Ecological Indicators in a Gray Catbird Population: Survival Rates, Population Density, and Site Fidelity

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ABSTRACT

This study was based on data collected by the authors over a sixteen-year period from recaptured Gray Catbirds *(Dumetella carolinensis)* during the breeding season from May to Sep 1988-2003 at the Featherbed Lane Banding Station located in Hopewell Township, Mercer County, NJ. The focus of this paper is to analyze the data in terms of population dynamics and apply the results to accepted ecological principles. The age structure of the population was studied as an indicator of population stability and site fidelity. Higher-than-average return rates for this species were recorded at this site. The survival rates of adult birds, measured by returns as a function of previous years' total captures, showed a constant rate of decline. Returning birds showed a density-dependent relationship with fledgling production the previous year.

INTRODUCTION

We looked for patterns in the banding data to indicate trends in Gray Catbird *(Dumetella carolinensis)* population dynamics. Five questions are addressed: What is the age structure of this population? Does it show evidence of site fidelity among after-second-year (ASY) birds? How do the birds' return rates compare with those of Gray Catbirds in the literature? Are second-year (SY) birds exhibiting natal philopatry? Do our data show correlation between increased hatch-year (HY) abundance during breeding season and returns the following year (density dependence)?

Age Structure and Site Fidelity - Consistent age structure can show stability in a population and can serve as a measure of habitat suitability. Among Gray Catbirds, a successful breeder (producing at least one fledgling) is more likely to return to a breeding site than an unsuccessful one (Darley et al. 1977). The survival of experienced breeders has the greatest potential impact on the population growth rate (McDonald and Caswell 1993). Ganter and Cooke (1998) studied the Lesser Snow Goose *(Chen caerulescens)* and its reaction to anthropogenic changes to its habitat. Their findings showed that as the habitat deteriorated, the cost-benefit relationship may have been changed, and flexibility in choosing breeding sites may have become more important than site fidelity. The implication is that the degree of site fidelity is correlated with the quality of the habitat. Selection, which traditionally may have favored site fidelity, could now be favoring site flexibility. Thus, a stable age distribution supported by a species common to the area can indicate quality in the habitat.

Return Rates and Survivorship - The ornithological literature indicates that annual survival rates are relatively lower for HY birds, typically 50% less than that for adults. Small land birds have a 30%-65% survival rate in their first year (Gill 1999). In passerines, the mortality of young birds in their first year may be up to 75%, based on banding recoveries (Terres 1980). Survival rates of HY British Lapwings *(Vanellus vanellus)* are lower than those of adults; but after reaching adulthood, survival rates are constant for birds of all ages (Peach et al.1994). Using rates of return as a measure of survivorship, we analyzed 268 recaptured birds of known age and grouped them by the number of years since banding to look for a specific age of sharp decline. It is accepted practice to calculate survivorship as returns/total number of possible returns (e.g. Murphy 1996). The implication here is not that mortality is the only causal factor to a non-returning individual. There are also site fidelity and likelihood of capture to consider. However, in an analysis of estimating mean survival rates from banding data, Dobson (1990) found that banding data of common British birds produce comparable estimates of survival and provide a pragmatic way of monitoring mortality rates of bird species.

Natal Philopatry - In a review paper of several species, including the Gray Catbird, natal philopatry, or the likelihood that individuals breed at or near their place of origin, was measured as HY return rates, which are typically low because young, inexperienced birds may be disadvantaged competing with established breeders in a population. Young birds have been observed taking advantage of an optimal breeding habitat only after it is vacated by an older individual (Greenwood and Harvey 1982). Weatherhead and Forbes (1994) reviewed published and unpublished data which showed that natal philopatry was low in 32 migratory passerines. They reported rates of 0.0%, 1.1 % and 1.5% for the Gray Catbird.

