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Final Report for

Bird Habitat Use within Home Ranges: Implications for Local Distribution

Abstract

Little is known about the factors that explain the distribution of the Wood Thrush (*Hylocichla mustelina*) on the landscape, despite mounting evidence of significant range-wide declines in the last few decades. I constructed a habitat suitability index (HSI) model and compared model-predicted suitability scores with Wood Thrush presence-absence data in the Chesapeake Bay lowlands of Virginia. There was no difference between HSI scores and Wood Thrush occurrence across the years. Large scale habitat factors therefore appear to be of little significance in the local area, but fine-scale effects have not yet been investigated. Using radio telemetry, vegetation, and invertebrate sampling, I tested for differences in structural attributes and food availability between home range core and non-core areas. Spatial distribution of these important, fine-scale core habitat attributes can provide information on why birds occur where they do. Furthermore, mechanistic knowledge of species distribution has important conservation implications for this iconic and quickly declining species.

Introduction

Following the trend of many migratory birds, populations of the Wood Thrush (*Hylocichla mustelina*) have experienced long-term range-wide population declines since 1966 (-1.8% $\pm$ 0.4% per yr; Sauer et al. 2003). Due to its conspicuous, flute-like song on the breeding grounds in the woodlands of eastern United States and southeastern Canada, the Wood Thrush is a charismatic and well-known species (Roth et al. 2011). Because of its prestige with the public and rapid decline along with other migratory birds (Ballard et al. 2003), this songbird has become a symbol of declining Nearctic-Neotropical migratory birds and the focus of conservation and management plans in many areas (Driscoll et al. 2005; Roth et al. 2011). A number of studies indicate that the Wood Thrush nesting success declines with decreasing forest patch size (Donovan 1995; Weinberg & Roth 1998), mainly due to increased nest-parasitism by Brown-headed Cowbirds (*Molothrus ater*) in smaller forest remnants (Trine 1998; Lloyd et al. 2005). While we

know that fragmentation is detrimental to the species, little is known about the factors which explain local Wood Thrush distribution in the first place. Is the species selecting for a defined suite of habitat characteristics that may lead it to use a particular forest patch over another? If so, what are these habitat attributes and at what spatial scale are they acting?

Evidence suggests that highly mobile organisms, like migratory birds, assess habitat suitability at various scales (Battin & Lawler 2006). I developed a habitat suitability index (HSI) model and compared model-predicted habitat suitability to local Wood Thrush distribution using a three-year point count dataset (Figure 1). HSI models are tools for assessing habitat quality over large areas based on suitability index score ranging from 0 (no suitability) to 1 (high suitability; Rittenhouse et al. 2010). To create a local HSI model, I modified literature-informed habitat indices from two existing Wood Thrush HSI models (USFWS 2001; Rittenhouse 2008), that incorporated effects of forest type, forest fragment area, amount of edge, and slope aspect. Using a three-year dataset from 123 point count stations, I constructed a Wood Thrush detection history and compared bird presence to model-derived HSI values at count stations (Figure 1). There was no difference between HSI scores and where and how consistently was the species detected (V. Jirinec, *unpublished data*), suggesting that broad-scale habitat patterns do not explain local distribution of the Wood Thrush.

The HSI analysis implies that fine-scale factors may affect local Wood Thrush presence. Habitat heterogeneity explained differential use within home ranges of Swainson's Warbler (*Limnothlypis swainsonii*; Anich et al. 2012), indicating that habitat physiognomy can predict bird occurrence at the home range scale. Correspondingly, spatial arrangement of critical habitat elements on the landscape should correlate with species occurrence. I hypothesize that the Wood Thrush has a defined, small-scale suite of habitat requirements whose availability determines bird occurrence and frequency of habitat use. I tested this hypothesis by tracking the movement of individual thrushes and comparing areas where the frequency of Wood Thrush use is high to areas where birds rarely venture. I predicted that high-use areas will have 1) a specific set of structural characteristics not found in low-use areas, and 2) higher food abundance than low-use areas. The objective of this project is to identify these crucial habitat attributes, and quantify the amount required by this species of conservation concern. This provides novel natural history information for a popular denizen of eastern deciduous forest, along with shedding some light on why a forest-associated bird can persevere in human-modified suburban landscapes.

Lastly, we investigated if diurnal space use corresponds with nocturnal sleeping areas by obtaining two roosting locations per bird on separate nights. Little attention has been devoted to roosting behavior, although this knowledge has important conservation implications because multiple habitats may require protection for species that roost in habitats separate from their diurnal activities (Brown & Sherry 2008).

