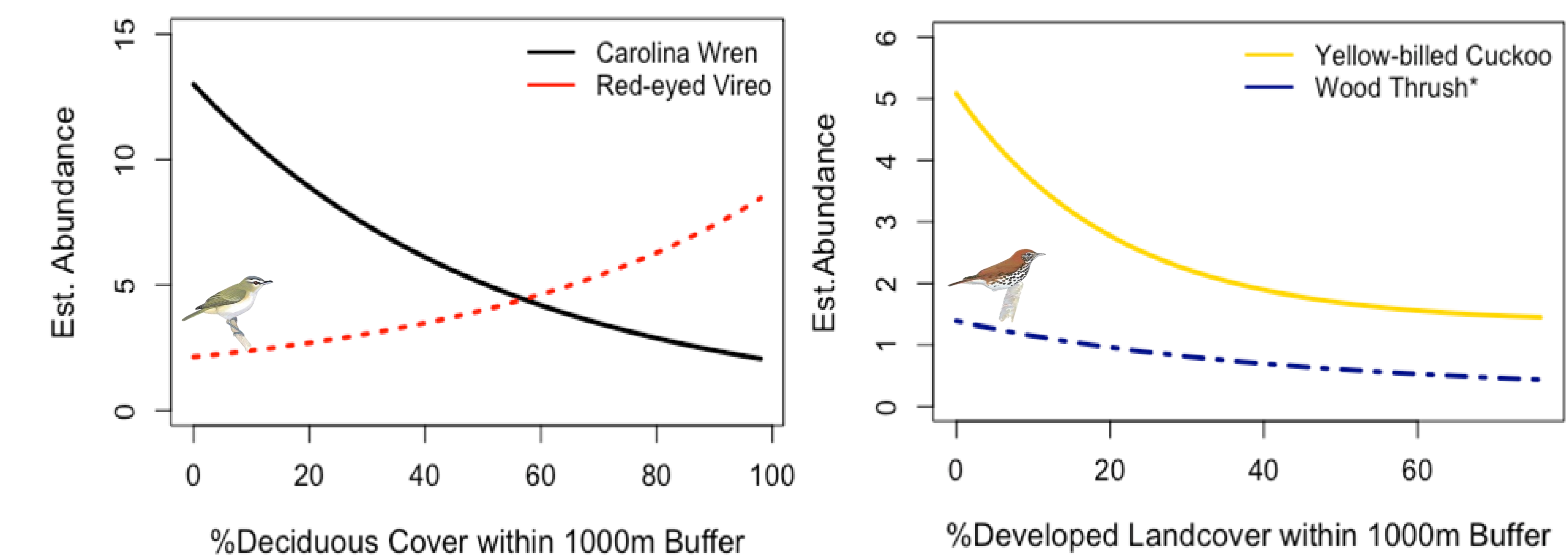


Figure 10. Estimated abundance of Carolina Wrens and Red-eyed Vireos as percentage of deciduous forest land cover increases within a 1000m buffer zone (radius=1000m) around sample site.

Figure 11. Estimated abundance of Yellow-billed Cuckoos ($p < .05$) and Wood Thrushes ($*p > .05$) as percentage of developed land cover increases within a 1000m buffer zone (radius=1000m) around sample site.

