FINAL PERFORMANCE REPORT

Bureau of Wildlife Diversity Conservation

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Abstract: We conducted a study to compare the reproductive biology, dispersal, and subadult survival of bald eagles from nest sites in suburban and rural landscapes in west central Florida from 1997 – 2001. Over this period, we carefully documented the reproductive outcome of 60 randomly selected suburban and 60 randomly selected rural bald eagle nest attempts, and we deployed satellite tracking packages (PTT) on 35 randomly selected rural and 35 randomly selected suburban bald eagle fledglings. Nest site occupancy varied among years, but averaged 90% for nests in both land-use categories. The onset of nesting varied inversely between suburban and rural bald eagle nests across years, but the overall mean start date was similar for both groups (11 December for suburban nests and 13 December for rural nests). Nests in both land-use categories raised an average of 1.3 young per occupied and 1.7 young per successful nest site to 8 weeks of age. Bald eagle fledglings from our study area migrated northward after dispersing from natal areas, with about 50% summering on the Chesapeake Bay and the remainder between there and Nova Scotia. Successful fledglings started northward migration earlier on average at rural nest sites (124 days of age) than at suburban nest sites (132 days of age). Survival of both groups was similar until dispersal (about 91%), but during the first northward migration mortality of suburban fledglings increased disproportionately. At the end of 1 year, survival of rural fledglings was 88% compared to 62% - 76% for suburban fledglings (depending on how transmitters of uncertain fate are treated). Survival of the 2 groups equalized at 92% in year 2. Five of 6 suburban bald eagles for which the cause of death could be determined died from anthropogenic factors, primarily electrocution and vehicle collisions. None of the 4 rural bald eagles for which a cause of death could be determined died of anthropogenic causes. We suggest suburban bald eagle fledglings were more acclimated to dangerous anthropogenic landscape features than rural eagles, and as such did not regard them with the same degree of caution once independent. Despite the difference in first-year mortality, population models suggest both groups are experiencing positive population growth rates.

INTRODUCTION

Florida's breeding population of bald eagles (*Haliaeetus leucocephalus*) continues to increase in number annually, with 1,102 occupied nest sites counted in 2001 compared to 601 in 1991 (Nesbitt 1996, Nesbitt 2001). Despite the continuing population increase, concern remains for the long-term welfare of the bald eagle in Florida because human development is increasing in occupied bald eagle habitat. Wildlife managers generally believe human encroachment and landscape alterations near bald eagle nest sites are deleterious, and that the closer such actions are to the nest, the more detrimental they are likely to be (Gerrard et al. 1975, Grub 1980, Fraser et al. 1985, Anthony and Issacs 1989, Wood et al. 1989, Buehler et al. 1991). Management guidelines (U.S. Fish and Wildlife Service 1987) for the bald eagle prescribe set-back buffer zones around eagle nest sites accordingly, and these guidelines have proven effective in mitigating effects of development (Nesbitt et al. 1993). Increasingly, however, some bald eagles continue to nest, or establish new nests, in closer proximity to human habitations and disturbance (suburban nests) than the management guidelines suggest is acceptable. What is not clear is whether these suburban bald eagle pairs are anomalies, or evidence an inherent ability of the species to accommodate to increasing human development. This is more than an academic question, for if bald eagles are capable of accommodating proximate to development, the species’ status might be more secure than is generally thought. Of equal importance, there may be relatively simple management options that can be undertaken around suburban nest sites to improve their value and permanence.

This study aimed to determine reproductive and demographic characteristics of bald eagles occupying suburban nest sites in west central Florida, and to compare those with similar statistics for rural bald eagles from the same area. Specifically, we estimated nest site occupancy, clutch initiation dates, nest success, productivity, survival of fledglings to dispersal, and post-dispersal survival for a randomly selected subset of suburban and rural bald eagle nest sites in west central Florida from 1997 – 2001. The results shed light on the relative contribution of suburban bald eagle nest sites to the west central Florida bald eagle subpopulation, and identify potential limiting factors and management options for suburban eagles.

STUDY POPULATION

Our study population consisted of all bald eagles occupying, or fledging from, nest sites in Hillsborough, Lee, Pasco, Pinellas, Polk, Manatee, Sarasota, and Charlotte counties, Florida, between 1997 and 2001(Fig. 1). In 1997, Lee and Pasco counties were excluded, but they were added in 1998 to meet sample size requirements.

METHODS

In 1997, we classified all known occupied (unless otherwise noted, defined as nests sites attended by at least 1 bald eagle in adult plumage) bald eagle nest sites on our study area as either rural (< 5% of the land area within 1,500 m of the nest in intense human use), intermediate (between 5% and 49% of the land area within 1,500 m of the nest tree in intensive human use), or suburban (> 50% of the land area within 1,500 m of the nest in intense human use). For classification purposes, we considered developed lands such as subdivisions, ball parks, golf courses, warehouses, shopping centers, and highways as intense human use areas. We chose the 1,500 m scale for classifications because fledgling bald eagles in Florida spend most of their time within this area before dispersal (Wood and Collopy 1995). Intense human use areas were identified and measured using current aerial photographs, and landscape characteristics were confirmed by site visits for nest sites that were selected for use in the study.

We generated estimates of nest site occupancy, nest success (unless otherwise noted, defined as nest sites successfully raising ≥ 1 young to ≥ 8 weeks of age), and productivity (unless otherwise noted, defined as number of young raised to ≥ 8 weeks of age) in 2 ways. First, the Florida Fish and Wildlife Conservation Commission (FWC), with funding assistance from the U.S. Fish and Wildlife Service and U.S. Forest Service, monitors these variables on a coarse scale statewide by surveying all known bald eagle nest sites twice (once at the approximate mid-point of incubation, and once at the approximate mid-point of the brood rearing period) from the air each breeding season (Nesbitt 1996). Data from this survey for nest sites from the core of our study area (Hillsborough, Manatee, Pinellas, and Sarasota counties) for the 1994, 1995, and 1996 breeding seasons (where 1994 refers to the breeding season from approximately October 1993 – June 1994) were analyzed to estimate nest site occupancy, nest success, and productivity at rural, intermediate, and suburban nest sites. We also used this data set to determine if proximity to the coast was a potentially confounding variable that might mask trends between land-use categories.

Our second approach involved direct monitoring of reproductive activity at sample nests during the course of this study. We randomly selected 12 suburban and 12 rural nest sites that had been occupied the previous year for intensive monitoring during each breeding season from 1997 – 2001 (Fig. 1, Appendix A). Each was checked a minimum of 4 times by helicopter to determine occupancy and productivity, and helicopter checks were staggered at bi-weekly intervals to help estimate the date of the onset of incubation. For nest sites where we subsequently handled young, we adjusted estimated laying dates based on the estimated age of eaglets when handled (Bortolotti 1984). On each visit after eggs had hatched, the number of nestlings in the nest was determined and the age of eaglets was estimated visually by plumage growth (Bortolotti 1984).

Seven of the 12 sample nests in each land-use category were randomly selected to have 1 eaglet equipped with a combination satellite platform transmitting terminal (PTT) (Microwave Telemetry Inc., Columbia, Maryland) – VHF (American Wildlife Enterprises, Monticello, Florida) radio transmitter package in each year (14 total transmitters annually). We chose this sample size because preliminary calculations using survival and variance estimates reported in Wood and Collopy (1995) suggested it would allow detection of a 10% annual difference in survival between land-use categories 80% of the time ($\beta = 0.80$). We also randomly selected 7 backup nest sites in each land-use category as alternates if primary nests failed, proved unclimbable, or were inaccessible due to landowner refusal to allow access. We ascended nests using conventional climbing techniques when nestlings were 7 – 10 weeks of age, and captured focal birds by hand. Captured eaglets were individually lowered down from the nest in a canvas bag. Eaglets were weighed in the bag, then removed, hooded, and gently restrained for processing. We measured foot-pad length, bill depth, and 8th primary length following methods in Bortolloti (1984) and Wood and Collopy (1995). Sex was estimated based on the relationship between foot-pad length and bill depth using Fig. 2-2 in Wood and Collopy (1995:9). We attached PTT packages using a harness design and materials similar to that used by Buehler et al. (1991) and Wood and Collopy (1995). Conventional VHF transmitters were bolted and epoxied on the PTTs.

In 1997, tagged fledglings were monitored on a weekly basis using conventional VHF telemetry and PTTs until birds could no longer be found in a 10 - 20 km radius of the nests. In 1998 and 1999, a sample of fledglings was intensively tracked from the ground, and all fledglings were monitored weekly from the air during the post-fledging pre-dispersal period (Tinkler 2000). In 2000 and 2001, fledglings were monitored by PTTs. Monitoring after dispersal in all years was accomplished using PTTs. PTTs transmitted data that was read by National Oceanic and Atmospheric Administration (NOAA) satellites. Service ARGOS received and translated satellite data, and then e-mailed daily reports to us for analysis and interpretation (ARGOS 1996). Data were obtained for pre-programmed duty cycles that consisted of 1, 12-hr cycle for the first 30 days of PTT operation; 3, 12-hr cycles per week for the next 6 months of PTT operation; and 1, 12-hr duty cycle per week for the remainder of the life of the PTT (calculated to be 4 - 5 yr).

A motion sensor in the PTTs indicated mortality of PTT-tagged bald eagles. Mortality sensor information was transmitted as part of each location message. When we suspected an eagle had died, we traveled to the best recent location indicted by the PTT, and began a search for the VHF transmitter. We were aided in this effort by other state fish and wildlife agencies when deaths occurred outside of Florida. We estimated survival functions for PTT-tagged eagles using the nonparametric Kaplan-Meier estimator (Kaplan and Meier 1958) for censored data, and compared survival functions for rural and suburban eagles using the Tarone-Ware log-rank test (Steinberg et al. 2000). Most bald eagle carcasses recovered were sent to the Laboratory of Wildlife Disease Research, Pathobiology Department, College of Veterinary Medicine, University of Florida, Gainesville, Florida, for necropsy, although some recovered outside of Florida were necropsied elsewhere. Many of the carcasses had decomposed beyond the point where meaningful analyses could be conducted. When the cause of mortality could be estimated, we classified the death as either human-related (e.g., vehicle collisions, electrocutions, introduced disease) or not (e.g., starvation, storms), and then looked for differences between eagles from nest sites in different land-use categories.

We determined the location of PTT-tagged eagles from ARGOS e-mail reports. Judging from accuracy of ARGOS reports for eagles still in nests (i.e., at known locations), we considered PTT messages with the following characteristics to be accurate to within ~1000 m: (1) NOPC $\geq$ 2; (2) LC $\geq$ 0; (3) X $\geq$ 4 and/or Y $\geq$ 3; and (4) pass duration > 200 sec (ARGOS 1996). The latitude and longitude from high quality data were entered into databases maintained for each PTT-tagged bald eagle, and were plotted using geographic information system (GIS) tools in ArcView (ESRI, Redlands, California). We developed contour maps of the summer (1 June – 1 September) and winter (2 September – 30 May) ranges of PTT-tagged bald eagles by pooling data for all individuals and applying a fixed-kernel home-range utilization distribution to the full data set using the Animal Movement Extension tool in ArcView (Hooge and Eichenlaub 1997).