Methods

Methods are summarized in Figure 3.

Radio telemetry is a commonly used method in studies of avian behavior, including movement (e.g. Marzluff et al. 2004; Gow et al. 2011). Study birds were captured at historical point count locations (Figure 2) using target-netting with vocalization playback and subsequently fitted with radio transmitters (Figure 5). A total of 23 birds (15 males, 8 females) were captured in Colonial National Historical Park (Colonial Parkway and Yorktown Battlefield) in summer of 2014 and subsequently tracked (e.g. Figure 4). Transmitters are BD-2 (Holohil Systems Ltd., Carp, ON, Canada), with average weight of 1.3 g and battery life of 60 days. Birds were tracked throughout May, June, and July between 0700 and 2000 EST, with locations spread throughout the day.

To determine what habitat characteristics are important at the home range scale, a home range was constructed for each radio-tagged individual (Figure 3). Home range based on utilization distribution (UD) has been used in telemetry studies to link frequency of use with underpinning habitat (Marzluff et al. 2004;

Millspaugh et al. 2006). In UD, animal locations derived through telemetry are used in order to construct a smoothed function of animal use probability. Thus, high location density coincides with high probability of use and vice versa. In this study, the 55% UD isopleth was considered the home range core (Anich et al. 2012), and habitat within and outside of the core was tested for differences.

Habitat structure and food abundance data were collected in both high-use and low-use portions of the home range (Figure 3). I took invertebrate samples at five random locations within the high-use segment and five random locations within the low-use segment of the home range for a total of 10 food samples per bird. Wood Thrush is known to forage on invertebrates mainly in forest leaf litter on semi-bare ground where herbaceous cover is limited. I collected leaf litter invertebrate samples taken in 50x50 cm plot at each random point. Litter samples were frozen at -80°C for processing during offseason, which involved both count and dry mass of invertebrates separated into five general categories (worms, beetles, spiders, centipedes, and other) for finer assessment of food availability. Since vegetation quantification is inherently time-consuming, habitat structure sampling was conducted at a subset of 6 of the 10 random locations for invertebrate sampling (3 in high-use, 3 in low-use). This allowed me to link vegetation data with food abundance, if needed. Vegetation was sampled inside 30 m-wide circular plots, and include tree species, tree count, trunk diameter, ground cover quantification, and volume of downed woody debris, all of which were designated *a priori* as potentially important structural variables.

Results

Please note that due to the low bird sample size at individual study sites, the following results represent a summary across all of the project study sites.

Many of the birds moved outside their original capture locations. To search for lost birds, we have implemented both aerial tracking using a fixed-wing aircraft as well as on-the-ground search using truck-mounted antennas. One individual relocated 6.3 km outside capture location into the Naval Weapons Station Yorktown, near the Gate 3 entrance.

Two individuals (both females) died during the course of tracking. One bird located east of Cook Rd was apparently struck by a passing car and died following a couple of days of immobility, leaving an active nest with hatchlings to be attended by her mate. Unfortunately the nest was predated almost 10 days later just prior to nestling independence. The other female located near College Creek was attacked while incubating her nest. Her mangled body was found the following day underneath the nest tree with nest destroyed and contents gone.

Habitat structure

Final analysis is pending, but preliminary investigation suggests high use areas correlate with higher volume of downed woody debris, high counts of understory woody stems, and fewer coniferous trees and pine needle ground cover.

Food availability

Final analysis is pending, but preliminary investigation revealed high use areas correlate with higher mass of leaf-litter invertebrates (Figure 6), particularly worms. Mean dry invertebrate mass was highest in home range cores, lower in low-use areas, and lowest in samples taken at bird survey locations where the species was never detected (red points, Figure 1). Soil moisture data collected in 2014 suggest home range areas are wetter than regions where birds were absent.

Roosting

Bird roosting locations did not necessarily correspond with diurnal use areas. Thirty-one percent of roosting locations were located completely outside diurnal home ranges, up to 322 meters away.

Concluding Remarks

Knowledge of the mechanism behind bird distribution is an important tool for land managers who can thus predict consequences of habitat conversion for avian populations. In the case of the Wood Thrush and other declining migratory birds, understanding habitat use dynamics is vital for targeting proper areas for conservation purposes.

Clear habitat use patterns are emerging from the data collected by this project. However, final conclusions need to be postponed until final analyses are done and published in a peer-reviewed scientific journal.