Density Dependence - Return rates may depend on density. Experimental evidence for Great Tits *(Parus major)* shows that reproductive decisions are affected causally by breeding density (Both 1998). Nestling survival and growth are higher in low density areas. More low-quality territories are occupied during high-density years. Density-dependent effects might not be present during times of abundant food availability; therefore, studies should continue over a long period to see the effect of natural variation. Clear evidence of density-dependent processes operating on a time-scale is detectable through annual censuses (Both 1998).

METHODS

The study site is located at 134 m elevation in the Sourland Mountains, Mercer County, NJ. The area consists of seven abandoned agricultural fields of approximately 43 ha total size. The fields are in various stages of re-growth, ranging from shrub lands with early stages of tree invasion to full second-growth woodlands. Adjacent to these is an unbroken forest preserve of 300 ha. Mist-netting has been conducted on site since 1979, and the banding station has been a charter member of the Monitoring Avian Productivity and Survivorship (MAPS) program since 1989. Gray Catbird data from the breeding season, 20 May through 7 Sep 1989-2003, were used for this study. The fields were transected with mist-nets (12 m, 4 shelf, 30 mm mesh) set end to end on fixed sites. Nets were hung one day a week at daybreak and checked every 30 min, for five hours. Birds were banded with U.S. Geological Service serially numbered bands. During breeding season, birds were taken back to their capture location for release. Statistical analyses were done using Microsoft Excel® (Microsoft 2003). Regression analyses were completed using Intercooled Stata® 8.0 (Stata Corp. 2005).

RESULTS

A total of 1593 Gray Catbird captures occurred during the breeding season of the 16-yr study. Of these, 243 were returning birds banded in previous years. Repeat captures caught during the same year as banded were not used in any population calculations.

Age Structure and Site Fidelity - Fig. 1 shows the age composition of this Gray Catbird population Even at its lowest point, the population was represented by 59 catbirds captured in that year. Fig 2 shows a consistent trend in adult returns to the site and a strong association with this habitat. Among the old fields in various stages of vegetative successional growth, catbirds preferred shrub land, which changes slowly. Age-specific return rates in these catbirds indicated regular association or site fidelity with a desirable habitat type. Thus the Ganter and Cooke (1998) index, used to identify a stable population, showed similar results when applied here to a successional habitat. This information can assist land managers in choosing the most valuable habitats to protect the species or to benefit the community as a whole.