Starting in 2000, we collected additional data on the health and condition of all bald eagle fledglings handled. Physical examinations were performed, which included clinical observations for any abnormalities of the feathers, skin, legs and feet, wings, eyes, ears, oral cavity, musculoskeletal system, central nervous system, genital and urinary system, and abdominal cavity by standard procedures (Harrison and Harrison 1986; Ritchie et al. 1994). Body condition and health were evaluated and scored. The type and degree of external parasite infestation was also noted. Blood was drawn from the cutaneous ulnar vein using a 25 gauge needle. Blood slides were made using traditional laboratory methods. Complete blood counts, serum chemistries, serum protein electrophoresis, and *Aspergillus* antibody and antigen serology were conducted at the Avian & Wildlife Lab, Division of Comparative Pathology, University of Miami, Miami, Florida (Cray and Tatum 1998). Aliquots of the blood, as well as small feather samples, were archived in a - 70^{o} C freezer at the FWC Wildlife Research Laboratory in Gainesville, Florida.

Using data on survival and fecundity from this study, we estimated the predicted population growth rate for suburban and rural bald eagles on our study area. We used the population viability modeling program Vortex 8.41 (Miller and Lacy 1999) for this analysis. We modeled populations 2 ways: (1) assuming a carrying capacity 2 times the current estimated breeding population size on our study area, and (2) assuming the current breeding population size on our study area was at carrying capacity, and there were as many floating non-breeding adults undetected in the population as breeding adults (as suggested by Hunt [1998] for some raptor populations at equilibrium). We used Vortex 8.41 to simulate 100 future population projections, and then estimated stochastic r (and SE r), the mean annual rate of population change. Several parameters required by the model had to be estimated for our study population: (1) we estimated that females first begin breeding at age 5 and males at age 6, based on data in Palmer (1988) for bald eagles and a general tendency for male raptors to first breed at older ages than females (Newton 1979); (2) we estimated a maximum breeding age of 25 years based on inferred population structure given rates of annual mortality we observed in older age classes, and observations of bald eagles surviving to 36 years of age in captivity (Newton 1979); (3) we estimated bald eagles maintained a long-term monogamous mating strategy (Palmer 1988); (4) in populations below carrying capacity we assumed the rate of non-breeding was the cumulative proportion of females that failed to successfully fledge young plus the proportion of unoccupied traditional nest sites in any given year; (5) in populations at carrying capacity we assumed there were as many non-breeding adults as breeding adults; (6) we assumed average annual mortality and variance about the mean remained constant after year 1; and (7) we assumed actual population size was 2 (below carrying capacity) to 4 (at carrying capacity) times the number of traditionally occupied nest sites plus the number of subadult eagles projected to be in the population assuming a stable age structure. We held these parameter estimates constant for all models.

Statistical tests were performed using SYSTAT 10 (SPSS Inc., Chicago, Illinois), with a significance level of $\alpha = 0.10$.

RESULTS

Nest Site Occupancy and Bald Eagle Reproduction

A total of 186 occupied bald eagle nest sites was present in our study area in 1997. Seventy-five (40.3%) were classified as rural sites, 85 (45.7%) as intermediate, and 26 (14.0%) as suburban. Most nests were in large, mature pines (primarily slash pines [P*inus elliottii*]), but we also observed 1 nest on a cellular phone tower, 6 on electric distribution poles, and 2 on artificial raptor nesting towers.

In our first approach toward analyzing reproductive variables employing data from the statewide survey, we found no significant difference in 3-yr occupancy (Mann-Whitney U_1 = 258, P = 0.95), nest success (Mann-Whitney U_1 = 251, P = 0.93), or productivity (Mann-Whitney U_1 = 263, P = 0.86) between coastal and inland nests (Table 1). Point estimates of means supported the statistical conclusion that there was little difference in these variables between coastal and inland nest sites on our study area. Based on these results, data for inland and coastal nest sites were pooled for analyses of the effect of land-use category. We found a significant difference in occupancy rate between rural and intermediate nest sites in this analysis (Kruskal-Wallis 1-way ANOVA H_2 = 6.04, P = 0.05; Dunn=s pairwise multiple comparison indicated rural and intermediate values differed at $P \leq 0.10$), but no other statistically significant differences were found (Kruskal-Wallis 1-way ANOVA for nest success H_2 = 1.24, P = 0.55; Kruskal-Wallis 1-way ANOVA for productivity H_2 = 0.28, P = 0.87) (Table 1). Point estimates for means did not suggest that a biologically significant difference existed for any of these variables.

With respect to reproductive performance during this study, we determined occupancy and reproductive outcome of 120 (60 rural and 60 suburban) bald eagle nesting attempts over the 5-yr study period (Appendix A and Table 2). Over all years, pooled occupancy rates ranged from 100% in 2 years to 75% in 1999, and averaged 90% (Fig. 2). In general, patterns of occupancy were similar between rural and suburban nest sites, and overall occupancy rates did not differ between categories (Mann-Whitney U_1 = 12.0, P = 0.91).

We confirmed that at least 1 egg was laid at 101 of the 120 randomly selected study nest sites. Based on backdating from estimated laying dates from flights and estimated ages of eaglets, bald eagles laid eggs on our study area as early as 25 October, and as late as 27 March (Fig. 3), the latter in a re-nest attempt following failure of a first nest. A 2-way ANOVA of rank-transformed least-square mean laying dates revealed a significant interaction effect between land-use category and year ($F_{4,91}$ = 2.09, P = 0.09) (Fig. 4). Main-factor effects for year (Kruskal- Wallace H_4 = 4.85, P = 0.30) and land-use category (Mann-Whitney U_1 = 1480.5, P = 0.16), when tested separately, were not significant. Thus, while patterns of variation in the onset of reproduction varied inversely between rural and suburban nest sites among years, nesting did not start consistently earlier for either group.

The number of young fledged per occupied nest site did not differ significantly among years (Kruskal- Wallace H_4 = 4.53, P = 0.33) or between land-use categories (Mann-Whitney U_1 = 1822.0, P = 0.96) (Fig. 5). The number of young fledged from successful nests did not differ significantly among years (Kruskal- Wallace H_4 = 5.96, P = 0.20) or between land-use categories (Mann-Whitney U_1 = 1168.0, P = 0.89). Over all years, 13 rural and 12 suburban nest sites failed to fledge young, a non-significant difference (Pearson χ^2_1 = 0.04, P = 0.84).

Survival and Dispersal

We were not able to meet our sample goal in the first 2 years of the study due to last-minute difficulties obtaining landowner permission, difficulties determining precisely the age of eaglets from the ground or helicopter, and our inability to climb some trees we initially thought to be accessible. We compensated by tagging additional birds in 1999 and 2001. It was critical not to tag different numbers of young in each land-use category in a year to avoid confounding year effects with land-use category effects, so we tagged the same number of rural and suburban young in each year of the study. PTTs were deployed on 4 suburban and 4 rural bald eagle fledglings in 1997, 6 urban and 6 rural fledglings in 1998, 9 urban and 9 rural fledglings in 1999, 7 suburban and 7 rural fledglings in 2000, and 9 suburban and 9 rural fledglings in 2001. One rural fledgling slated for a PTT in 1997 sustained a fractured tibio-tarsus during capture. We submitted this individual for treatment to the Audubon Wildlife Center in Maitland, Florida, where it was determined this bird was severely malnourished, and would almost certainly have died after reaching 8 weeks of age but before dispersing from the natal area had it not been injured (Reese Collins, Audubon Center of Florida, personal communication). We treat this individual as a pre-dispersal fatality in our analyses. Problems with small sample size were confounded during year 1 of the study by the complete failure of all but 1 PTT by October, 1997 (Appendix B). Failures occurred late enough that we were able to document survival status through dispersal for all study birds. The manufacturer diagnosed and corrected the problem before the 1998 breeding season.

Dispersal. – Fledgling bald eagles remained in close proximity of nests until late March, at which point widespread wandering occurred. Most birds still returned to the natal areas at night during this period. Sixty-three PTT-tagged fledglings survived to undergo initial dispersal (defined as a period of $\geq$ 1 week without returning to the natal area). Initial dispersal occurred from 1 April until 8 July.

Age at dispersal (0 = 128 days, SE = 2.1, n = 63) was independent of the estimated laying date (Pearson correlation r = 0.16, P = 0.19), but it did not differ significantly among years (Kruskal - Wallace 1-way ANOVA H_4 = 3.74, P = 0.44) or between sexes (Mann-Whitney U_1 = 446.5, P = 0.89). Accordingly, we pooled data and determined that eagles from rural nests underwent initial dispersal significantly earlier than suburban eagles (Mann-Whitney U_1 = 333.5, P = 0.02)(Fig. 6b). The frequency distribution of rural and suburban eagle dispersal dates suggested natal dispersal for suburban fledglings peaked bi-modally, with one peak at about 135 days and another at about 160 days (Fig. 6a). The frequency of natal dispersal dates for rural fledglings tended more toward a normal distribution, and all rural fledglings dispersed by 150 days of age.

Movements of 57 bald eagles that survived to disperse with functioning PTTs were analyzed to determine summer and winter ranges. The core summer range of west central Florida juvenile and subadult bald eagles, constructed from 4,212 PTT-reported locations, extended from Florida northward through Nova Scotia, Newfoundland, and Quebec. Nearly 50% of all PTT-tagged eagles summered on the Chesapeake Bay and Coastal Plain of North Carolina (Fig. 7). The core winter range of west central Florida juvenile and subadult bald eagles, constructed from 1,555 PTT-reported locations, was in western and central Florida, the

Florida Panhandle Gulf Coast, and the Coastal Plain of South Carolina (Fig. 8). Detailed analyses of geographic components of dispersal will be presented in another paper, but movement and important use area information for these bald eagles are presented and updated bi-monthly on maps linked to the FWC home page (http://wld.fwc.state.fl.us/eagle/eagle.htm).

***Survival.* --** We recovered carcasses of 10 of 13 eagles that appeared to have died based on PTT mortality signals. The unrecovered PTTs were last detected at sea (1 case), or began emitting mortality signals after VHF radios expired (2 cases). Fourteen PTTs failed before the end of their projected battery life. Nine of these were censored for survival analyses at the time of failure. The 5 other PTT's ceased reporting under suspicious circumstances. In 4 cases, PTT transmissions simply stopped, after no indications of impending battery failure or malfunction, except that in 1 case the final transmission indicated the transmitter was atypically hot (P. Howie, Microwave Telemetry Inc., Columbia, Maryland). In the remaining case, the PTT began emitting a mortality signal in Ontario, Canada, but before we could effect a ground search there, the PTT began moving southward to Florida, and then subsequently settled in Martin County, near a landfill frequented by other bald eagles. The transmitter continued to emit a mortality signal throughout this period. The PTT became stationary at the Martin County landfill in late December 2000, and subsequently ceased transmitting locality information but continued to transmit a mortality signal. We were unable to locate that PTT in subsequent ground searches. In the first 4 cases, the available evidence is most consistent with a hypothesis that all 4 birds met violent deaths (e.g., vehicle collisions, electrocutions) that caused their PTTs and VHF radios to cease functioning. In the last case, we suspect the eagle died at the Martin County landfill. In none of these cases can we be certain what happened, therefore we ran survivorship models 2 ways: (1) censoring all 5 transmitters as though they had failed, and (2) treating each as a mortality at the time the PTT reports became suspicious.

Our data set for survival analyses contained 40 estimated females, 28 estimated males, and 2 eagles of uncertain sex. There was no difference in survival functions of estimated males and females (Tarone – Ware log-rank test with PTTs of uncertain fate censored $\chi^2_1 = 0.22$, $P = 0.64$; Tarone – Ware log-rank test with PTTs of uncertain fate assumed dead $\chi^2_1 = 0.82$, $P = 0.37$), so data for both sexes were pooled for subsequent analyses. In the full data set, bald eagles from nests where the onset of incubation was earlier than the population mean survived significantly better than those from nests where incubation started later (Tarone – Ware log-rank test with PTTs of uncertain fate censored $\chi^2_1 = 3.66$, $P = 0.05$; Tarone – Ware log-rank test with PTTs of uncertain fate assumed dead $\chi^2_1 = 7.45$, $P = 0.0006$). This relationship did not hold for age at dispersal, as we found very weak evidence of a difference in survival between fledglings that dispersed earlier vs. later than the mean dispersal age (Tarone – Ware log-rank test with PTTs of uncertain fate censored $\chi^2_1 = 1.26$, $P = 0.26$; Tarone – Ware log-rank test with PTTs of uncertain fate assumed dead $\chi^2_1 = 2.66$, $P = 0.11$).