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Figures

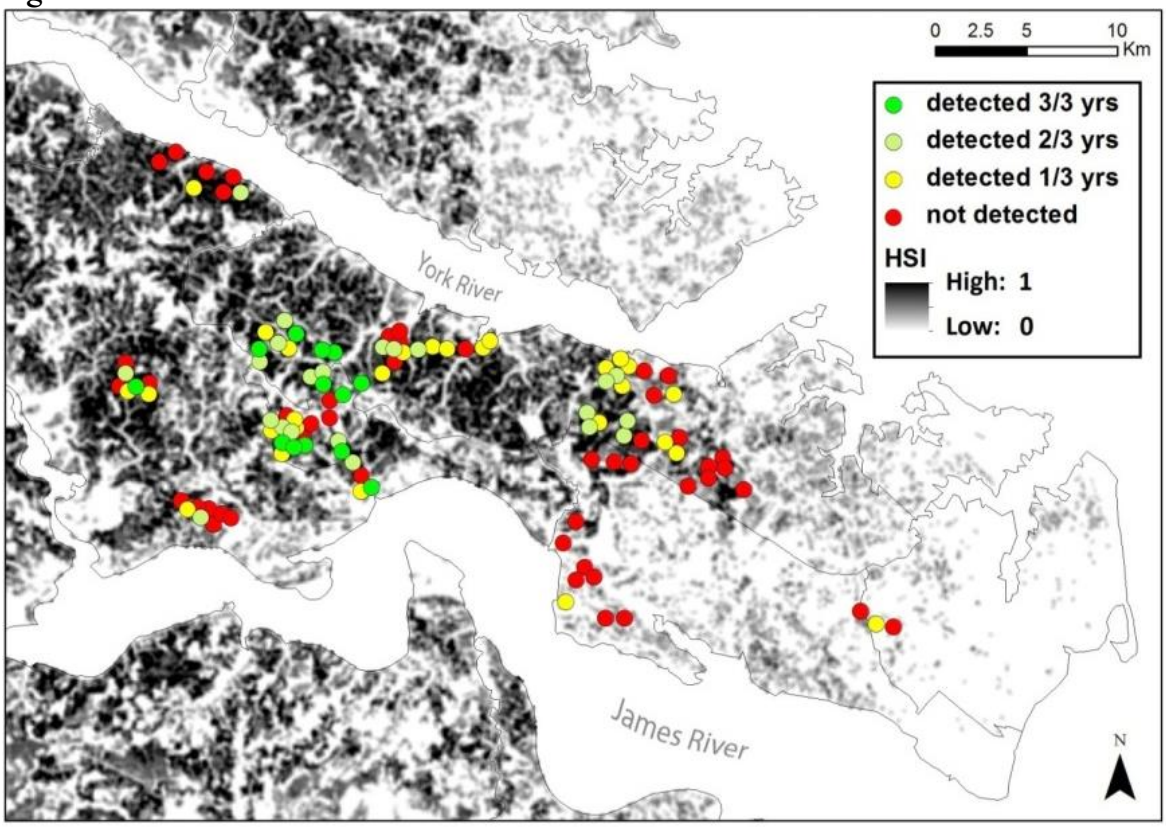


Figure 1. Wood Thrush (*Hylocichla mustelina*) habitat suitability index (HSI) model whose values represent literature-derived score based on forest patch size, composition, amount of edge, and slope aspect in the Chesapeake Bay lowlands of Virginia. Low HSI value (light) denotes none to marginal habitat suitability, whereas high HSI value (dark) represents highly suitable habitat. Circles are point count stations surveyed in June over three years (2010-2012). Circle color indicates stations where birds were detected all three years (green), two of three years (light green), one of three years (yellow), and none of three years (red). I found no difference between HSI scores and where and how consistently was the species detected.

