# Chipping Sparrow *Spizella passerina*

Draft: 4 June 2003

## EXECUTIVE SUMMARY


**Preferred breeding habitat:** Open, grassy woodland with abundant shrubby vegetation, with a strong preference for coniferous habitats

**Nest placement:** Typically at a height of 1-3 m in a thick cluster of needles or leaves at the outer extremity of a tree or shrub, preferring conifers over deciduous.

**Mean clutch size and fledging brood size (**±SD**):**

- Non-parasitized nests: clutch 3.7 ± 0.65; brood 3.00 ± 1.25
- Cowbird parasitized nests: clutch 2.5 ± 0.76; brood 2.00 ± 0.96

**Number of broods per season:** Two

**Annual adult survival rates:** Unknown

**Requirements for population stability** ($\lambda \geq 1$)**:** Uncertain

**Nest mortality and parasitism rates in relation to landscape context:**

- Daily nest predation increases non-significantly as degree of forest fragmentation, from the patch scale of distance to nearest edge, to landscape scales, increases
- Nest parasitism rate increases strongly as the degree of forest fragmentation across multiple spatial scales increases.

**The importance of spatial scale to the relationship between nesting success and landscape context:** Uncertain, due to limited data.

**General conclusions:**

- Nest parasitism has a severe effect on breeding productivity, reducing host fledging success by 33% among parasitized nests.
- Nest parasitism rate is strongly positively correlated with the degree of forest fragmentation at spatial scales from the forest patch to within a 100 km radius.
- Nest predation rate is positively correlated with forest fragmentation across multiple scales.
- Lambda is negatively correlated with the degree of forest fragmentation at multiple spatial scales, from the forest patch to within a 100 km radius.

**Management guidelines:**

- The Chipping Sparrow's preference for shrubby, coniferous habitats bordering open, grassy spaces pre-adapted it to human-transformed environments, so it has generally benefited from anthropogenic forest fragmentation. Agriculture, particularly cereal crop production, in proximity to shrubby woodland patches, and the establishment of landscaped suburban habitats with a combination of open, grassy areas and shrubby tree growth, have created appropriate nesting habitat with abundant food sources over much of its range. At the continental scale, the Chipping Sparrow is widely distributed, abundant, and populations appear healthy, so no active management is thought necessary (Middleton 1998). At local scales, mixed, less intensive farming, timber harvesting, and prescribed or uncontrolled burning will maintain suitable breeding habitat.
- Given the evidence suggesting a strong negative relationship between lambda and degree of forest fragmentation, despite the positive effect of forest fragmentation on breeding habitat availability, much apparently suitable breeding habitat may be

functioning as a sink on populations. More widespread monitoring of breeding productivity is required to adequately assess potential source/sink dynamics.

## DETAILED and BACKGROUND INFORMATION

### *Distribution and habitat preference*

The Chipping Sparrow is a breeding migrant within much of the United States and the southern half of Canada, but year-round resident within parts of the southern United States (from southern California in the west, to Virginia in the east), Mexico, Guatemala, Belize, Honduras and Nicaragua. It appears in winter only in parts of southeastern Georgia, Florida, southern Louisiana, southern, western and north-central Texas, southern Kansas, southern New Mexico, southwestern Arizona, and southern California (Middleton 1998).

Breeding habitats vary with geographic location, but generally prefers open, grassy, coniferous forests, woodland glades or edges, aspen (*Populus* spp.) groves in prairie, and river and lake shorelines. In northern and montane regions, it breeds in early successional or low-growth woodlands with abundant shrubby vegetation, with a strong preference for conifers. In southern regions, breeds in a variety of deciduous forest types, but retains affinity for nesting in shrubby habitats with conifers. Because of its preference for shrubby, coniferous habitats bordering open, grassy spaces, the Chipping Sparrow has benefited from habitat modification associated with moderate levels of forest fragmentation, and is now often more abundant in suburban areas and around homesteads than in undisturbed habitats (Middleton 1998).

Wintering habitats are similar to breeding habitats, but it is more common in riparian than coniferous forests (Middleton 1998).