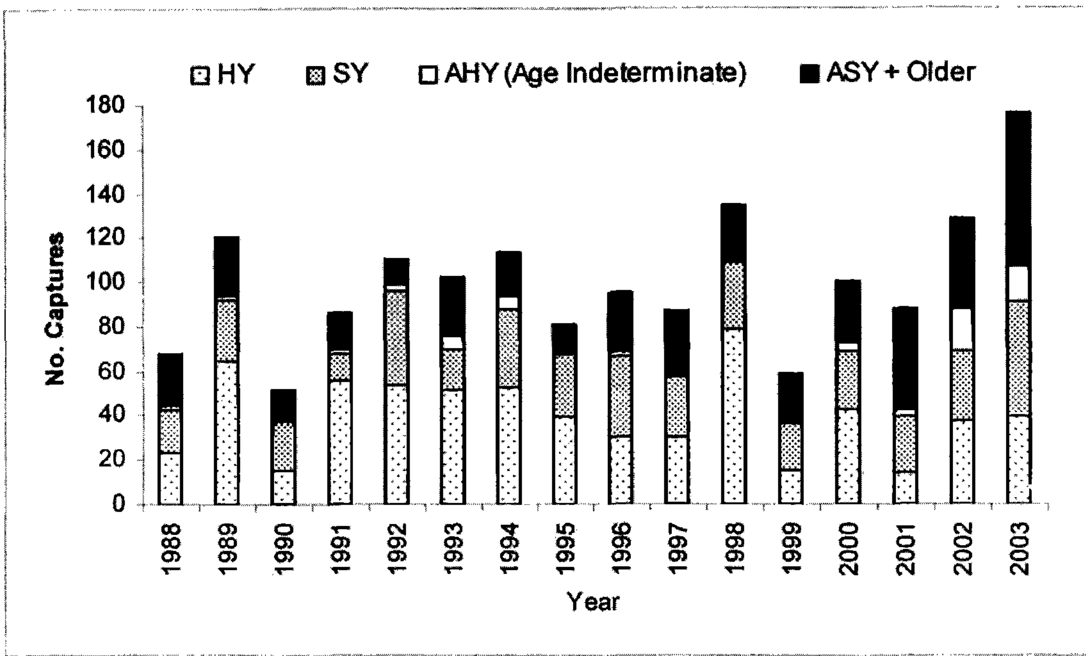

Fig. 1. Variation in Annual Age Structure for a population of Gray Catbirds in a Mercer County Banding Station in NJ from 1988-2003. Total captures during breeding season (e.g. 19 May - 31 Aug) ranged from 59 in 1990 to 150 in 2003.

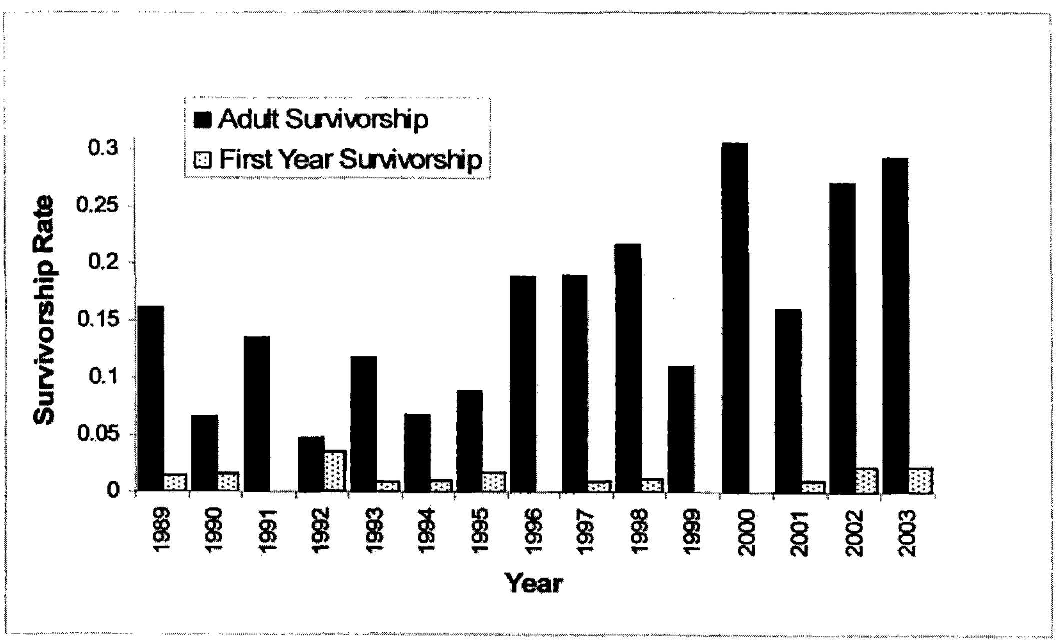

Fig. 2. Annual variation in survivorship rates of Gray Catbirds. Survivorship is measured as no. returns/no. possible returns. ASY and older birds showed survivorship rates ranging from 4.6% to 30.5%. Second-year catbirds returned at rates from 0% (no individuals captured from last year) to 3.4% of last year's banded HYs.

Survivorship - In this paper, survivorship is defined as returns divided by total possible returns (all of last year's captures). Fig. 2 shows the survivorship rates as compared on an annual basis and separated by age class. Sixteen years of our Gray Catbird banding data support a consistent trend in age-dependent survival rates. ASY and older birds showed survivorship rates ranging from 4.6% to 30.5%. HY survivorship, measured by returning banded SYs, was significantly lower, ranging from 0%-3.4%, but higher than in Weatherhead and Forbes (1994). Analysis of returning older birds that remain faithful to the site for several years can offer insight into age-dependent survival rates. High rates of return in older Gray Catbirds could indicate a motivation to return to breed in successful grounds (Darley et al. 1977).