When the 5 eagles of unknown fate were treated as mortalities, the difference between survival functions for rural and suburban eagles was significant (Tarone – Ware log-rank test $\chi^2_1 = 2.86$, $P = 0.09$) (Fig. 9a), with suburban bald eagles experiencing significantly higher mortality. When these eagles were censored as transmitter failures, the difference became non-significant (Tarone – Ware log-rank test $\chi^2_1 = 0.59$, $P = 0.44$) (Fig. 9b), but the general pattern of variation remained similar. In both cases, the substantially higher mortality of suburban bald eagles occurred after dispersal from natal areas in the first year of life, primarily during the first northward migration (n = 3) or on the return fall migration (n = 4) (Fig. 10). Prior to dispersal, survival of suburban eagles was slightly higher than for their rural counterparts (Table 3). For both rural and suburban eagles, annual survival seemed to stabilize after year 1 at 92%.

Apparent causes of mortality of bald eagles from rural nest sites included starvation and malnourishment (n = 2), disease (avian pox; n = 1), storm-caused trauma (n = 1), and unknown factors (n = 1). All deaths except the 1 for which a cause was not determined occurred within the natal area. Causes of mortality among bald eagles from suburban nest sites included electrocution (n = 2), vehicle collisions (n = 2), secondary poisoning from predator control efforts (n = 1), disease (n = 2, 1 from a Chlamydial infection and 1 unknown), and unknown factors (n = 4 – 9, depending on the classification of 5 bald eagles of uncertain fate). Only 1 of these deaths occurred in the natal area (Chlamydial infection). We classified 6 of 7 suburban bald eagle deaths of known cause as human-related, compared to 0 of 4 rural bald eagle deaths. The cause of death was not independent of land-use category (Yates corrected χ^2_1 = 4.48, P = 0.03), leading us to conclude suburban bald eagles more often died from human-related causes than rural bald eagles.

Estimating Health and Condition of Bald Eagle Fledglings

In 2000, 13 of the 14 eaglets handled were in good to excellent body condition (Appendix C). All 7 of the chicks from rural nest sites and 6 of the 7 from suburban nest sites appeared healthy at initial handling. The single suburban eaglet that was in poor health died 3 weeks after it was handled. Necropsy revealed that this bird had a severe pericarditis and histology indicated that the infection was most likely caused by *Chlamydia psittaci.* In 2001, 17 of the 18 eaglets handled were in good to excellent body condition. All 9 of the chicks from suburban nest sites and 8 of the 9 from rural nest sites appeared healthy at initial handling. The rural eaglet that appeared in poor health subsequently fledged and dispersed normally. In all cases, healthy birds all had well-developed breast musculature and adequate body weights for their age and sex. Over both years, stress marks and retained feather sheaths were noted on the feathers of 3 of the 32 eaglets handled, 2 from rural nest sites 1 from a suburban nest site.

External parasites were observed on 12 of the 14 eaglets in 2000, and 15 of 18 eaglets in 2001. The most commonly observed parasite was a feather louse (*Mallophaga* spp.), which was detected on 15 of 16 rural eaglets and 12 of 16 suburban eaglets. No blood parasites were microscopically observed in blood slides from any of the eaglets from either the rural or suburban nests.

Serologic evidence of *Aspergillosis* spp. exposure was revealed in 12 of the 14 eaglets in 2000, and 8 of the 18 eaglets in 2001. Combining both years, 12 of 16 suburban eaglets demonstrated positive serological responses, compared to 8 of the 16 rural eaglets. This difference is not statistically significant (Yates corrected $\chi^2_1 = 1.20$, $P = 0.27$). Overall, 15 of the 32 eaglets PTT-tagged in 2000 and 2001 revealed a pattern of response that would indicate that they had been exposed to *Aspergillus*, but were probably not currently infected, and 3 of 16 suburban eaglets and 2 of 16 rural eaglets had test results that showed they probably were currently infected. Two of the 18 eaglets, both from a rural nest, had test results that were inconclusive.

Population Trend Predictions

We used data reported earlier in this paper to estimate population-specific input parameters for nest site occupancy, nest success, brood size at 8 weeks of age, and age-specific survival for Vortex models. With these input data, at carrying capacity and assuming only 40% of adults successfully nested annually, mean *r* was 0.06 (SE = 0.0001) for rural and 0.04 (SE = 0.0001) for suburban population models. Assuming populations were at 50% of carrying capacity and 80% of adults successfully nested annually, mean *r* = 0.12 (SE = 0.009) for rural and 0.09 (SE = 0.0009) for suburban population models. No populations went extinct in any simulation, and all populations remained stable at carrying capacity.

DISCUSSION

Nesbitt (2001) reported that statewide in Florida from 1991 to 2000, bald eagle nest success averaged 74.1%, with 1.15 young fledged per occupied and 1.54 per successful nest site. The Southeastern States Bald Eagle Recovery Plan (U. S. Fish and Wildlife Service 1989) established bald eagle recovery criteria of 50% nest success, an average of 0.9 young fledged per occupied nest site, and an average of 1.5 young fledged per successful nest site. Both suburban and rural nest sites on our study area substantially exceeded both the statewide averages and recovery benchmarks for each of these variables, indicating bald eagles were reproducing at healthy levels in west central Florida.

We detected no differences in nest site occupancy, nest success, or number of young fledged between bald eagles occupying suburban or rural nest sites, except that the onset of nesting varied inversely between nests in the different land-use categories. There is a strong correlation for some species of raptors between early nesting and high nest success (Newton 1979), and this pattern has been reported for west central Florida bald eagles (Broley 1947). Prey availability is positively correlated with early nesting in some raptors (Newton and Marquiss 1981, Dijkstra et al. 1982), and we suspect this might account for the variation we observed. If so, the inverse pattern of variation among years in the onset of nesting between bald eagles in the different land-use categories could reflect differences in diet between suburban and rural bald eagle pairs. We are currently evaluating prey remains collected from suburban and rural nest sites over the course of this study to determine if a detectable difference in diet exists. Regardless of the causal mechanism, our results suggest there was a strong advantage to starting nesting early, because fledgling bald eagles from early nests had higher survival than those fledged from late nests.

Three other recent studies have estimated survival rates of bald eagles from eastern North America. McCollough (1986), using band re-sighting data, estimated survival of Maine bald eagles at 74% to 1.5 years of age, and 84% between 1.5 and 2.5 years. Buehler et al. (1991) estimated survival from a VHF radio-tagged sample of eagles from the Chesapeake Bay at 100% to 1.5 years and 92% from 1.5 to 2.5 years of age. Wood and Collopy (1995) estimated survival of VHF radio-tagged bald eagles from a rural north central Florida study area at 63% to 1.5 years, and 84% from 1.5 to 2.5 years. Data from our study are within the range of results reported here, although it is important to consider that PTTs provided more complete histories of survival than was possible in any of the previous studies.

Maine and Florida bald eagles showed a generally increasing trend in annual survival with age (McCollough 1986, Wood and Collopy 1995), which corresponds to the pattern we observed in our data. During the first year, most mortality we observed in PTT-tagged bald eagles occurred during or between the first northward and first southward return migrations. Wood and Collopy (1995) also observed the greatest mortality in their sample of radio-tagged eagles at this time, and it seems reasonable to conclude this is the time when Florida bald eagles are at their greatest risk.

Bald eagles from suburban and rural nest sites in our study had similar survival rates until they dispersed. Subsequently, and over the next 9 months, eagles from suburban nest sites experienced considerably higher mortality. Significantly, humans were either directly or indirectly involved in all but 1 of the deaths of suburban bald eagles for which a cause could be determined. In contrast, the limited mortality of fledglings from rural nests sites we observed occurred largely prior to dispersal, and no rural eagles for which a cause of death could be determined died from human causes. There is no clear explanation for this disparity, but it suggests suburban bald eagle fledglings may have been more acclimated to dangerous anthropogenic landscape features than rural eagles, and as such did not regard them with the same degree of caution once independent.

Health screenings revealed no consistent differences in condition between bald eagle nestlings from suburban or rural nest sites. Perhaps the most significant finding was the discovery of a Chlamydial infection in 1 suburban fledgling. Free-ranging native birds in Florida are not known to carry Chlamydial infections, and while this disease has been reported in other raptors, the condition is rare in free-ranging bald eagles (Heidenreich 1997). The disease is relatively common in psittacine birds and finches held in captivity for the pet bird industry (Friend 1987, Brand 1989). High concentrations of this organism can be shed in the excreta of infected birds, leading to the most common route of transmission to other birds through aerosol inhalation or ingestion of infected fecal material (Brand 1989). Studies have revealed transmission can also occur through the consumption of infected carcasses and by arthropod vectors such as lice and mites (Brand 1989). In our study, the Chlamydial infection was most likely caused by a cross-species transmission from non-native monk parakeets (*Myiopsitta monachus*) that formed a nesting and roosting colony in a tree adjacent to this eagle's nest. Because monk parakeets are established only in urban and suburban areas in Florida (Robertson and Woolfenden 1992), this mortality agent primarily threatens suburban eagles.

Habitat guidelines for the protection of bald eagle nest sites in Florida prescribe protective buffer zones around Florida bald eagle nests of at least 227 m (U.S. Fish and Wildlife Service 1987). All suburban bald eagle nests in this study had human structures or significant human activity at closer distances than this. Tinkler (2000) compared habitat use, feeding rates, ranging behavior, and adult attentiveness in a sample of the PTT-tagged rural and suburban bald eagles that comprised our study population. She found no consistent differences in any of these behavioral factors between the 2 groups, but noted that both suburban and rural fledglings tended to spend most of their time in the part of the natal area that was least subject to disturbance. Given the absence of significant differences in fledging success, body condition, and pre-dispersal survival between suburban and rural bald eagles, it is tempting to conclude freedom from disturbance, while perhaps a preference, is not a necessity for successful nesting by bald eagles on our study area. It is important to note, however, that we were unable to ascertain the histories of many of the suburban nest sites in our study, thus it was not possible to distinguish between sites where eagles voluntarily built nests in developed areas as opposed to sites where development encroached on a previously established nest site. Intuitively, we suspect bald eagles in the latter category are more likely to respond negatively to disturbance, and we caution that our results and those of Tinkler (2000) might not be generally applicable to all bald eagle nest sites on the study area.

MANAGEMENT IMPLICATIONS

Our results paint a generally optimistic picture for the future of west central Florida bald eagles. The demographic characteristics we observed would be expected to yield steady positive population growth, and in the absence of catastrophes, bald eagle populations on this study area are likely limited only by the carrying capacity of the environment.

The most significant population limiting environmental factor in west central Florida is probably suitable nesting sites. However, perhaps in response to building bald eagle population pressure, eagles are expanding in their choice of nest substrates on our study area, as evidenced by the 8 nests we observed on human-made structures. We expect this trend to continue. The increasing use of human-made nest substrates by bald eagles raises important regulatory questions, because current protective federal statutes prohibit the removal or moving of bald eagle nest structures (U.S. Fish and Wildlife Service 1987). Some management flexibility in this regard is critical for the protection of both bald eagles and operating equipment for some of the nests on human-made structures we observed. In most cases, both the eagles and equipment operators would be better served if the nests could be relocated from their present location to safer platforms appended to the tower or pole.