### *Nest site characteristics*

The open-cup nest is generally placed 1-3 m high (range 0-19 m) in a thick cluster of needles or leaves at the outer extremity of a tree or shrub. It displays a distinct preference for conifers, with 88% of nests in conifers and 12% in deciduous trees and shrubs (n = 478) in Ontario (Middleton 1998). Mean nest height 2.6 m (SD = 1.7) in Ontario (Middleton 1989).

## BREEDING PRODUCTIVITY

### *Laying seasons*

Earliest and latest nests in the BBIRD database were initiated on 14 April and 11 July respectively. The timing and length of the laying season appears to vary quite considerably with latitude. The limited BBIRD data available for latitudes 30-35°N suggest a relatively extended laying season, potentially from mid-April to late June or early July (Figure 1). Data for more northerly latitudes suggest a more limited laying season, with a clear 4-week peak in the period 21 May to 17 June (Figure 1). Peak egg-laying is known to vary with latitude, 10-30 May, with first nests as early as 24 March in California (Johnson 1968), late April-early May in Ohio (Peterjohn 1989), early-mid May in central Michigan (Walkinshaw 1944), late May-early June in northwestern Minnesota (Keller 1979 cited in Middleton 1998), and 4-20 June in northern Ontario (Peck & James 1987).

The average length of a typical laying season is difficult to estimate, due to the limited BBIRD data available (estimated length of the season varies according to sample size), and possible latitudinal variation in season length. Using data from latitudes 35-50°N, where the seasons appear approximately similar, the overall length of the laying season is estimated at 57 days. However, in a suburban area of central Michigan, nest initiation dates for one female that fledged 3 broods from 5 nest attempts were May 4 and August 10 for first and last nests respectively, yielding an individual laying season of 99 days. First and last nest laying dates for a second female were May 6 and July 14 respectively, yielding an individual laying season of 70 days. Thus, it is possible that a typical laying season is longer than we assume.

### *Assumptions in calculations of breeding productivity*

Eggs are laid at daily intervals (Middleton 1998). The mean clutch size of unparasitised nests among BBIRD sites is 3.71 (SD = 0.54), similar to that reported for Ontario (3.7: Middleton 1998), Michigan (3.62: Walkinshaw 1944), and Pennsylvania (3.8: Stull 1968). The mean incubation period has been reported as 11.9 days (range 11-14 days, n = 9) in Michigan (Walkinshaw 1952), and 11.9 days (n = 49) in Ontario (Middleton 1998). The nestling period is 9-12 days (Walkinshaw 1952, Middleton 1998), with most young fledging at 9 days in Ontario, although daily measuring probably contributed to premature fledging (Reynolds & Knapton 1984). Re-nesting is common after nest failure, usually beginning within 1-2 days of nest failure. Nests initiated in June are completed in 3.6 days on average (n = 19), significantly shorter than early nests in May (4.4 days, n = 39), and July nests are completed in 2-3 days (Middleton 1998). The first egg is laid 1 day after nest completion (Walkinshaw 1944, Reynolds & Knapton 1984). These data suggest a re-nesting interval of approximately 6 days after nest loss. A re-nesting interval of approximately 5 days was observed following nest abandonment after parasitism during laying (Middleton & Prescott 1989). On account of the protracted breeding season, the Chipping Sparrow regularly produces two broods per season, rarely 3 (Middleton 1989). The average re-nesting interval following successful fledging is 9.3 days (SD = 6.0, n = 6: Keller 1979 cited in Middleton 1998), although Walkinshaw (1952) observed that at several nests, females laid eggs 5 days after young had left earlier nests. To calculate breeding productivity, we used a 57-day laying season, 25-day nesting period (3-day laying, 12-day incubation, 10-day nestling), and re-nesting intervals of 5 days and 9 days after nest failure and fledging respectively.