Return Rates - As Peach et al. (1994) found with British Lapwings, we found our Gray Catbirds had a low survival rate during the hatching year but constant rates of decline in the adult years regardless of age. Fig. 3, Distribution of Returning Birds, shows a regression of the number of return encounters as a function of the age of the catbirds with the 268 recaptured birds we used. Each data point indicates the number of adult birds living a given year past its banding date. The graph shows a gradual decline in returns with no sharp drops after the second year of age. After reaching the second year in age, surviving Gray Catbirds showed a uniform decline in returns each successive year after first capture. Establishing trends in survival rates of successful species can create a baseline of information to help detect declines in populations of those species which are of concern, or those that can serve as ecological indicators.

Natal Philopatry - Our return rates of HYs, 0% - 3.4%, was broader in range than the 0% - 1.5% that Weatherhead and Forbes (1994) reported for catbirds. This could reflect high natal dispersal rates, low natal philopatry, low HY survival rates, or some combination of factors. Roughly, our average yearly production of 40 banded HYs, if reduced by the estimated 30% to 75% mortality, leaves a high of 28 or a low of 10 birds surviving to return. The high incidence of unbanded SY birds in proportion to

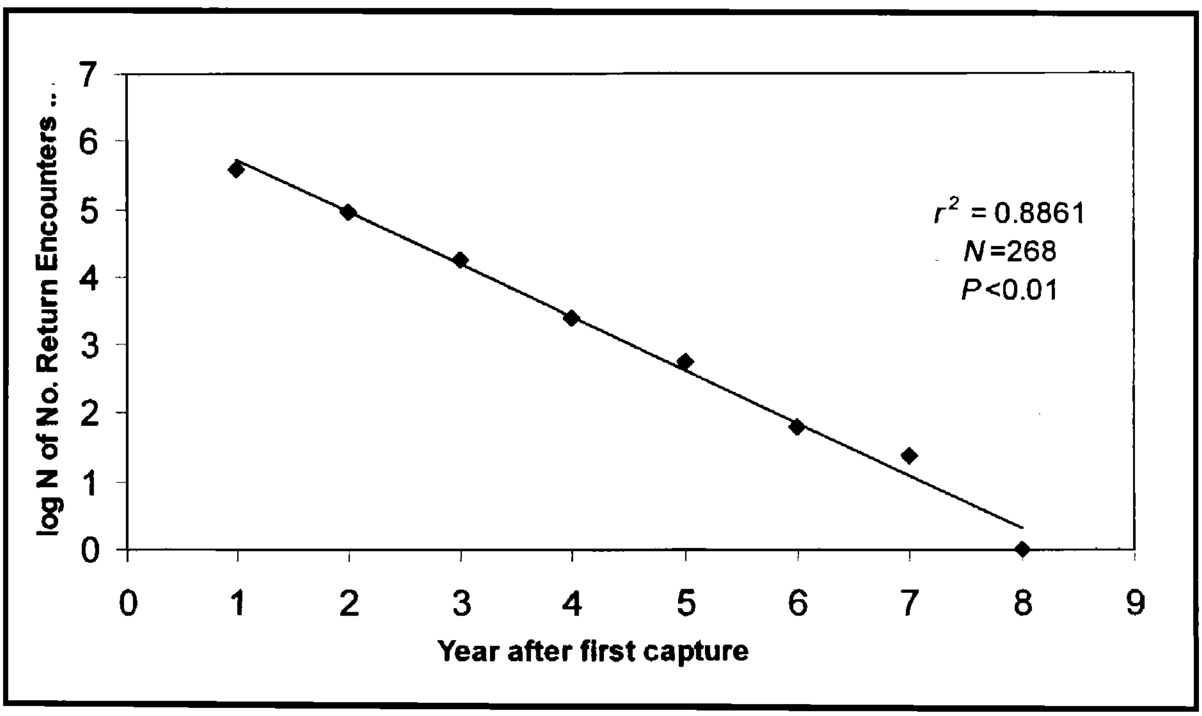

Fig. 3. Distribution of returning Gray Catbirds from breeding and fall seasons 1988-2003. After surviving the first year of life, Gray Catbirds showed a uniform decline each successive year after first capture in returning to the site regardless of age.

banded SYs (returning HY) present on site, approximately 10 to 1, supports the theory of juvenile dispersal. Obviously there are surviving juveniles but they are not returning to their birth site. No measurable effect was found in a regression of the number of HY birds in year x and the number of SY birds in year x+1.