Although we detected no negative ramifications of increased human disturbance in our estimates of demographic variables for suburban bald eagles, Tinkler's (2000) work indicates refuges from human activity are actively sought out and used by suburban eagles. Accordingly, suburban planners, particularly in suburban areas where bald eagles already occur, should consider this in the design of developments. In many cases, these refuges could be accommodated in greenspaces set aside for other purposes, but they would be most beneficial if human entry was prohibited while bald eagles were nesting, especially during the post-fledgling period. Tinkler's (2000) results suggest suburban bald eagle refuges should be within 455 m, and preferably within 227 m, of occupied or potential nest sites, and contain numerous suitable bald eagle perch trees (especially large pines interspersed with scatted snags).

Among the mortality factors we documented in this study, 3 warrant continued or increased management attention. Electrocution has long been known as a mortality factor for bald eagles, and despite considerable corrective attention (APLIC 1996), it was 1 of 2 leading causes of death for suburban bald eagles in this study. Methods to resolve raptor electrocution hazards are well known for nearly all types of power distribution structures (APLIC 1996). Our results suggest this problem has not been satisfactorily resolved in Florida (where all the electrocutions we observed occurred), and we recommend representatives of the utility industry, the FWC, and the U.S. Fish and Wildlife Service begin discussions on how best to proceed to address the issue. A second mortality issue that warrants attention is the transmission of Chlamydial infection to suburban eagles by monk parakeets. Monk parakeets interact with bald eagles in suburban environments because eagle nest structures are used for nesting and roosting by the parakeets. Where feasible, consideration should be given to eradication of parakeet flocks that are using eagle nest structures to reduce exposure to this disease by bald eagles. Finally, our study documents that secondary impacts from predator control operations pose a risk to bald eagles in the Southeast. One bald eagle in this study died after eating an opossum (*Didelphis virginiana*) that consumed a Carbofuran-laced chicken egg that was purposely placed to attract and kill northern bobwhite (*Colinus virginianus*) nest predators (FWC, Division of Law Enforcement, Tallahassee, Florida, personal communication). Subsequent law enforcement investigation revealed that this illegal activity was occurring on at least 2 north Florida properties, and throughout southwestern Georgia. The practice was curtailed following enforcement action by the FWC Division of Law Enforcement and the Georgia Bureau of Investigation (FWC, Division of Law Enforcement, Tallahassee, Florida, personal communication). This incident highlights the importance of monitoring to ensure predator control operations, when necessary, are conducted in a responsible and controlled manner.

We urge caution in the application of our findings to the question of the need for protective measures to minimize human disturbance at bald eagle nest sites. The principle application of our work is in establishing the population-level significance of suburban bald eagle pairs. That some eagles can and do successfully co-exist with intense human activity does not mean that all can. Further work is needed to better define general levels of acceptance of human activity by nesting Florida bald eagles in today's landscape, and that knowledge should be used to evaluate and fine-tune regulations and policies governing the protection of nest sites.

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Table 1. Occupancy, success, and productivity of bald eagle nest sites in west-central Florida by proximity to coast and land-use category for the 1994, 1995, and 1996 breeding seasons. Data are from the Florida Fish and Wildlife Conservation Commission (FWC) bald eagle monitoring project (S. Nesbitt, Florida Fish and Wildlife Conservation Commission, Gainesville, Florida, personal communication).

	n[a]	Occupancy 0 (SD)[b]	Success 0 (SD)[c]	Brood Size 0 (SD)[d]
a) Proximity to coast				
Interior	40	2.65 (0.58)	2.13 (0.97)	4.03 (1.38)
Coastal	10	2.70 (0.48)	2.10 (0.99)	4.11 (1.69)
b) Land-use category				
Rural	21	2.86 (0.36)	2.19 (0.98)	3.57 (1.78)
Intermediate	16	2.38 (0.72)	2.00 (0.82)	3.44 (1.93)
Suburban	13	2.69 (0.48)	2.15 (1.14)	3.69 (2.14)

[a] *n* = number of nest sites. Nest sites that were not monitored for the full 3 breeding seasons were excluded from the analysis.

[b] Occupancy is the total number of nesting seasons (maximum = 3) in which the nest site was known to be occupied by at least 1 bald eagle in adult plumage.

[c] Success is the total number of nesting seasons (maximum = 3) in which an occupied nest site had young in the nest on the second annual nest survey flight.

[d] Brood size is the sum over the 3 years of the total number of young seen in the nest on the second annual nest survey flight.

Table 2. Comparison of estimated laying date and productivity of focal suburban and rural bald eagle nest sites, west-central Florida, 1997 - 2001. Values in the table are mean (SD, *n*).

Category	Start day[a]	No. young per occupied nest site[b]	No. young fledged per successful nest site[c]
Suburban			
1996-97	11/26/96 (26.0, 12)	1.91 (0.67, 12)	1.91 (0.67, 12)
1997-98	12/16/97 (39.2, 12)	1.33 (0.89, 12)	1.78 (0.44, 9)
1998-99	11/28/99 (26.7, 8)	1.08 (0.90, 12)	1.67 (0.50, 8)
1999-00	12/25/99 (30.3, 9)	1.25 (0.97, 12)	1.67 (0.71, 9)
2000-01	12/17/00 (24.3, 10)	1.08 (0.67, 12)	1.30 (0.48, 10)
0	12/11 (30.8, 51)	1.33 (0.86, 60)	1.67 (0.60, 48)
Rural			
1996-97	12/16/96 (17.5, 12)	1.42 (0.67, 12)	1.55 (0.52, 11)
1997-98	12/16/97 (25.6, 8)	1.00 (1.04, 12)	2.00 (0, 6)
1998-99	12/24/98 (13.9, 6)	1.25 (0.87, 12)	1.63 (0.52, 9)
1999-00	12/07/99 (12.9, 9)	1.25 (0.97, 12)	1.67 (0.71, 9)
2000-01	12/23/00 (22.5, 12)	1.58 (0.52, 12)	1.58 (0.52, 12)
0	12/15 (19.3, 51)	1.31 (0.83, 60)	1.67 (0.52, 48)
Pooled	12/13 (26, 101)	1.32 (0.84, 120)	1.67 (0.56, 96)

[a] Estimated date when incubation started, based on observations from bi-weekly overflights, and adjusted for estimated age of young if handled for radio-tagging.

[b] Number of young that survived to ≥ 8 weeks of age per occupied nest site.

[c] Number of young that survived to ≥ 8 weeks of age per successful nest site.

Table 3. Interval survival estimates for bald eagles from rural and suburban nest sites tagged with satellite transmitters at approximately 8 weeks of age in west central Florida, 1997 – 2001. The exact fates of 5 bald eagles were uncertain, so they are treated 2 ways in the analysis. In the Uncertains Censored estimates, they are treated as transmitter failures and censored. In the Uncertains Dead estimate, they are treated as if they died the date transmissions became suspect. Survival is the proportion of eagles at risk at the start of the interval (*n*) that remained alive at the end.

Interval		Suburban	Rural	Pooled
<u>Uncertains censored</u>				
Fledge - dispersal				
	Survival	0.94	0.88	0.91
	SD	0.07	0.05	0.03
	n	30	30	60
Fledge - 1 year				
	Survival	0.76	0.88	0.82
	SD	0.09	0.07	0.06
	n	19	20	39
1 year - 2 year				
	Survival	0.92	0.92	0.92
	SD	0.07	0.08	0.06
	n	12	20	22

Uncertains dead			
Fledge – dispersal			
Survival	0.83	0.88	0.86
SD	0.06	0.05	0.04
n	35	30	65
Fledge - 1 year			
Survival	0.67	0.88	0.76
SD	0.09	0.07	0.06
n	19	20	39
1 year - 2 year			
Survival	0.92	0.92	0.92
SD	0.07	0.08	0.06
n	12	10	22

Appendix A. Estimated laying date and productivity of study suburban and rural bald eagle nest sites in west central Florida, 1997 - 2001. Nest sites were randomly selected each year from the pool of all nest sites that had been occupied the preceding year.

Nest Number	Land-use category	Year	Laying date	No. fledged
HL-06D	Rural	96-97	01/02/97	2
HL-16	Rural	96-97	12/02/96	1
MN-02B	Rural	96-97	?	2
MN-06B	Rural	96-97	12/16/96	2
MN-07	Rural	96-97	?	0
MN-08	Rural	96-97	01/11/97	2
MN-10	Rural	96-97	11/14/96	2
MN-11A	Rural	96-97	12/27/96	1
PI-21	Rural	96-97	11/28/96	2
SA-04A	Rural	96-97	12/14/96	1[a]
SA-18A	Rural	96-97	12/27/96	1[b]
SA-New	Rural	96-97	12/20/96	1[b]
CH-18A	Rural	97-98	None	0
HL-09C	Rural	97-98	11/21/97	0
HL-11A	Rural	97-98	?	0
HL-22A	Rural	97-98	12/23/97	2

LE-09	Rural	97-98	11/25/97	2
LE-19A	Rural	97-98	11/21/97	0
LE-39	Rural	97-98	01/27/98	0
MN-11A	Rural	97-98	12/26/97	2
HL-11A	Rural	97-98	?	0
PO-37C	Rural	97-98	01/23/98	2
PO-65A	Rural	97-98	12/11/97	2
PO-66	Rural	97-98	12/03/97	2
CH-02	Rural	98-99	12/5/98	0
CH-28A	Rural	98-99	11/20/98	2
HL-22A	Rural	98-99	12/20/98	1
LE09B	Rural	98-99	12/6/98	2
LE-28A	Rural	98-99	12/20/98	2
MN-07	Rural	98-99	None	0
MN-13	Rural	98-99	12/07/98	2
PI-21	Rural	98-99	12/5/98	2
PO-11	Rural	98-99	None	0
PO-48	Rural	98-99	12/05/98	2
PS-05	Rural	98-99	1/9/99	1
SA-04A	Rural	98-99	12/31/98	1

PO-41	Rural	99-00	11/22/99	1
CH-02	Rural	99-00	12/16/99	3
CH-26	Rural	99-00	None	0
CH-08	Rural	99-00	12/02/99	2
MN-07	Rural	99-00	None	0
PO-124	Rural	99-00	12/10/99	2
LE-24B	Rural	99-00	12/16/99	2
PO-123	Rural	99-00	12/23/99	2
MN-12	Rural	99-00	?	0
HL-9C	Rural	99-00	11/23/99	1
PO-39B	Rural	99-00	11/23/99	1
MN-6B	Rural	99-00	12/23/99	1
MN-10	Rural	00-01	02/16/01	1
PO-45B	Rural	00-01	12/13/00	2
CH-08B	Rural	00-01	12/01/00	2
SA-06D	Rural	00-01	12/08/00	2
PO-126A	Rural	00-01	12/20/00	2
PO-37C	Rural	00-01	01/10/01	2

MN-06B	Rural	00-01	01/06/01	2
SA-15A	Rural	00-01	12/20/00	1
MN-08	Rural	00-01	12/23/00	1
PO-48	Rural	00-01	11/24/00	2
PO-124	Rural	00-01	12/20/00	1
LE-25B	Rural	00-01	12/04/00	1
HL-20	Suburban	96-97	12/05/96	2
HL-24	Suburban	96-97	11/14/96	2
MN-01E	Suburban	96-97	11/06/96	3
PI-07H	Suburban	96-97	11/25/96	2
PI-13D	Suburban	96-97	11/11/96	2
PI-19A	Suburban	96-97	12/29/96	2
PI-20A	Suburban	96-97	11/28/96	2
PI-22B	Suburban	96-97	11/21/96	3
SA-01B	Suburban	96-97	10/28/96	2
SA-07B	Suburban	96-97	10/31/96	1
SA-19	Suburban	96-97	12/16/96	1
SA-20	Suburban	96-97	01/23/97	1
CH-29B	Suburban	97-98	11/14/97	0