In Minnesota, where there was a 12% frequency of double broods and approximately 50% nest success (Keller 1979 cited in Middleton 1998), double-brooded pairs produced a mean of 4.5 fledglings/season (n = 4), and single-brooded pairs 2.6 fledglings/season (n = 15). If 12% of females produce two broods, and all other females produce a single brood, with the mean number of young per successful nest 2.5 (average from first and second broods reported above), mean breeding productivity would be 2.8

fledglings/season (i.e. a maximum estimate, given that some females may fail to raise even one brood). Under the assumptions of our model, a population in which nesting success is 50% and the mean number of young fledged per successful nests is 2.5, a breeding productivity of 2.8 fledglings/season is predicted. Estimated breeding productivity among BBIRD sites ranged from 1.9-3.8 fledglings/season (Table 1). These inferential data suggest that the breeding productivity model has adequate performance, at least in the northern regions of the Chipping Sparrow's range. However, in a suburban garden in central Michigan, where nesting success averaged 62.5% (an overestimate, given some nests found during incubation/nestling period), annual breeding productivity averaged 4.43 fledglings/female (range 2-8, n = 7: Walkinshaw 1952)

***Assumptions in calculations of finite rate of population increase (λ)***

Data on annual adult survival of color-banded individuals are limited, and likely heavily influenced by breeding dispersal. Returns in years following banding, for males and females respectively are 15.6% and 25.6% in Ontario (n = 88 birds: Middleton 1998), 10.5% and 21% in Minnesota (n = 19 birds: Keller 1979 cited in Middleton 1998), and 50% for both sexes (n = 10) in Michigan (Walkinshaw 1952). The lower return rates for males are thought to indicate that males have lower fidelity to breeding areas than females (Middleton 1998). Average annual survival in the related Clay-colored Sparrow (*Spizella pallida*) is 56.6% (Martin 1995). We consider the available survival data for Chipping Sparrow to be inadequate, so to obtain approximate estimates of lambda for Chipping Sparrow, we assume an annual adult female survival rate of 56.6%, and a juvenile survival rate of 28.3% (50% of the adult survival rate estimate, following the hypothesis of Greenberg (1980) and Temple & Cary (1988) that juvenile survival is approximately 50% of adult survival among small, north-temperate passerines). Even using these relatively high estimates of survival, estimated lambda was ≥1 at only 1 of 5 BBIRD sites (Table 1).

***Effects of nest micro-habitat on probability of nest predation and parasitism***

In one study, nests in deciduous trees were more commonly parasitized than those in conifers, and nests 1.5-2.5 m above ground tended to be less heavily parasitized than more elevated nests (Middleton 1986), but other studies have found no such differences between successful and parasitized nests (Buech 1982).

**Table 1**. Summary of Chipping Sparrow breeding productivity and estimated finite rate of population increase (λ) across BBIRD sites.

| Site | No. of nests | Clutch size[1] | Parasitism rate (%)[2] | DPR (%)[3] | Nest success (%)[4] | Fledglings/ nest[5] | Annual fecundity[6] | Lambda |
|---|---|---|---|---|---|---|---|---|
| Snake River, ID | 11 | 4.00 | 27.27 | 5.41 | 7.74 | | | |
| Priest Lake, ID | 16 | 3.75 | 0 | 1.80 | 54.55 | | | |
| Coconino Natl Forest, AZ | 13 | 3.25 | 0 | 6.72 | 17.55 | 3.33 | 1.86 | 0.83 |
| Colfax County, NM | 36 | | 8.33 | 4.13 | 22.15 | 2.87 | 1.89 | 0.83 |
| Upper Mississippi, MN, WI, IL | 7 | | 14.29 | 2.08 | 45.22 | 2.25 | 2.38 | 0.90 |
| Ouachita Natl Forest, AR | 13 | 3.85 | 0 | 1.46 | 47.67 | 2.50 | 2.74 | 0.95 |
| Bitterroot, MT | 27 | 3.77 | 3.70 | 0.90 | 67.27 | 2.82 | 3.80 | 1.10 |