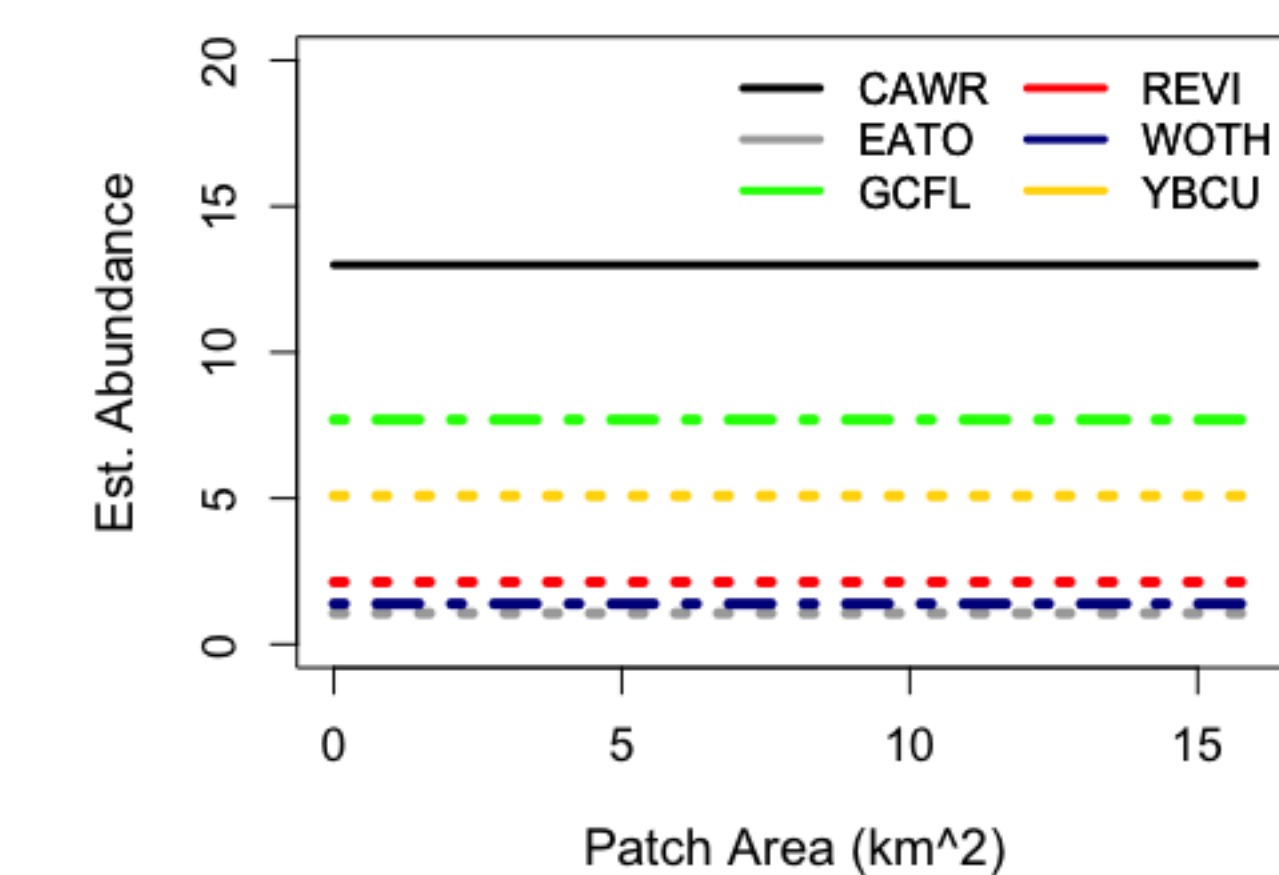


Figure 12. Estimated abundance of Carolina Wrens (CAWR), Eastern Towhee (EATO), Great Crested Flycatchers (GCFL), Red-eyed Vireos (REVI), Wood Thrushes (WOTH) and Yellow-billed Cuckoo (YBCU) across vary forest patch areas measured in km^2 .

Conclusion and Future Research

Regional: Highest habitat quality was located near the northern boundary of the region. Populated forest anthromes of the Piedmont had lower habitat quality. Easements had higher quality habitat than protected areas and the region as a whole.

Local Abundance: We saw no area threshold for abundance among focus species. However, it is clear that the matrix around a forest patch affects abundance.

- The surrounding land cover may be more important than overall patch area for conserving bird species. For development, this suggests that the LULC around forest patches is crucial to maintaining species.

Land management may affect bird abundance, but uncertainty exists in our estimates.

- Easements seem to provide better habitat quality for certain bird species, and unprotected land seems to be of worse habitat quality. Though there is uncertainty, this leads us to believe easements in Upstate S.C. are being effectively managed and have high conservation value.

Local Behavior: Studying behavior can give us valuable insight into habitat quality and how species are faring given the aforementioned habitat changes. Focusing on foraging behaviors theoretically indicates habitat quality in that higher quality habitats have higher energy availability and therefore birds wouldn't require as much time foraging to get the energy they need.

- Land Management results in behavior frequencies significantly different for Carolina Chickadee's and Tufted Titmice. Although Easements are shown to be better quality habitat, these species are spending more time foraging there than in unprotected areas. This tells a different story than our data regarding abundance and indicates that perhaps different approaches to land protection need to be investigated, specifically in regards to energy availability and density.
- Patch area has a significant effect on the frequency of foraging behaviors in Titmice with more active foraging happening in smaller patches. This is consistent with the hypothesis that larger patches are higher quality habitats and that deforestation is affecting the availability and density of energy resources for birds.

Future Research Needs

1. Analyses for overall richness by management, area and matrix
2. Vegetation sampling at habitat level to elucidate results
3. Continuation of behavioral sampling in more diverse patches, and include other factors into data analysis
 - Aim is to eventually have a quantity of behavioral data comparable to the amount of abundance data we collected this summer
4. Communicate with stakeholders (easement holders, private land owners, conservation non-profits, developers) in order to develop conservation strategies that optimize habitat quality and maintain biodiversity as the Piedmont Region continues to rapidly develop

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