CH-30B	Suburban	97-98	11/25/97	2
LE-06G	Suburban	97-98	12/28/97	2
LE-027	Suburban	97-98	12/05/97	2
MN-01E	Suburban	97-98	11/28/97	2
PI-07G	Suburban	97-98	12/15/97	0
PI-13D	Suburban	97-98	03/27/98	2
PI-19A	Suburban	97-98	12/21/97	1
PS-02	Suburban	97-98	01/20/98	2
SA-01B	Suburban	97-98	11/21/97	1
SA-05B	Suburban	97-98	11/10/97	2
SA-20	Suburban	97-98	None	0
CH-05A	Suburban	98-99	11/5/98	2
CH-30C	Suburban	98-99	11/20/98	1
LE-06G	Suburban	98-99	12/31/98	1
LE-27	Suburban	98-99	12/13/98	2
LE-35	Suburban	98-99	10/25/98	1
LE-36A	Suburban	98-99	None	0
PI-07	Suburban	98-99	12/2/98	2
PI-13	Suburban	98-99	11/6/98	2
PI-22B	Suburban	98-99	None	0

PS-02	Suburban	98-99	None	0
SA-07C	Suburban	98-99	1/5/99	2
SA-19	Suburban	98-99	None	0
PI-13D	Suburban	99-00	02/17/00	2
PI-20A	Suburban	99-00	12/02/99	2
SA-20	Suburban	99-00	02/03/00	2
PI-19	Suburban	99-00	12/30/99	1
LE-36	Suburban	99-00	12/09/99	2
LE-27	Suburban	99-00	?	0
PS-02	Suburban	99-00	None	0
CH-30C	Suburban	99-00	None	0
CH-05	Suburban	99-00	01/09/00	1
HL-24	Suburban	99-00	12/09/99	3
MN-01E	Suburban	99-00	12/02/99	1
CH-29B	Suburban	99-00	11/23/99	1
LE-06I	Suburban	00-01	01/06/01	2
PO-67B	Suburban	00-01	01/13/01	1
CH-19A	Suburban	00-01	12/04/00	2

SA-05B	Suburban	00-01	11/17/00	1
PI-13E	Suburban	00-01	12/08/00	1
PI-19A	Suburban	00-01	None	0
HL-24A	Suburban	00-01	None	0
SA-07A	Suburban	00-01	12/08/00	1
PI-07H	Suburban	00-01	12/23/00	1
HL-20A	Suburban	00-01	01/26/01	2
SA-01B	Suburban	00-01	11/17/00	1
HL-23A	Suburban	00-01	11/27/00	1

[a] The lone eaglet in this nest sustained a fractured tibio-tarsus while being handled for radio-tagging. During subsequent treatment of that fracture, other fractures developed. The eaglet was determined at necropsy to be severely malnourished. Because the eaglet would likely have survived another 1.5 weeks in the nest to reach fledging age, we have counted it here as a fledgling.

[b] Various factors prevented us from returning to these nests to ascertain the number of young that fledged. Numbers given are best estimates based on brood size on the last visit.

Appendix B. Estimated dispersal dates, mortality dates, and causes of mortality of PTT-tagged nestling bald eagles from the west central Florida study area, 1997 - 2001 breeding seasons.

PTT	Sex	Nest Category	Laying date	Dispersal date	Mortality date (cause)	PTT Status
28112	F	Rural	12/02/96	05/12/97		Failed 04/23/97
N/A	F	Rural	12/14/96	----	03/20/97 (starvation)	----
28116	F	Rural	12/27/96	06/20/97		Failed 01/04/99
28111	F	Rural	01/06/97	06/14/97		Failed 07/21/97
28113	F	Rural	12/11/97	05/15/98		Active
02217	M	Rural	12/12/97	05/28/98	05/04/99 (unknown)	----
03543	F	Rural	12/26/97	06/13/98		Active
02216	F	Rural	12/26/97	----	05/03/98 (storm/trauma)	----
28118	U	Rural	01/25/98	----	03/30/98 (disease)	----
28110	F	Rural	01/29/98	05/29/98		Active
13167	F	Rural	12/06/98	05/21/99		Active
01439	F	Rural	12/06/98	05/26/99		Active
13487	M	Rural	12/06/98	05/08/99		Active
13494	F	Rural	12/12/98	05/17/99		Active
13520	F	Rural	12/12/98	05/13/99		Active
03567B	M	Rural	12/12/98	05/21/99		Failed 03/03/00
28106B	M	Rural	12/20/98	----	05/13/99 (starvation)	----
28112B	M	Rural	12/31/98	05/27/99		Active
28107B	M	Rural	01/09/99	06/11/99		Active
24984	M	Rural	12/04/99	05/17/00		Active

24978	U	Rural	12/05/99	05/16/00		Active
24981	M	Rural	12/10/99	05/13/00		Active
24982	F	Rural	12/11/99	05/24/00		Presumed failed 05/26/01
24980	M	Rural	12/12/99	05/21/00		Active
28106c	F	Rural	12/16/99	05/24/00		Active
28109b	M	Rural	12/23/99	05/19/00		Active
01438C	F	Rural	12/11/00	05/11/01		Active
12558B	F	Rural	12/19/00	05/20/01		Active
22985	F	Rural	12/07/00	05/22/01		Active
22987	M	Rural	12/16/00	05/11/01		Active
22988	F	Rural	01/02/01	06/02/01		Active
22990	F	Rural	01/04/01	06/02/01		Active
22991	F	Rural	11/14/00	05/16/01		Active
22992	F	Rural	12/18/00	05/20/01		Active
28110B	F	Rural	01/13/01	06/26/01		Active
28107	M	Suburban	11/14/96	04/26/97		Failed 04/27/97
28108	M	Suburban	11/25/96	05/31/97		Failed 06/15/97
28106	F	Suburban	12/05/96	05/24/97		Failed 04/24/97
28109	F	Suburban	12/21/96	06/01/97		Failed 10/02/97
28115	M	Suburban	11/10/97	05/23/98		Active
28114	F	Suburban	11/21/97	05/05/98	01/01/01 (unknown)	----
28117	F	Suburban	11/28/97	05/21/98		Active
28119	M	Suburban	12/13/97	05/29/98		Active
03558	M	Suburban	12/21/97	05/24/98	08/30/98 (shot or trapped)	----

03567	F	Suburban	12/28/97	06/17/98	06/27/98 (electrocution)	----
03542	F	Suburban	10/25/98	04/10/99		Failed 10/12/99
13498	F	Suburban	11/06/98	05/11/99		Active
03557	M	Suburban	11/06/98	05/18/99	07/16/00 (hit by car)	----
12558	M	Suburban	12/11/98	05/11/99	10/04/99 (unknown)	----
13490	M	Suburban	12/13/98	05/18/99		Active
13510	M	Suburban	12/13/98	06/23/99	10/99 (unknown)	----
01438	F	Suburban	12/31/98	05/29/99	07/29/99 (poisoned)	----
02216B	F	Suburban	12/31/98	07/08/99	09/20/99 (electrocution)	----
28118B	F	Suburban	01/24/99	07/01/99		Active
24986	F	Suburban	12/06/99	06/08/00		Active
24977	F	Suburban	12/09/99	05/09/00		Active
24985	M	Suburban	12/09/99	06/09/00		Active
24983	M	Suburban	12/09/99	04/15/00		Active
24979	F	Suburban	12/11/99	06/27/00		Active
28108b	M	Suburban	12/19/99	05/05/00		Active
01438b	M	Suburban	12/30/99	----	04/10/00 (Chlamydial infection)	----
02216C	F	Suburban	12/06/00	05/11/01		Active
03557B	F	Suburban	01/03/01	06/02/01		Active
22986	M	Suburban	12/19/00	--	?	Unknown as of 04/18/01
22989	F	Suburban	11/18/00	05/03/01	?	Unknown as of 05/20/01

22993	M	Suburban	12/08/00	05/18/01		Active
22994	F	Suburban	11/22/00	--	?	Unknown as of 06/01/01
22995	F	Suburban	12/01/00	04/01/01	?	Unknown as of 06/08/01
22996	F	Suburban	11/03/00	04/24/01		Active
22997	F	Suburban	12/23/00	06/19/01		Active

Appendix C. Individual health profiles of nestling bald eagles from west central Florida bald eagle nests, 2000 - 2001 breeding seasons. Headings indicate nest site and PTT number.

SA-05B, 28108B, Suburban nest. Handled on 2/08/00. This 3100 gram eaglet, the only chick in the nest, was estimated to be 6 2 weeks old and appeared in good body condition and health. No abnormal findings were noted on the physical examination. There was a moderate lice infestation. No blood parasites were microscopically observed. The *Aspergillus* antibody test revealed a moderate positive response while the antigen test was negative. This would indicate that the eaglet was exposed to *Aspergillus* but is probably not currently infected. A mild to moderate increase in gamma globulins was present which probably indicated an active humoral immune response.

CH-29B, 24983, Suburban nest. Handled on 2/16/00. This 3200 gram eaglet, 1 of 2 chicks in the nest, was estimated to be 7-7 2 weeks old and appeared in good condition and health, although slightly thin. Physical exam noted a 0.5 cm superficial laceration of the left outer talon pad. There was a moderate lice infestation. No blood parasites were microscopically observed. The *Aspergillus* antibody test revealed a moderate positive response while the antigen test was negative. This would indicate that the eaglet was exposed to *Aspergillus* but is probably not currently infected.

PO-119A, 24986, Suburban nest. Handled on 2/28/00. This 3400 gram eaglet, was estimated to be 7 weeks old and appeared in good body condition and health. No abnormal findings were noted on the physical examination. There was a moderate lice infestation. No blood parasites were microscopically observed. The *Aspergillus* antibody test revealed a moderate positive response while the antigen test was negative. This would indicate that the eaglet was exposed to *Aspergillus* but is probably not currently infected

LE-35, 24979, Suburban nest. Handled on 3/2/00. This 3950 gram eaglet, the only chick in the nest, was estimated to be 10 2 weeks old and appeared in excellent body condition and health. Physical exam revealed a slight lesion on the corner of the right eye. There was a mild lice infestation. No blood parasites were microscopically observed. The *Aspergillosis* antibody test revealed a moderate positive response and the antigen test was positive. This would indicate that the eaglet was exposed to *Aspergillus* and could be currently infected. A mild increase in gamma globulins was present which probably indicated an active humoral immune response.

LE-36A, 24985 , Suburban nest. Handled on 3/2/00. This 3150 gram eaglet, 1 of 2 chicks in the nest, was estimated to be 6 2 weeks old and appeared in good body condition and health. No abnormal findings were noted on the physical examination. There was a moderate lice infestation. No blood parasites were microscopically observed. The *Aspergillus* antibody test revealed a strong positive response while the antigen test was positive. This would indicate that the eaglet was exposed to *Aspergillus* and could be currently infected.