[1]Number of host eggs incubated in non-parasitized nests

[2]Percentage of nests that received 1 or more cowbird eggs

[3]Percentage of nests lost to predators per day

[4]Percentage of nests that produced at least 1 host fledgling or cowbird

[5]Number of host young fledged per successful nest

[6]Average number of host young fledged per female per year

**Table 2.** Summary of the best predictor variables (fragmentation indices) for the relationship between landscape structure and each of nest parasitism rate, daily nest predation rate, and lambda among BBIRD sites (plot averages for scales of patch and 1-10 km radii) using multiple regression analysis. Spatial scales included: the patch of forest within which the study plot was embedded; 1-10 km radii of study plot centers; and 50-100 km radii of study site centers. Non-significant results included for comparison across scales. $^{*}P < 0.05$; $^{**}P < 0.01$; $^{***}P < 0.001$.

| Scale | Plots Dependent variables | Sites Independent variables | Adj. R2 | Slope |
|---|---|---|---|---|
| Patch | Parasitism | Core forest area | 0.71* | -0.052 |
| | Predation | To nearest edge | -0.05 | |
| | Lambda | Patch size | 0.34 | |
| 1 km | Parasitism | Shannon-Weaver diversity | 0.73** | 0.33 |
| | Predation | % cropland | -0.11 | |
| | Lambda | % cropland | -0.04 | |
| 5 km | Parasitism | % developed | 0.88** | 0.66 |
| | Predation | Fractal dimension | -0.02 | |
| | Lambda | Forest edge density | 0.05 | |
| 10 km | Parasitism | % developed | 0.93*** | 0.7 |
| | Predation | Fractal dimension | 0.09 | |
| | Lambda | Total edge density | -0.02 | |
| 50 km | Parasitism | Shannon-Weaver diversity | 0.93*** | 0.64 |
| | Predation | Fractal dimension | 0.13 | |
| | Lambda | Core forest area | -0.11 | |
| 100 km | Parasitism | Shannon-Weaver diversity | 0.81** | 0.7 |
| | Predation | % forest cover | 0.35 | |
| | Lambda | % forest cover | 0.44 | |

***Effects of Brown-headed Cowbird nest parasitism on host reproductive success***

BBIRD data indicate that the mean clutch size in non-parasitized nests was 3.71 (SD = 0.54, n = 48), whereas a single parasitized nest held 4 eggs. Mean fledging success at non-parasitized nests was 3.00 (SD = 0.96, n = 49), whereas two parasitized nests did not fledge any host young. Comparative data from a site in Ontario with 41% parasitism (Middleton 1998) suggest that the mean clutch size in parasitized nests (2.5, SD = 0.76) was 32% lower than that of non-parasitized nests (3.7, SD = 0.65, n = 377). Mean fledging success was 33% lower from successful parasitized nests (2.00, SD = 0.96) than from non-parasitized nests (3.00, SD = 1.25). Each cowbird egg laid resulted in the average loss of 0.9 Chipping Sparrow eggs in Ontario (Middleton 1998), but 0.5 host eggs in Minnesota (Keller 1979 cited in Middleton 1989).

***Effects of landscape-level habitat variables on nest parasitism***

BBIRD data suggest a strong positive relationship between nest parasitism rate and degree of forest fragmentation across multiple spatial scales (Table 2, Figure 2). There are no other published data.

***Effects of landscape-level habitat variables on nest predation rate***

The limited BBIRD datum points, all but two of which are based on sample sizes of <20 nests, suggest a negative relationship between daily nest predation rate and the degree of forest fragmentation at multiple spatial scales, although the relationship was never significant (Table 2, Figure 3). There are no other published data.

***Effects of landscape-level habitat variables on the finite rate of population increase***

The limited BBIRD data available suggest a negative relationship between lambda and the degree of forest fragmentation at multiple spatial scales, especially the patch scale and within a 100 km radius, but the relationship was never significant (Table 2, Figure 3). There are no other published data.

***Effects of silviculture on nest predation and nest parasitism***

No data on effects on nest success. The limited data available suggest that logging elevates Chipping Sparrow densities (Webb et al. 1977), as is expected for a species that prefers shrubby habitats bordering open, grassy spaces. Border-edge cutting of fragmented woodlots, that created a shrub transitional zone 15-40 m in width at forest/agricultural field edges, increased Chipping Sparrow densities in mature, forest-edge habitat (Fleming et al. 1998). Two hardwood-reduction techniques (herbicide application, and felling and girdling) applied to previously fire-excluded longleaf pine forest in northwestern Florida resulted in 62-92% hardwood stem mortality, and dramatically increased densities of wintering Chipping Sparrows.