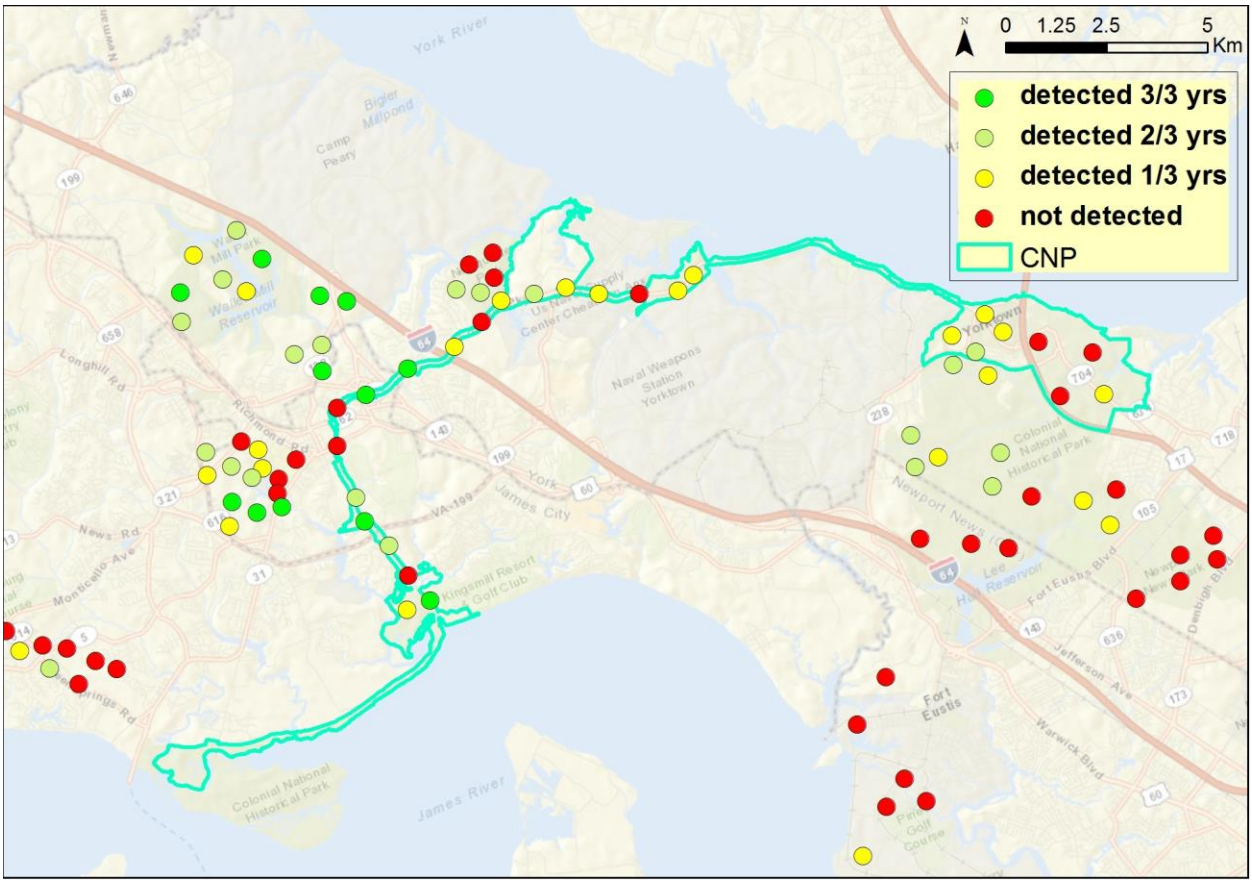


Figure 2. Wood Thrush distribution on the property of Colonial National Historical Park according to historical bird surveys. Circles are point count stations surveyed in June over three years (2010-2012). Circle color indicates stations where birds were detected all three years (green), two of three years (light green), one of three years (yellow), and none of three years (red).