HL-24A, 24977, Suburban nest. Handled on 3/3/00. This 2950 gram eaglet, 1 of 3 chicks in the nest, was estimated to be 8 weeks old and appeared in good body condition and health. No abnormal findings were noted on the physical examination. No external parasites were observed. No blood parasites were seen microscopically. The *Aspergillus* antibody test revealed a strong positive response while the antigen test was negative. This would indicate that the eaglet was exposed to *Aspergillus* but is probably not currently infected

PI-19A, 01438B, Suburban nest. Handled on 3/21/00. This 2500 gram eaglet, the only chick in the nest, was estimated to be 8 weeks old, appeared in poor body condition and health. Physical exam revealed the bird was extremely thin and had crusty material over the vent area. The animal was not able to hold itself up correctly. The feathers revealed stress marks. There was a mild lice infestation. No blood parasites were observed. The *Aspergillosis* antibody test revealed a strong positive response and the antigen test was positive. This would indicate that the eaglet was exposed to *Aspergillus* and could be currently infected. A mild to moderate increase in gamma globulins was present which probably indicated an active humoral immune response. This eaglet was found dead on 12 April 2000 near its nest. Necropsy revealed that this bird had a severe pericarditis. Histology indicated that the infection was most likely caused by *Chlamydia* sp. Free-ranging native birds in Florida are not known to carry this disease. Thus this organism was probably transmitted from non-native monk parakeets that have formed a colony in a tree nearby this eagle nest.

PO-124A, 24981 , Rural nest. Handled on 2/26/00. This 2850 gram eaglet, 1 of 2 chicks in the nest, was estimated to be 6 weeks old and appeared in good body condition and health. No abnormal findings were noted on the physical examination. There was a mild lice infestation. No blood parasites were microscopically observed. The *Aspergillus* antibody test revealed a strong positive response while the antigen test was negative. This would indicate that the eaglet was exposed to *Aspergillus* but is probably not currently infected. The A/G ratio was decreased due to increases in Alpha 2 and Beta globulins and this could reflect an underlying inflammatory process.

PO-125, 24984, Rural nest. Handled on 2/26/00. This 3000 gram eaglet, 1 of 2 chicks in the nest, was estimated to be 7 weeks old and appeared in good body condition and health. Physical examination reveal a small mammal claw/nail (0.3 cm) superficially imbedded in the skin over the foot. No external parasites were noted. No blood parasites were microscopically observed. The *Aspergillus* antibody test was negative and the antigen test was negative. This would indicate that no significant exposure to this organism has occurred.

HL-22A, 24978, Rural nest. Handled on 2/27/00. This 3350 gram eaglet, the only chick in the nest, was estimated to be 7 weeks old and appeared in good body condition and health. Physical exam revealed only a mild tracheal sound that was most likely from mucus being present in the area. There was a moderate lice infestation. No blood parasites were microscopically observed. The *Aspergillus* antibody test revealed a weak positive response while the antigen test was negative.   This would indicate that the eaglet was exposed to *Aspergillus* but is probably not currently infected

LE-21A, 24982, Rural nest. Handled on 3/1/00. This 4050 gram eaglet, 1 of 2 chicks in the nest, was estimated to be 6 2 weeks old and appeared in good body condition and health. Physical exam revealed small marked from dermestid beetles on the talon pads. There was a mild lice infestation. No blood parasites were microscopically observed. The *Aspergillus* antibody test was negative and the antigen test was negative.   This would indicate that the eaglet was exposed to *Aspergillus* but is probably not currently infected   A mild to moderate increase in gamma globulins was present which probably indicated an active humoral immune response.

CH-8B, 24980, Rural nest. Handled on 3/2/00. This 3100 gram eaglet, 1 of 2 chicks in the nest, was estimated to be 6 2 weeks old and appeared in good body condition and health.   Physical exam revealed moderate stress marks on the feathers. There was a moderate lice infestation. No blood parasites were microscopically observed. The *Aspergillus* antibody test revealed a strong positive response while the antigen test was negative.   This would indicate that the eaglet was exposed to *Aspergillus* but is probably not currently infected.

CH-2B, 28106C, Rural nest. Handled on 3/14/00. This 3900 gram eaglet, 1 of 3 chicks in the nest, was estimated to be 7 weeks old and appeared in good body condition and health. No abnormal findings were noted on the physical examination. There was a mild lice infestation. No blood parasites were microscopically observed. The *Aspergillus* antibody test was negative while the antigen test was positive. These results are inconclusive.

MN-6B, 28109B, Rural nest. Handled on 3/16/00. This 3250 gram eaglet, the only chick in the nest, was estimated to be 7 weeks old and in good body condition and health. Physical exam revealed fishing line tangled on the bird=s feet. This was removed and no trauma appeared have resulted. There was a moderate lice infestation. No blood parasites were microscopically observed. The *Aspergillus* antibody test revealed a weak positive response while the antigen test was negative.   This would indicate that the eaglet was exposed to *Aspergillus* but is probably not currently infected.

CH-19, 22995, Suburban nest.   Handled on 3/2/01.   This 3850 gram eaglet, 1 of 2 chicks in the nest, was estimated to be 8 weeks old and appeared to be in excellent body condition and health. Physical exam noted a fresh puncture wound on a distal left digit.   There was a mild lice infestation. No blood parasites were microscopically observed.   The *Aspergillus* antibody test was weakly positive while the antigen test was negative. This would indicate the eaglet was exposed to *Aspergillus* and is probably not currently infected.

CH-29B, 22996, Suburban nest. Handled on 2/6/01. This 4050 gram eaglet, 1 of 2 chicks in the nest, was estimated to be 8 ½ - 9 weeks old and appeared in excellent body condition and health. No abnormal findings were noted on the physical examination. Only a mild lice infestation was noted. No blood parasites were microscopically observed. The *Aspergillus* antibody test was negative while the antigen test was negative. This would indicate the eaglet is probably not currently infected.

There was a second chick in this nest (629-26541), which was not radio instrumented as part of this study, that also appeared in excellent body condition and health.

LE-27, 03557B, Suburban nest. Handled on 4/4/01. This 3700 gram eaglet, 1 of 2 chicks in the nest, was estimated to be 8 weeks old and appeared in excellent body condition and health. No abnormal findings were noted on the physical examination. There was a heavy lice infestation. No blood parasites were microscopically observed. The *Aspergillus* antibody test was weakly positive while the antigen test was negative. This would indicate the eaglet was exposed to *Aspergillus* and is probably not currently infected.

There was a second chick in this nest (629-23863), that was not radio instrumented as part of this study, which weighed 3050 grams and appeared in excellent body condition and health. No abnormal findings were noted on the physical examination. There was a heavy lice infestation. No blood parasites were microscopically observed. The *Aspergillus* antibody test was weakly positive while the antigen test was positive. This would indicate the eaglet was exposed to *Aspergillus* and is probably is currently infected. This bird was electrocuted before dispersal on a power pole near the nest. The carcass was retrieved by USFWS and is being held as evidence. Final necropsy report is pending.

LE-36A, 22994, Suburban nest. Handled on 2/28/01. This 3950 gram eaglet, 1 of 2 chicks in the nest, was estimated to be 10 weeks old and appeared in good body condition and health. No abnormal findings were noted on the physical examination, except that the chick exhibited behavior of moderate handling stress. Eaglet was taken to a local rehabilitation center for a more complete physical examination and returned that same afternoon to it's nest. There was a mild lice infestation. No blood parasites were microscopically observed. The *Aspergillus* antibody test was weakly positive while the antigen test was negative. This would indicate the eaglet was exposed to *Aspergillus* and is probably not currently infected.

PI-07H, 22997, Suburban nest. Handled on 3/24/01. This 3850 gram eaglet, the only chick in the nest, was estimated to be 8 weeks old and in excellent body condition and health. No abnormal findings were noted on the physical examination. There was a mild lice infestation. No blood parasites were microscopically observed. The *Aspergillus* antibody test was negative and the antigen test was negative. This would indicate the eaglet is probably not currently infected.

PO-119, 02216C, Suburban nest. Handled on 2/28/01. This 3800 gram eaglet, 1 of 2 chicks in the nest, was estimated to be 7 weeks old and appeared in good body condition and health. No abnormal findings were noted on the physical examination. There was a mild lice infestation. The nest was infested with fire ants. No blood parasites were microscopically observed. The *Aspergillus* antibody test was weakly positive while the antigen test was negative. This would indicate the eaglet was exposed to *Aspergillus* and is probably not currently infected. A mild increase in gamma globulins was present which probably indicated an early or waning humoral immune response.

<u>SA-05B, 22989,</u> Suburban nest. Handled on 2/7/01. This 3950 gram eaglet, the only chick in the nest, was estimated to be 6 - 6 ½ weeks old and appeared in excellent body condition and health. No abnormal findings were noted on the physical examination. There was a moderate lice infestation. No blood parasites were microscopically observed. The *Aspergillus* antibody test was moderately positive while the antigen test was negative. This would indicate the eaglet was exposed to *Aspergillus* but is probably not currently infected.

<u>SA-07, 22993,</u> Suburban nest. Handled on 3/11/01. This 3050 gram eaglet, the only chick in the nest, was estimated to be 6 weeks old and appeared in good body condition and health. An old healed wound was noted on the back of the right tarsus. There was a heavy parasite infestation. No blood parasites were microscopically observed. The *Aspergillus* antibody test was negative and the antigen test was negative. This would indicate the eaglet is probably not currently infected.

<u>SA-19, 22986,</u> Suburban nest. Handled on 3/10/01. This 3450 gram eaglet, 1 of 2 chicks in the nest was estimated to be 6.5 weeks old and appeared in good body condition and health. No abnormal findings were noted on the physical examination. There was a moderate lice infestation. No blood parasites were microscopically observed. The *Aspergillus* antibody test was negative while the antigen test was positive. The *Aspergillus* test results are inconclusive. An increase in alpha 2 globulins was present which may reflect an underlying acute inflammation.

<u>CH-08B, 01438C,</u> Rural nest. Handled on 3/2/01. This 3550 gram eaglet, 1 of 2 chicks in the nest, was estimated to be 6 ½ weeks old and appeared in poor body condition and health. The sheaths were retained on feathers and a sharp keel was prominent. The eaglet exhibited a marked stress response to handling by shuddering. No external parasites were observed on this eaglet. No blood parasites were microscopically observed. The *Aspergillus* antibody test was moderately positive while the antigen test was negative. This would indicate the eaglet was exposed to *Aspergillus* and is probably not currently infected. A moderate increase in gamma globulins was present which probably indicated an active humoral immune response.

<u>MN-06B, 22990,</u> Rural nest. Handled on 4/5/01. This 3050 gram eaglet, 1 of 2 chicks in the nest was estimated to be 8 weeks old and was in good physical condition and health. No blood parasites were microscopically observed. The *Aspergillus* antibody test was weakly positive while the antigen test was negative. This would indicate the eaglet was exposed to *Aspergillus* and is probably not currently infected.

There was a second chick in the nest (629-23864), which was not radio instrumented as part of this study, which weighed 3850 grams, and appeared in excellent body condition and health.

PO-48, 22985, Rural nest. Handled on 2/26/01. This 3500 gram eaglet weighed with it's transmitter, 1 of 2 chicks in the nest, was estimated to be 6 ½ - 7 weeks old and appeared to be in excellent body condition and health. No abnormal findings were noted on the physical examination. There were no external parasites observed on this eaglet. No blood parasites were microscopically observed. The *Aspergillus* antibody test was weakly positive while the antigen test was positive. This would indicate the eaglet was exposed to *Aspergillus* and is probably currently infected. A moderate increase in gamma globulins was present which probably indicated an active humoral immune response.

PO-65A, 22987, Rural nest. Handled on 3/21/01. This 3725 gram eaglet, 1 of 3 chicks in the nest, was estimated to be 8 ½ weeks old and appeared to be in excellent body condition and health. No abnormal findings were noted on the physical examination. There was a mild lice infestation. No blood parasites were microscopically observed. The *Aspergillus* antibody test was negative and the antigen test was negative. This would indicate the eaglet is probably not currently infected.

The second eaglet from this nest (629-23854), which was not radio instrumented as part of this study, weighed 3750 grams and appeared to be in excellent body condition and health. This eaglet had no abnormal findings were noted on the physical examination. There was a mild lice infestation. No blood parasites were microscopically observed. The *Aspergillus* antibody test was negative and the antigen test was positive. The *Aspergillus* test results are inconclusive.