***Effects of burning on nest success***

No data on effects on nest success. Breeding densities were significantly increased by winter prescribed burning of pine forests (used to maintain open, mature pine forest for Red-cockaded Woodpecker) in the Georgia Piedmont (White et al. 1999). Similarly breeding density responded positively to fire in the Sierra Nevada, being greatest 6-8 years after the fire (1.2 territories/8.5 ha plot), declining to 0.4-0.5 territories/plot 10 and 20 years later, and ranging from 0-0.2 territories/plot on unburned controls (Raphael et al. 1987). However, spring burning in previously fire-excluded longleaf pine forest, which resulted in 41% hardwood stem mortality, did not significantly increase wintering densities in northwest Florida (Provencher et al. 2002).

***Effects of grazing/browzing on nest success***

No data.

***Overview of landscape-level habitat effects on breeding productivity and population growth rate***

The Chipping Sparrow's preference for shrubby, habitats bordering open, grassy spaces, which has pre-adapted it to human-transformed environments and anthropogenic forest fragmentation, also places it at particular risk of Brown-headed Cowbird brood parasitism, given that the cowbird exhibits similar habitat preferences. Consequently, the Chipping Sparrow incurs parasitism rates of up to 92% (Scott & Lemon 1996). Among BBIRD sites, nest parasitism rate was strongly positively related to the degree of forest fragmentation at multiple spatial scales, particularly landscape scales (Table 2, Figure 2). Nest parasitism has a relatively strong negative effect on Chipping Sparrow breeding productivity, reducing fledging success by an average of 33%. Given that the limited data available suggest a similar positive relationship between nest predation rate and the degree of forest fragmentation at multiple spatial scales (Table 2, Figure 3), a strong negative effect of landscape-level forest fragmentation on lambda is expected. The limited data available support this (Table 2, Figure 4).

***Mapping predicted source and sink habitat***

Uncertainty surrounding assumptions required for the estimation of lambda (relating to length of laying season, and adult survival rates), and insufficient resolution in the relationship between lambda and landscape metrics of forest fragmentation across BBIRD sites, preclude the mapping of predicted source and sink habitat.

## MANAGEMENT GUIDELINES

The Chipping Sparrow's preference for shrubby, coniferous habitats bordering open, grassy spaces pre-adapted it to human-transformed environments, so it has generally benefited from anthropogenic forest fragmentation. Agriculture, particularly cereal crop production, in proximity to shrubby woodland patches, and the establishment of landscaped suburban habitats with a combination of open, grassy areas and shrubby tree growth, have created appropriate nesting habitat with abundant food sources over much of its range. At the continental scale, the Chipping Sparrow is widely distributed, abundant, and populations appear healthy, so no active management is thought necessary (Middleton 1998). At local scales, mixed, less intensive farming, timber harvesting, and prescribed or uncontrolled burning will maintain suitable breeding habitat.

Given the evidence suggesting a strong negative relationship between lambda and degree of forest fragmentation, despite the positive effect of forest fragmentation on breeding habitat availability, much apparently suitable breeding habitat may be functioning as a sink on populations. More widespread monitoring of breeding productivity is required to adequately assess potential source/sink dynamics.

## FILLING THE GAPS – FUTURE RESEARCH AND MONITORING NEEDS

BBIRD data suggest there may be considerable latitudinal variation in the length of the laying season. Given the importance of this parameter to any model of breeding productivity, estimates of the average length of the laying season are required from different latitudes, particularly south of 35°N. This requires intensive monitoring of nest initiation dates throughout a breeding season (at least 100 nests).

An accurate estimate of annual adult female survival rate is critical for the estimation of lambda, but is currently lacking for the Chipping Sparrow. This should be determined with intensive monitoring, over a period of at least five years, of a color-banded population occupying an area where reproductive success is high, given that poor reproductive success may result in higher levels of breeding dispersal (e.g. Darley et al. 1977, Roth & Johnson 1993, Porneluzi & Faaborg 1999, Bayne & Hobson 2002).