Additional nearby locations for mark recapture studies could provide support for the natal dispersal theory. It is interesting to note that none of our catbirds have been recaptured at more distant banding sites in southern NJ: Palmyra, 56 km (35 mi) south along the Delaware River; Island Beach State Park, a barrier beach 113 km (70 mi) southeast on the Atlantic coast; and Cape May, 161 km (100 mi) in the Delaware Bay area; nor in the Great Swamp, 56 km (35 mi) northeast. Locating banded SY birds in territories nearby but not on the site would answer questions about the range of juvenile wandering and post-fledgling dispersal.

Density Dependence - The literature supports the theory that significant portions of natal dispersal occur in independent juveniles prior to their first migration (post-fledgling dispersal; Greenwood and Harvey 1982). Morton (1992) found that the Mountain White-crowned Sparrow *(Zonotrichia leucophrys oriantha)* juveniles wander extensively–possibly acquainting themselves with local physiographic features in next year's breeding areas. Migrant juveniles may be taking the opportunity to assess habitat features in summertime, when time constraints and energy stresses are lighter than during migration. It is also possible that post-fledgling dispersal may serve to improve nutritional conditions prior to migration, allowing juveniles to molt and gain fat stores in preparation for the flight (Morton 1992). In an analysis of Christmas Bird Counts from seven English passerines, Greenwood and Baillie (1991) found density dependence apparent in population changes of birds wandering in wintering woodland plots, but it was less evident in those using farmland. A significant negative relationship was measured in a regression of the proportion of Gray Catbirds returning to our study area during one year, relative to the number of fledglings captured in the previous year (Fig. 4). The suggestion is that in years of higher productivity, fewer birds return to their natal/ breeding sites the following year. Since it is shown that in catbirds successful breeders are more likely to return to the breeding site the following year (Darley et al. 1977), the above trend would appear to support the density-dependence theory in which the disadvantage of high population density outweighs the benefit of optimum breeding habitat.