A third eaglet from this nest (629-23855), which was also not radio instrumented as part of this study, weighed 2800 grams and appeared to be in excellent body condition and health. No abnormal findings were noted on the physical examination. There was a mild lice infestation. No blood taken was taken for analysis from this chick.

PO-124, 22992, Rural nest. Handled on 3/23/01. This 3400 gram eaglet, the only chick in the nest, was estimated to be 8 ½ weeks old and appeared in good body condition and health. A fresh puncture wound on the left wing was noted during physical examination. There was a heavy lice infestation. No blood parasites were microscopically observed. The *Aspergillus* antibody test was negative and the antigen test was positive. The *Aspergillus* test results are inconclusive. A mild to moderate in crease in beta globulins was present and reflective of acute inflamation.

PO-126A, 12558B, Rural nest. Handled on 3/20/01. This eaglet, 1of 2 chicks in the nest, was estimated to be 8 weeks old and appeared in good body condition and health. There was mild feather damage, most likely due to the heavy lice infestation. No blood parasites were microscopically observed. No fecal parasites were microscopically observed. The *Aspergillus* antibody test was negative and the antigen test was negative. This would indicate the eaglet is probably not currently infected. A mild increase in the alpha 1 globulins was present which probably indicated an acute inflammation.

<u>LE-25B, 22991,</u> Rural nest. Handled on 2/10/01. This 3950 gram eaglet, the only chick in the nest, was estimated to be 7 ½ weeks old and appeared to be in good body condition and health. No abnormal findings were noted on physical examination. There was a moderate lice infestation. No blood parasites were microscopically observed. The *Aspergillus* antibody test was negative and the antigen test was negative. This would indicate the eaglet is probably not currently infected.

<u>SA-34, 22988,</u> Rural nest. Handled on 4/7/01. This 3250 gram eaglet, was 1 of 2 chicks in the nest and was estimated to be 8 ½ to 9 weeks old and appeared to be in good body condition and health. There was a mild lice infestation. No blood parasites were microscopically observed. The *Aspergillus* antibody test was negative while the antigen test was positive. This *Aspergillus* test results are inconclusive. An increase in beta and gamma globulins were present and reflective of acute inflammation with stimulation of humoral immunity.

<u>PS-05, 28110B</u>, Rural nest. Handled on 3/31/01. This 3250 gram eaglet, the only chick in the nest, was estimated to be 6 weeks old and appeared to be in good body condition and health. No abnormal findings were noted on physical examination. There was a mild lice infestation. No blood parasites were microscopically observed. The *Aspergillus* antibody test was negative and the antigen test was negative. This would indicate the eaglet is probably not currently infected.

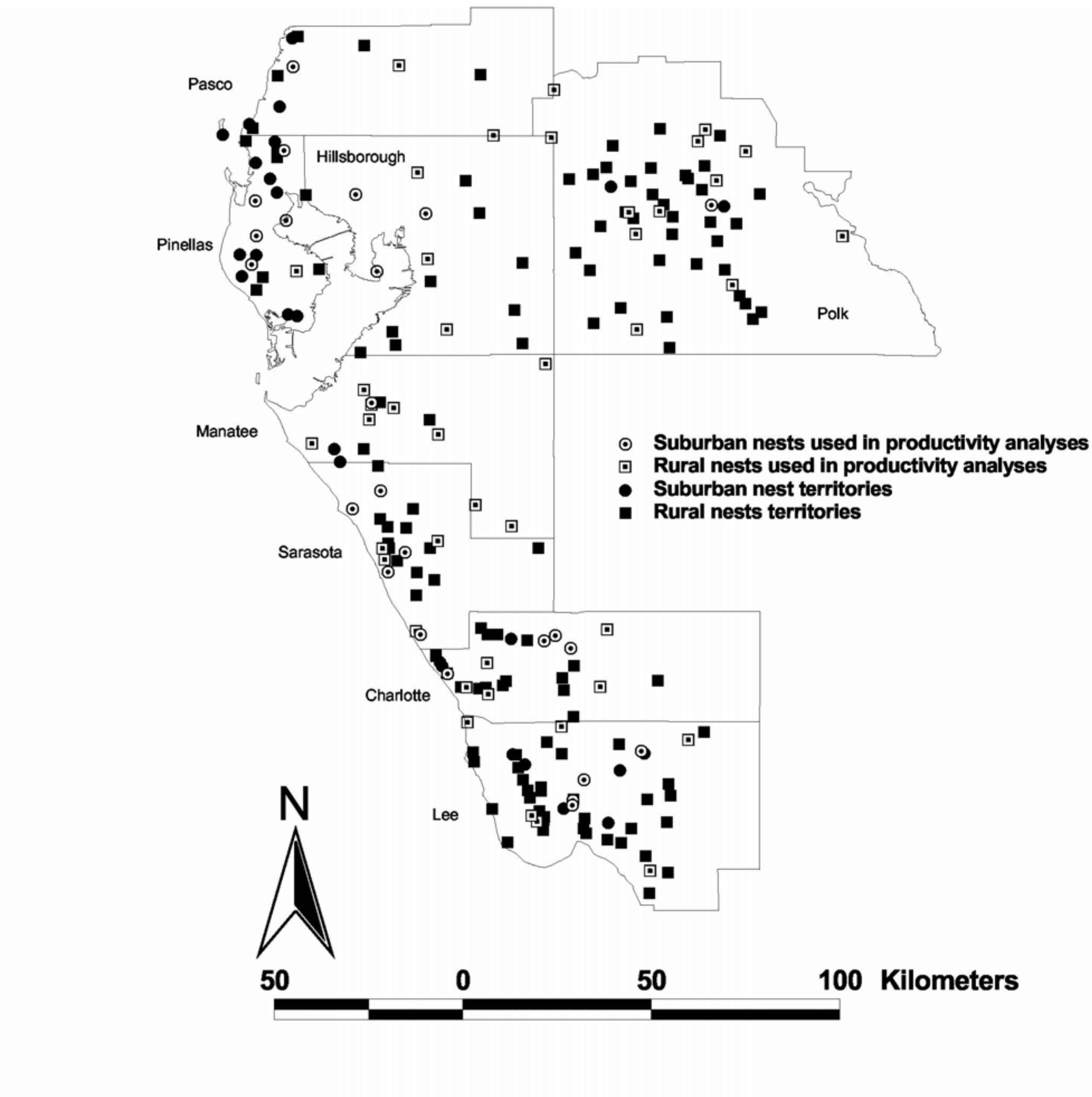


Figure 1. Map of the west central Florida study area where we investigated demographic characteristics of suburban and rural bald eagle subpopulations from 1997 - 2001. Lee and Pasco counties were added in 1998.

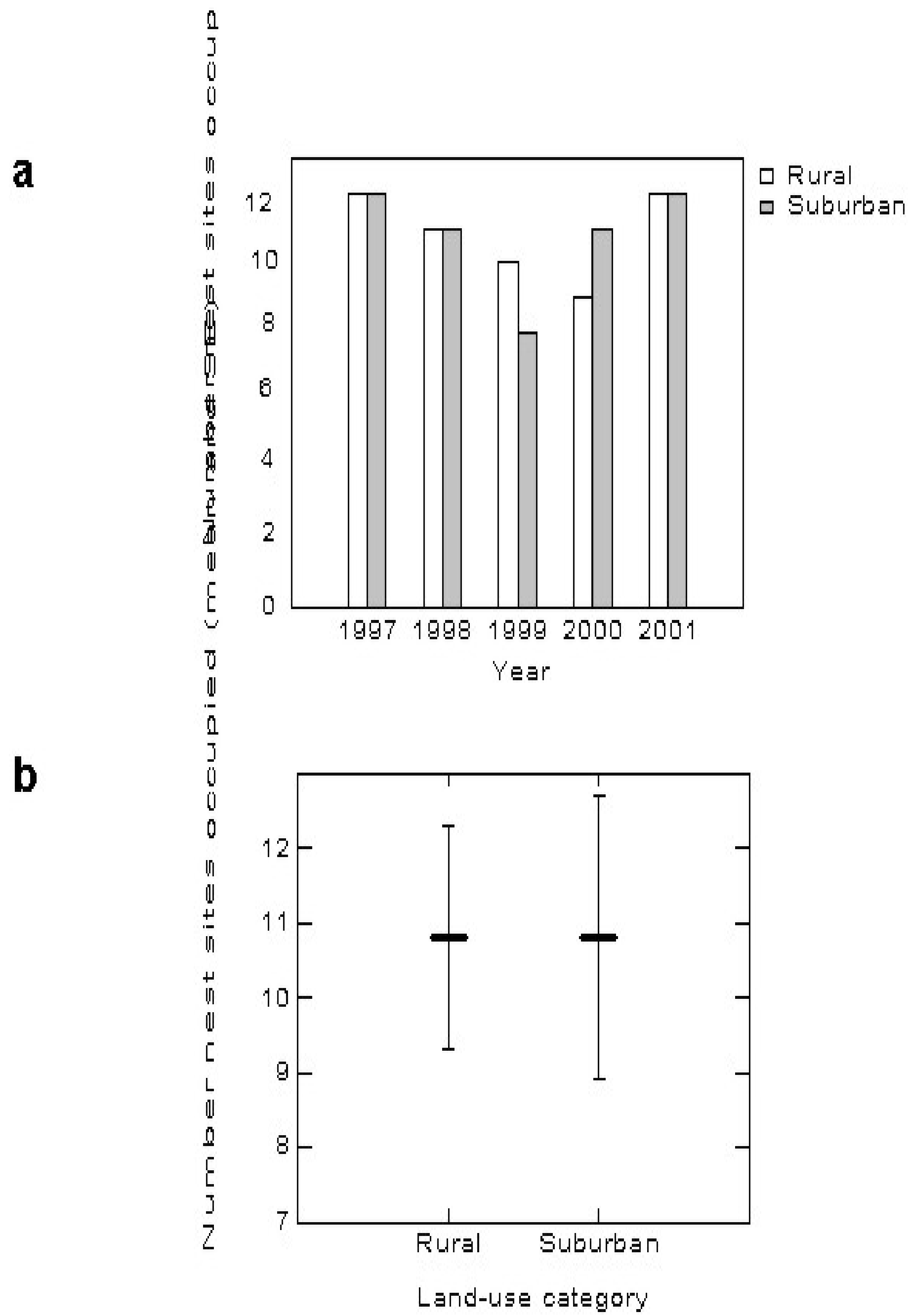


Figure 2. Bald eagle nest site occupancy varied among years (a), but there was no significant difference between suburban and rural nest sites (b). Data were collected from 1997 - 2001 in west central Florida.