Further data on nesting success in both small and large forest patches in landscapes with differing extents of forest fragmentation at broad scales in different regions within the breeding range of the American Redstart are needed to improve resolution in our understanding of the influence of landscape structure on breeding productivity, and thus on the patterns of sources and sinks in the landscape. These data are not difficult to collect, requiring a sample of ideally at least 25 nests (to give a sample of at least 10 successful nests for a reliable estimate of mean number of host young fledged per successful nest) that are monitored frequently enough to accurately determine their fate, and collected from a plot, up to 50 ha in size, of homogenous habitat whose center can be geo-referenced with a precision of approximately 30 meters (to allow plot-specific landscape features to be characterized from a digital land cover map). If any nests are located within 100 m of a habitat edge, measurements of the distance between that nest and the nearest edge would be useful for investigating patch-scale edge effects.

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**Figure 1**. Chipping Sparrow laying season (number of new nests initiated each week) in relation to latitude. Data from latitudes 40-45°N and 45-50°N are combined due to their similarity.

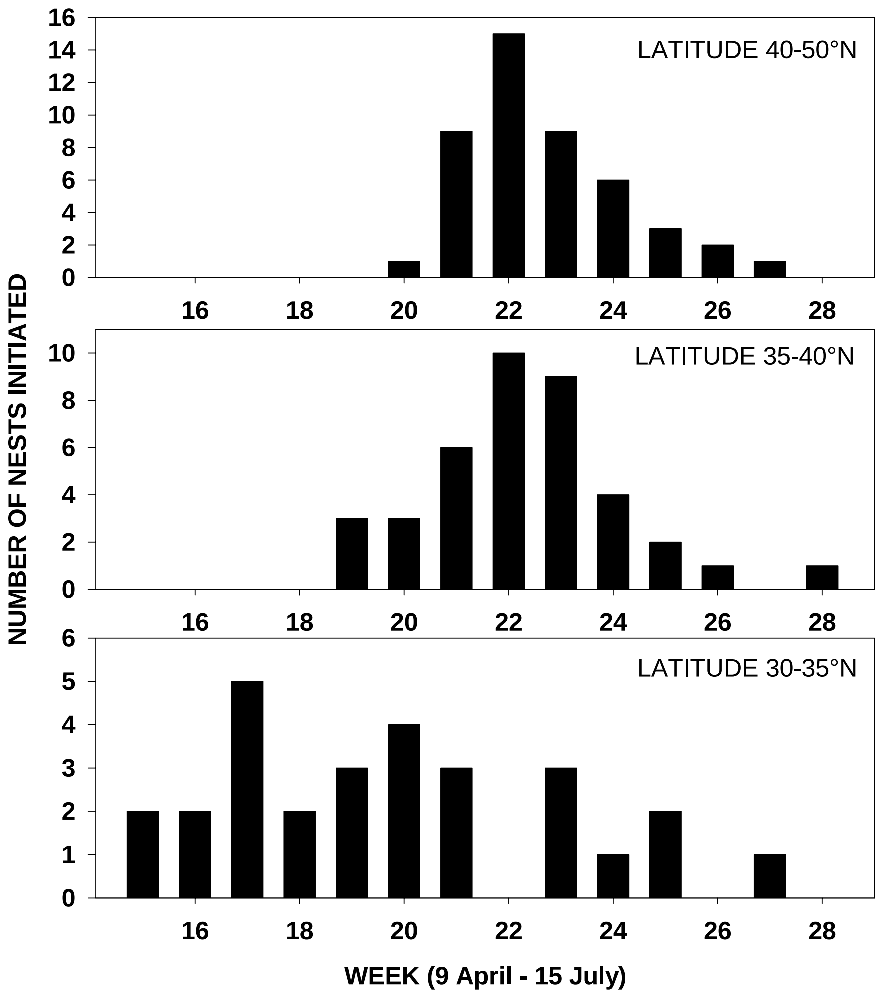

**Figure 2**. Relationship between nest parasitism rate (arcsine transformed) and various indices of forest fragmentation at spatial scales of the forest patch, within 1-10 km radii of plot centers (site averages), and within 50-100 km radii of site centers.