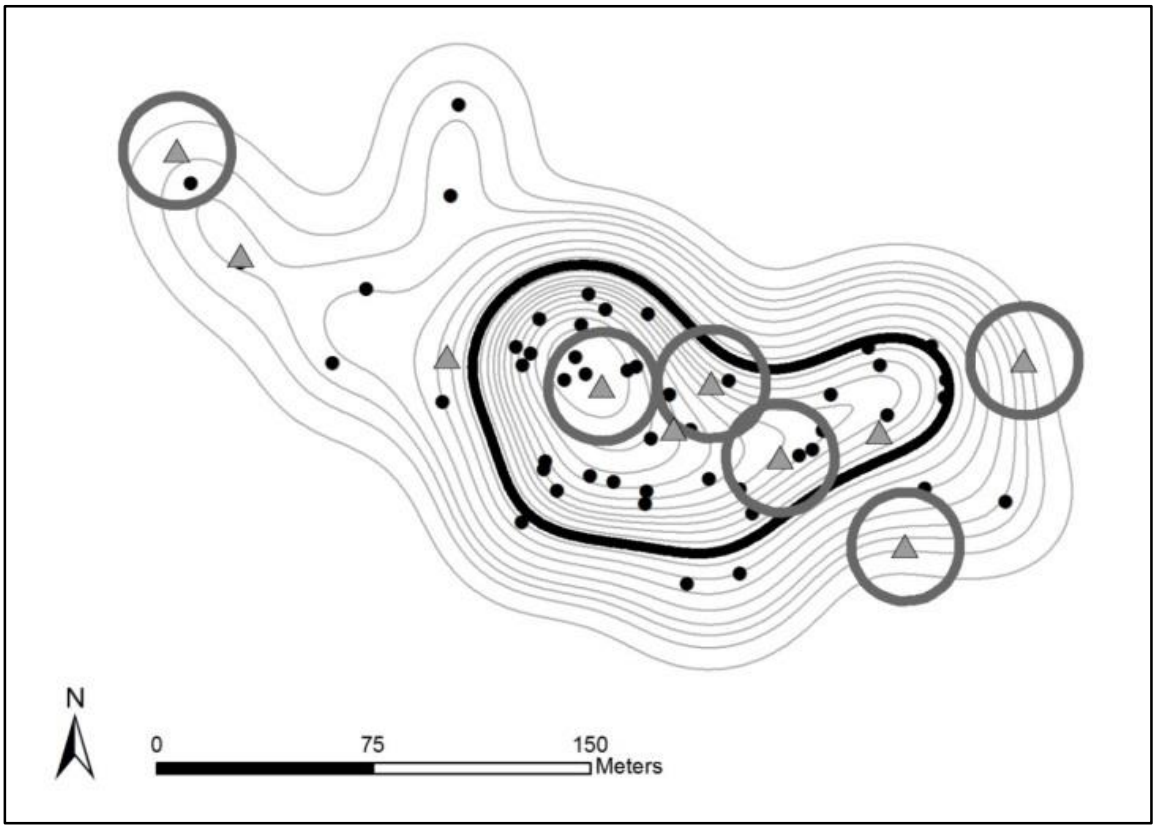


Figure 3. A typical home range of a Wood Thrush male in the project area (bird identified as WAM2 pictured here, captured in 2013). Home range is constructed using kernel density estimation in Geospatial Modeling Environment, which utilizes telemetry location (black dots, n≥50) density to approximate probability of bird use (grey isopleths). The black isopleth separates high-use area (55% probability of use and above) from low-use section of the home range. Both home range segments were sampled for food abundance using invertebrate plots (triangles, n=10) and habitat structure in 30 m plots (grey circles, n=6) randomly placed in both segments.