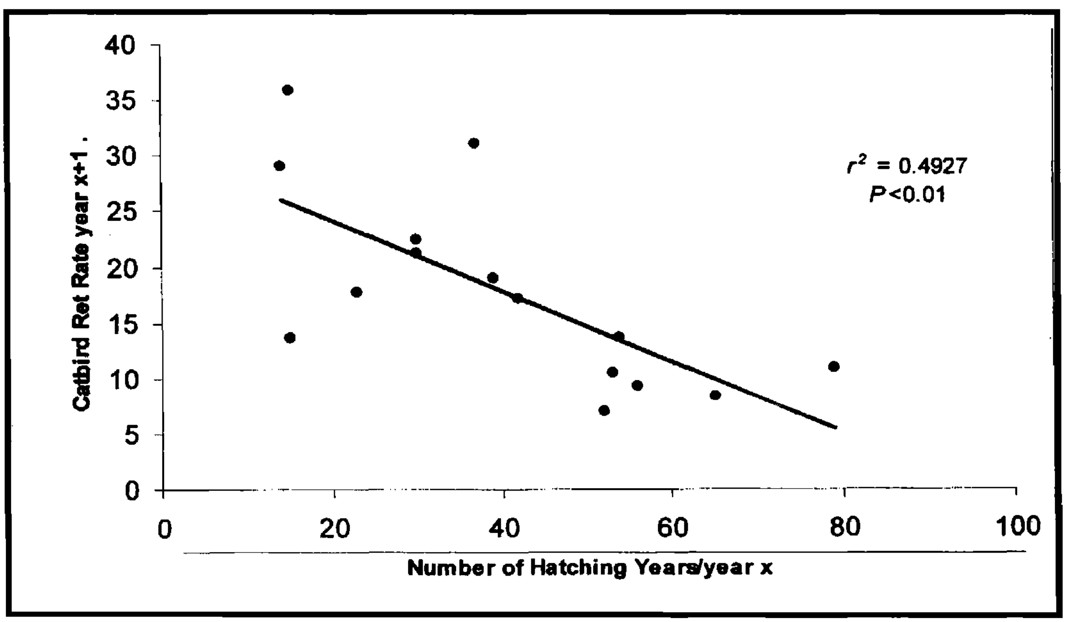

Fig. 4. Gray Catbird return rate as a function of density of population in the previous year. A significant negative relationship was measured in a regression of the proportion of Gray Catbirds returning to our study area during one year, relative to the number of fledglings captured in the previous year.

Evidence from weather data shows an increase in SY and AHY new captures after a previous year of unfavorable breeding conditions, such as drought, long periods of cold soaking rains, or record high temperatures. These birds appear to be filling the spaces left by the reduced population the previous year.

Competition within species could cause higher juvenile mortality or higher rates of natal dispersal and subordinate young birds must go elsewhere. Flexibility seems to be a necessary trait if a balance between resources and population is to be achieved.

DISCUSSION

The value of successional old fields with a diversity of shrub species and fruiting vines as a slowly changing habitat for this particular species is shown clearly by the high rate of site fidelity in return captures and diverse age structure of Gray Catbirds at this study site.

Further study of the density-dependence theory as it correlates to HY survival rates and post- fledgling dispersal of the Gray Catbird would benefit from continued long-term studies and higher numbers for better statistical significance. However, we have only 38 returns from breeding season fledglings out of 1782 HY catbirds banded at this site since 1978. Experimental change in sections of the breeding site over winter followed by monitoring of behavior upon the population's return in the spring could give insight into this species' ability to compete in new territories and adapt to change. Previous studies show that shrubland birds at this site moved to adjacent shrubland as former breeding sites overgrew into second growth forests (Suthers 1988, Suthers et al. 2000). The data gathered from long-term studies at this site can be used for land management decisions and conservation of valuable habitat for avian populations. Banding data can be applied to specific questions and lead to further understanding of species population dynamics.

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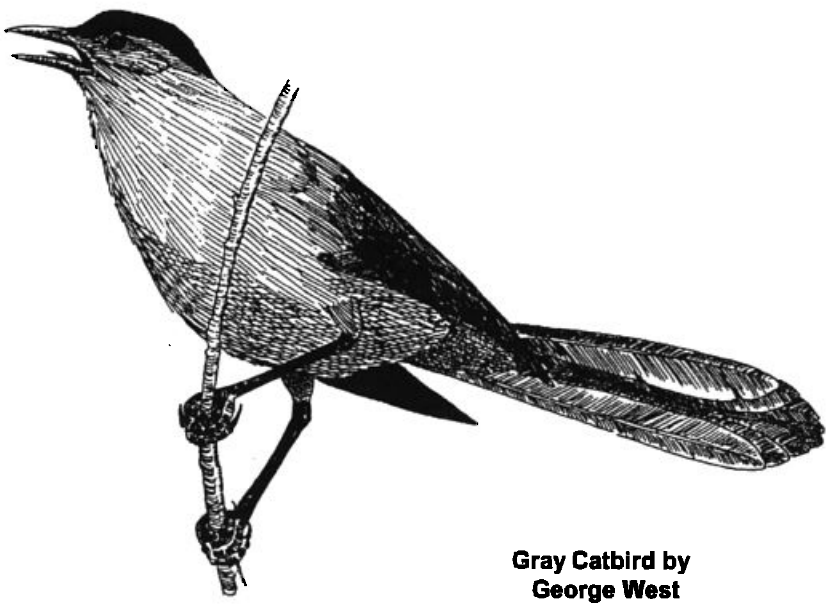

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