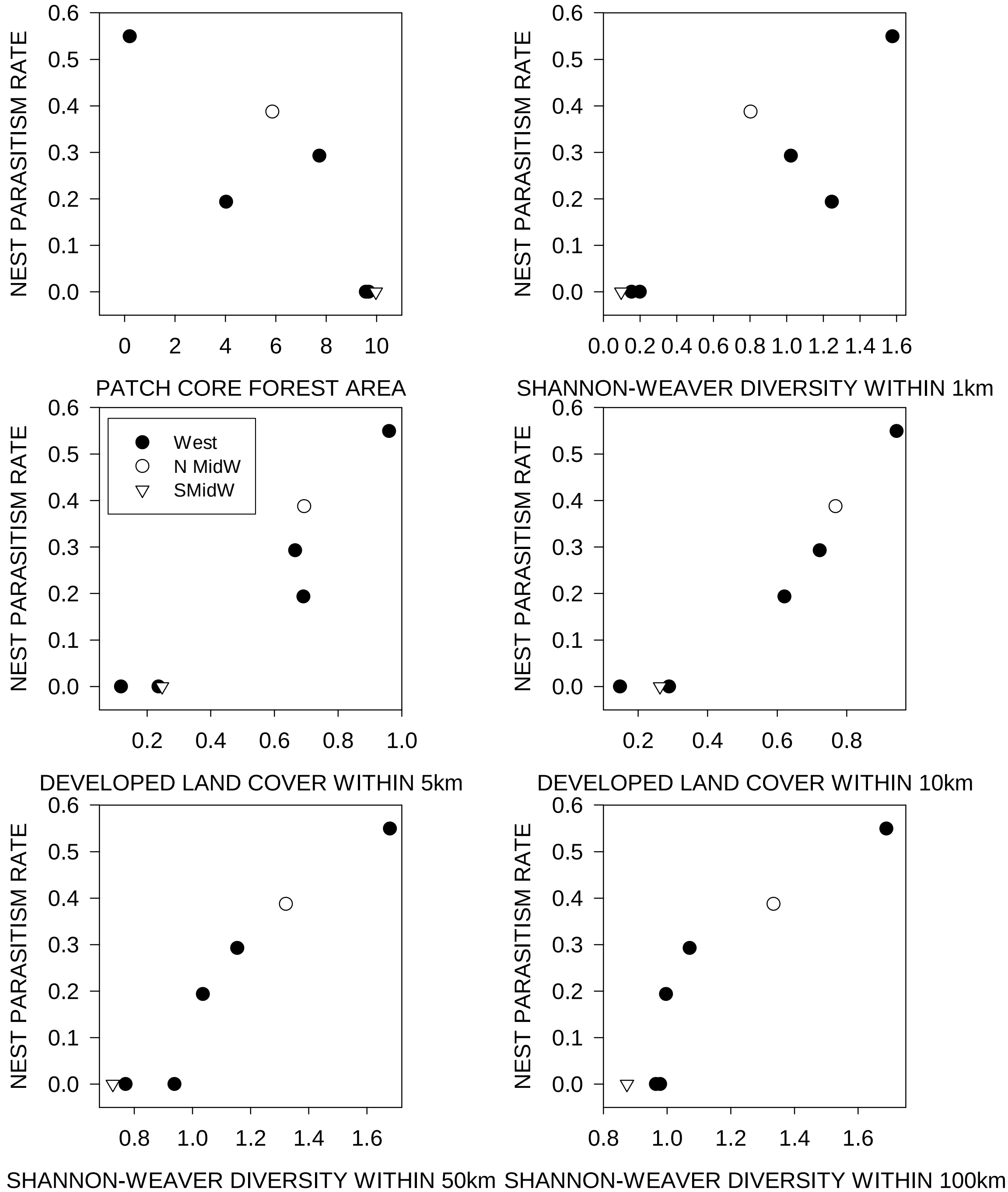

**Figure 3.** Relationship between daily nest predation rate and various indices of forest fragmentation at spatial scales of the forest patch, within 1-10 km radii of plot centers (site averages), and  within 50-100 km radii of site centers.