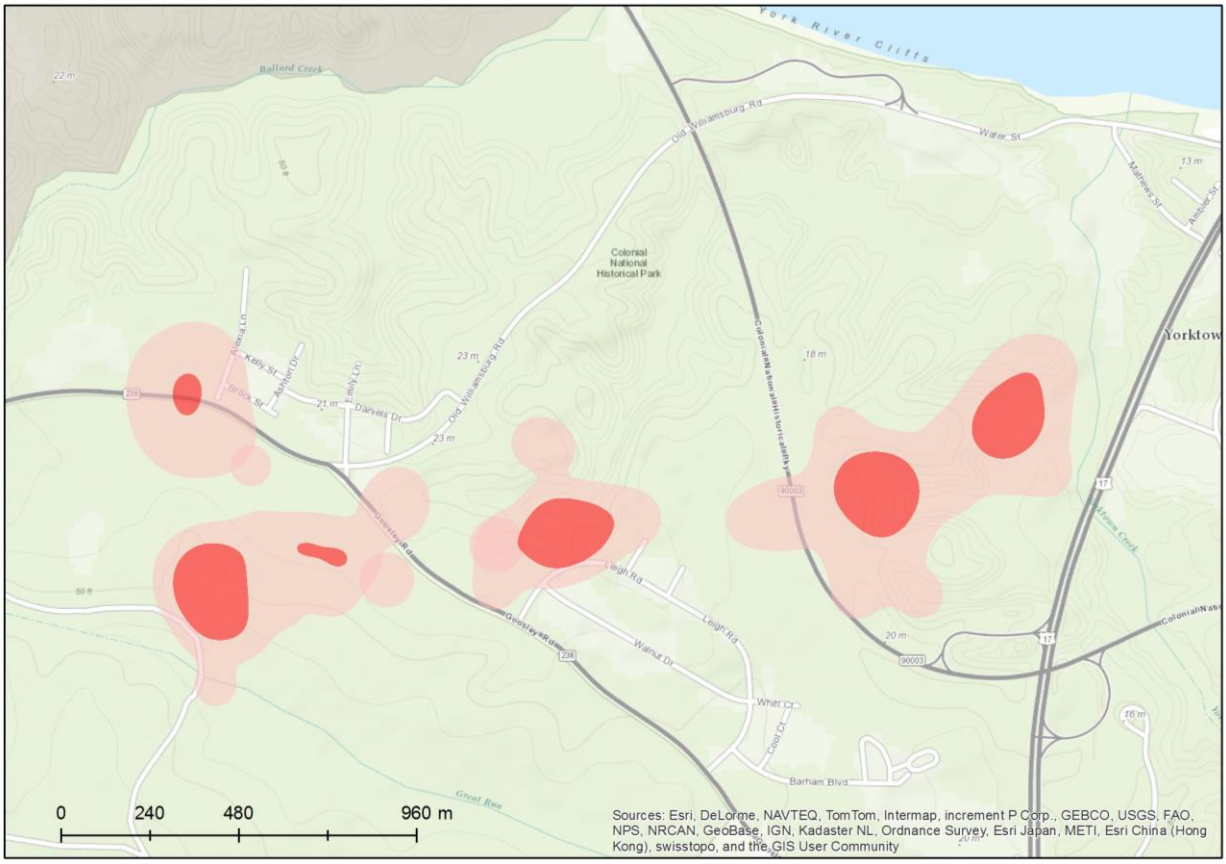


Figure 4. Example home ranges of three Wood Thrush males captured in the Yorktown portion of the Colonial National Historical Park. Dark-red areas represent home range cores, whereas light-red regions are low-use sections of respective home ranges.



Figure 5. One of the birds captured in Colonial National Historical Park. Note color bands with unique individual combination and transmitter antenna. This is a male whose mate (also radio-tagged) was killed by a passing car on Cook Rd. This "super male" widower proceeded to raise the nestlings on his own, nearly succeeding to fledging. Unfortunately the nest was eventually predated.

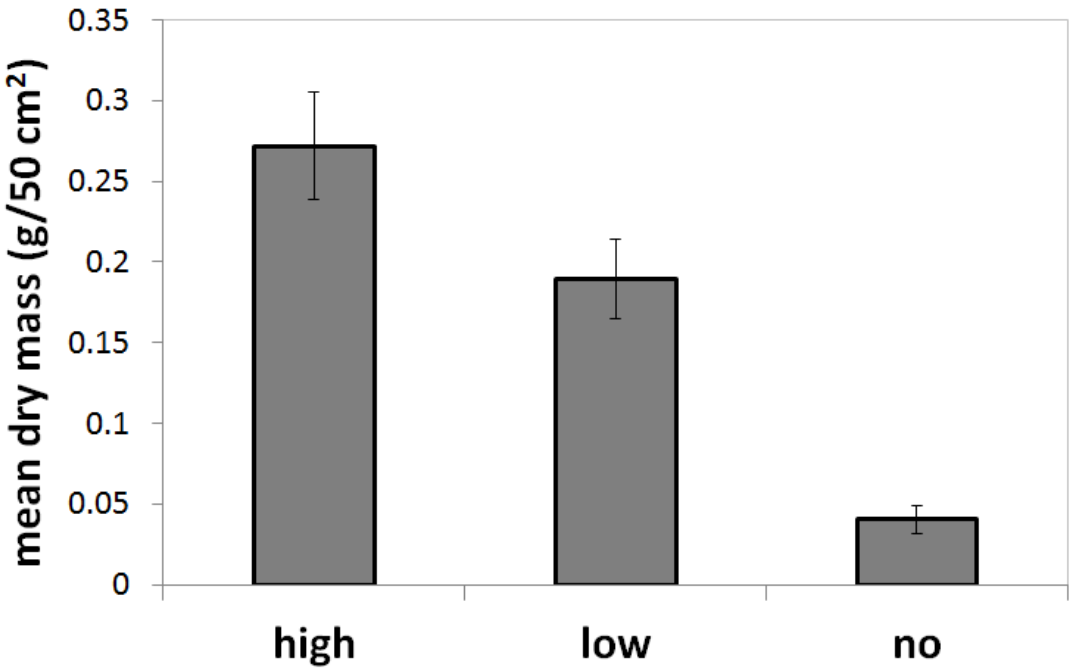


Figure 6: Mean invertebrate mass vs. frequency of use by radio-tagged birds: high = home range cores, low = low-use home range areas, no = survey locations where birds were not detected over multiple years. Error bars equal 1 SE.