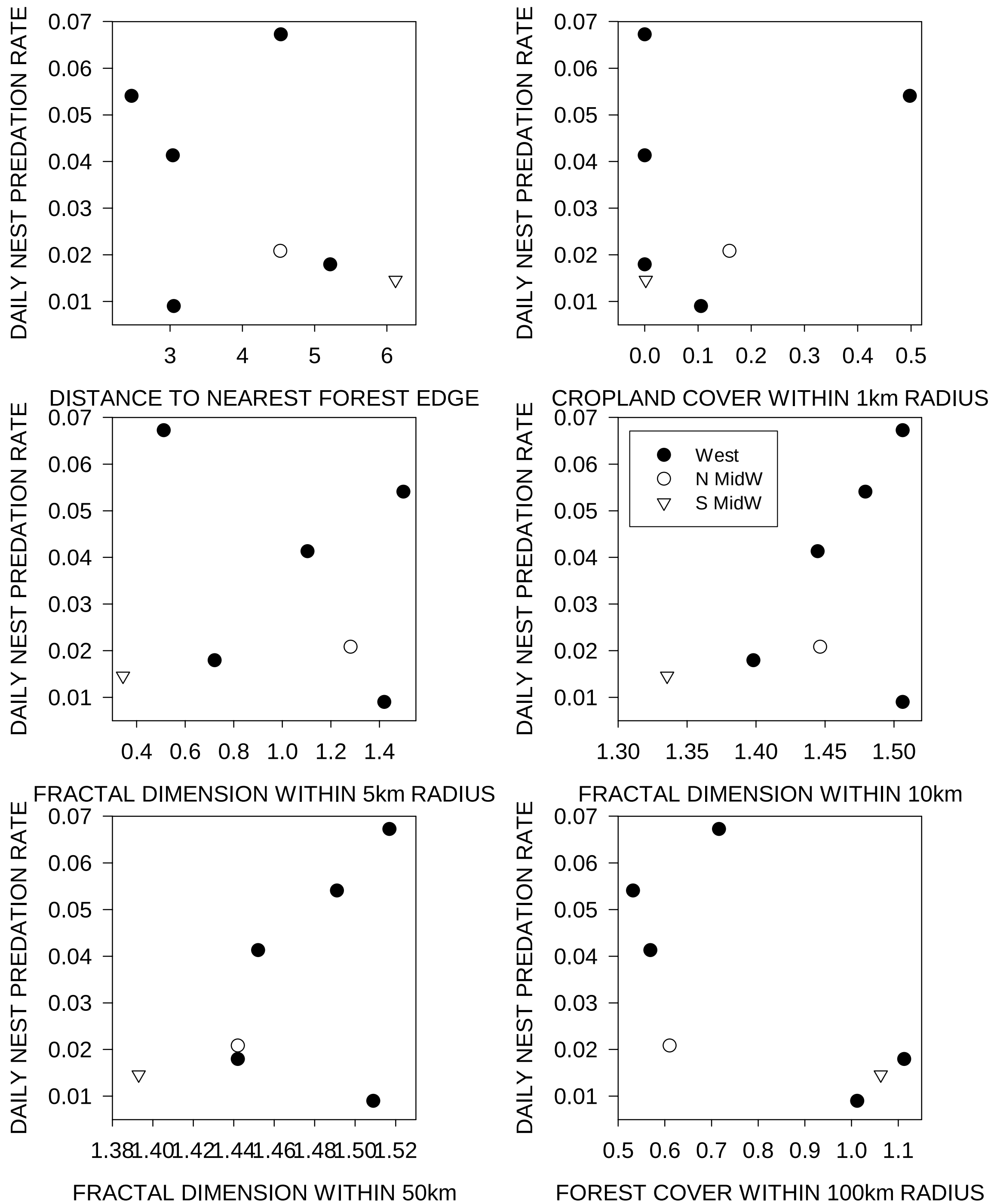

**Figure 4.** Relationship between lambda and various indices of forest fragmentation at spatial scales of the forest patch, within 1-10 km radii of plot centers (site averages), and within 50-100 km radii of site centers.