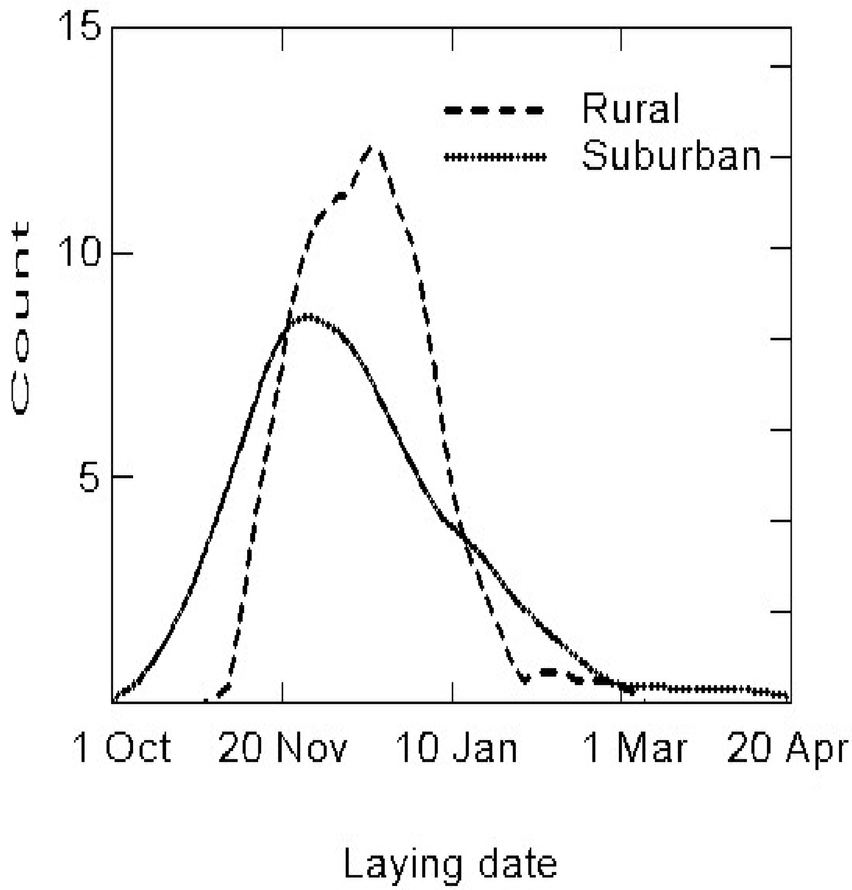


Figure 3. Kernel frequency distributions of estimated nest start dates of suburban and rural west central Florida bald eagles, 1997 -2001.

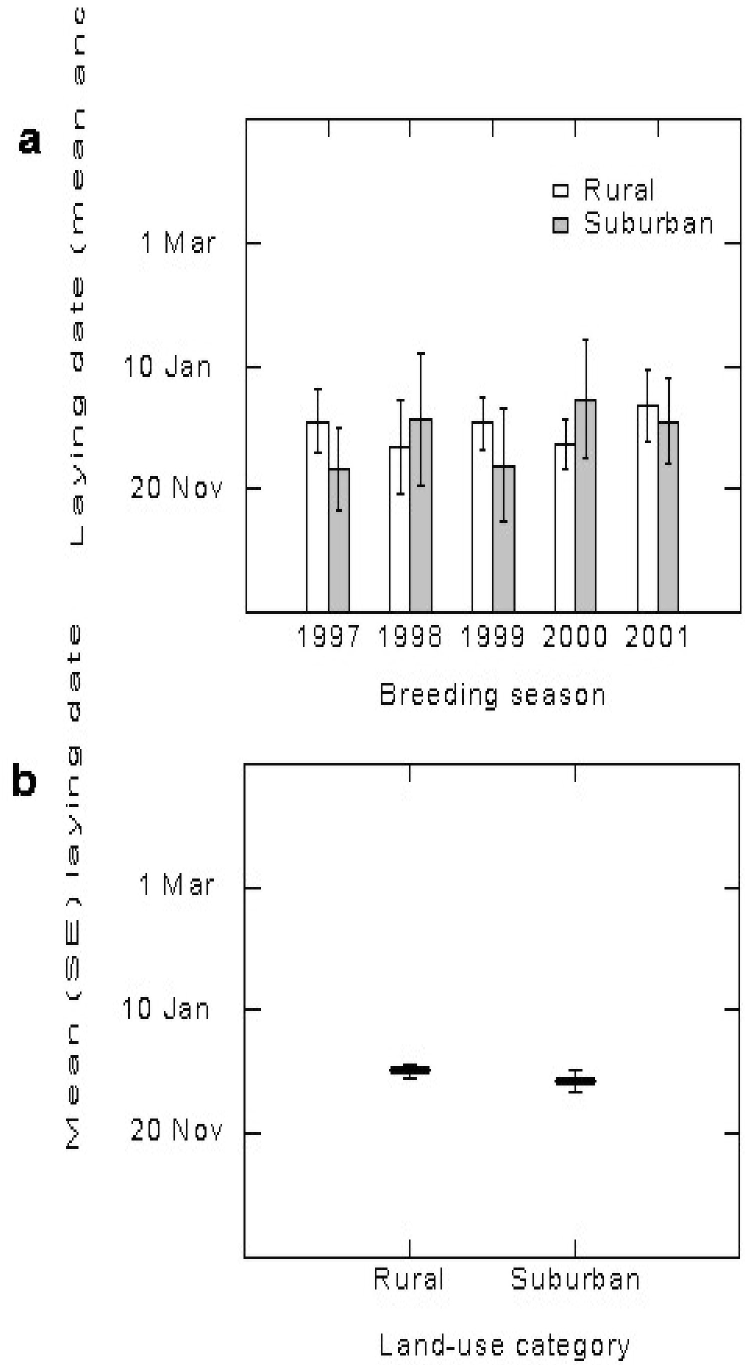


Figure 4. Mean nest start dates for suburban and rural bald eagles varied inversely among years (a), but means were not significantly different (b). Data were collected from 1997 - 2001 in west central Florida.

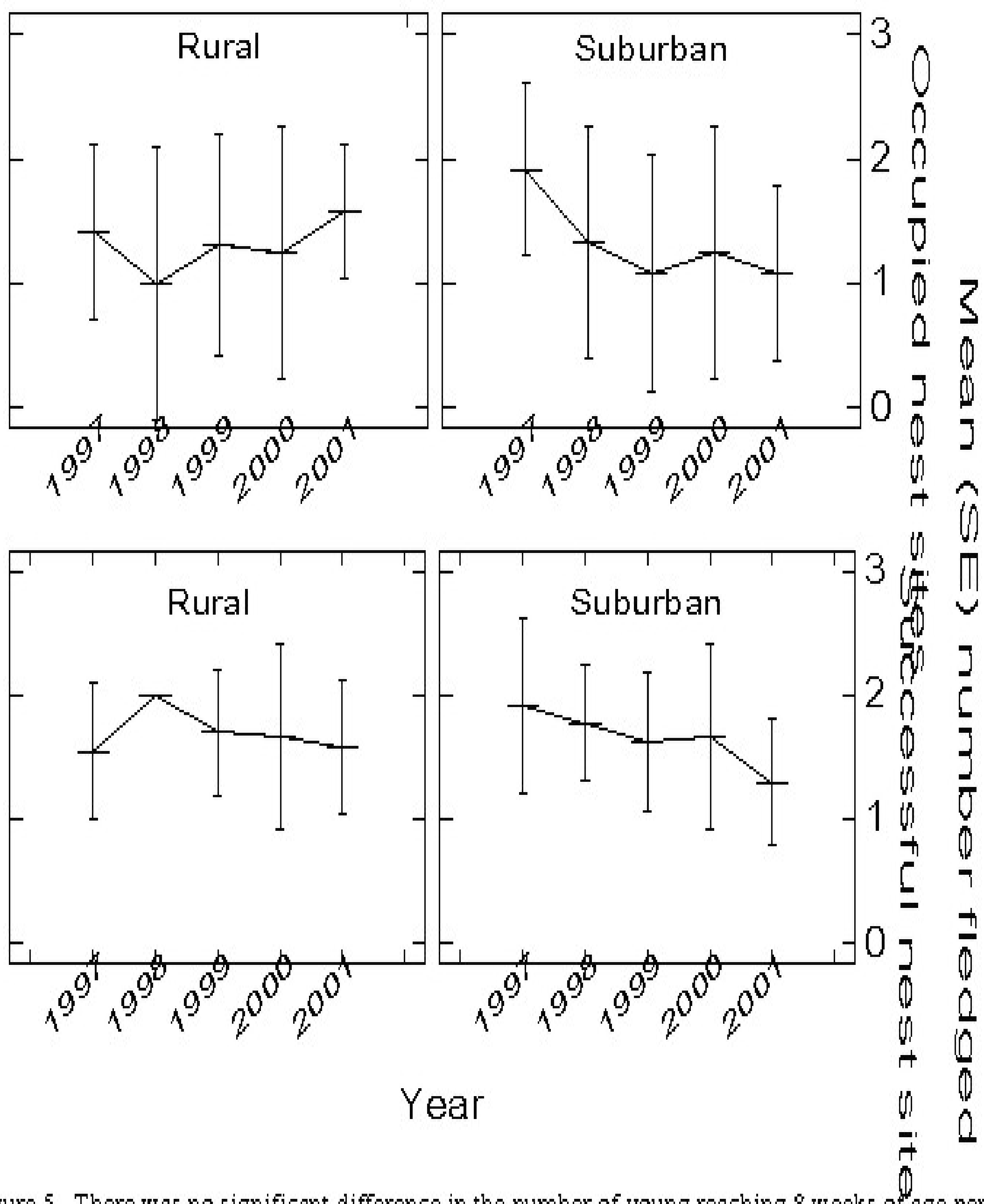


Figure 5. There was no significant difference in the number of young reaching 8 weeks of age per occupied or per successful nest site between suburban and rural bald eagles in west central Florida, 1997 - 2001.

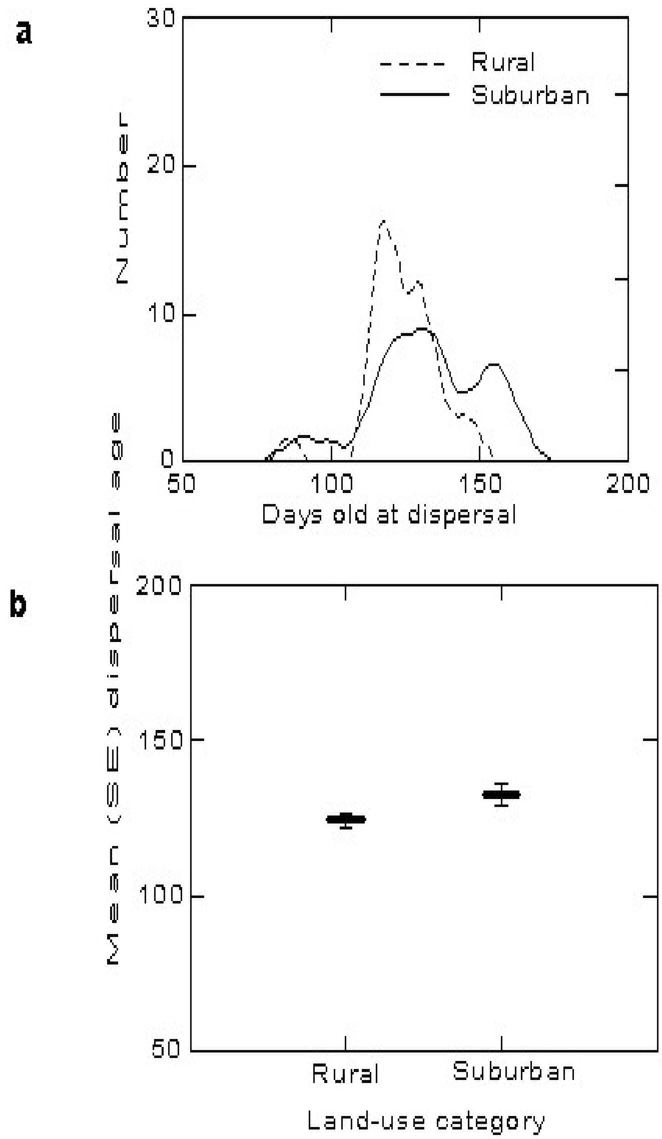


Figure 6. Unlike rural bald eagle fledglings, suburban fledglings exhibited a bimodal peak in dispersal dates (a). As a result, dispersal tended to occur significantly later date for suburban bald eagles (b). Data were collected from 1997 - 2001 in west central Florida.

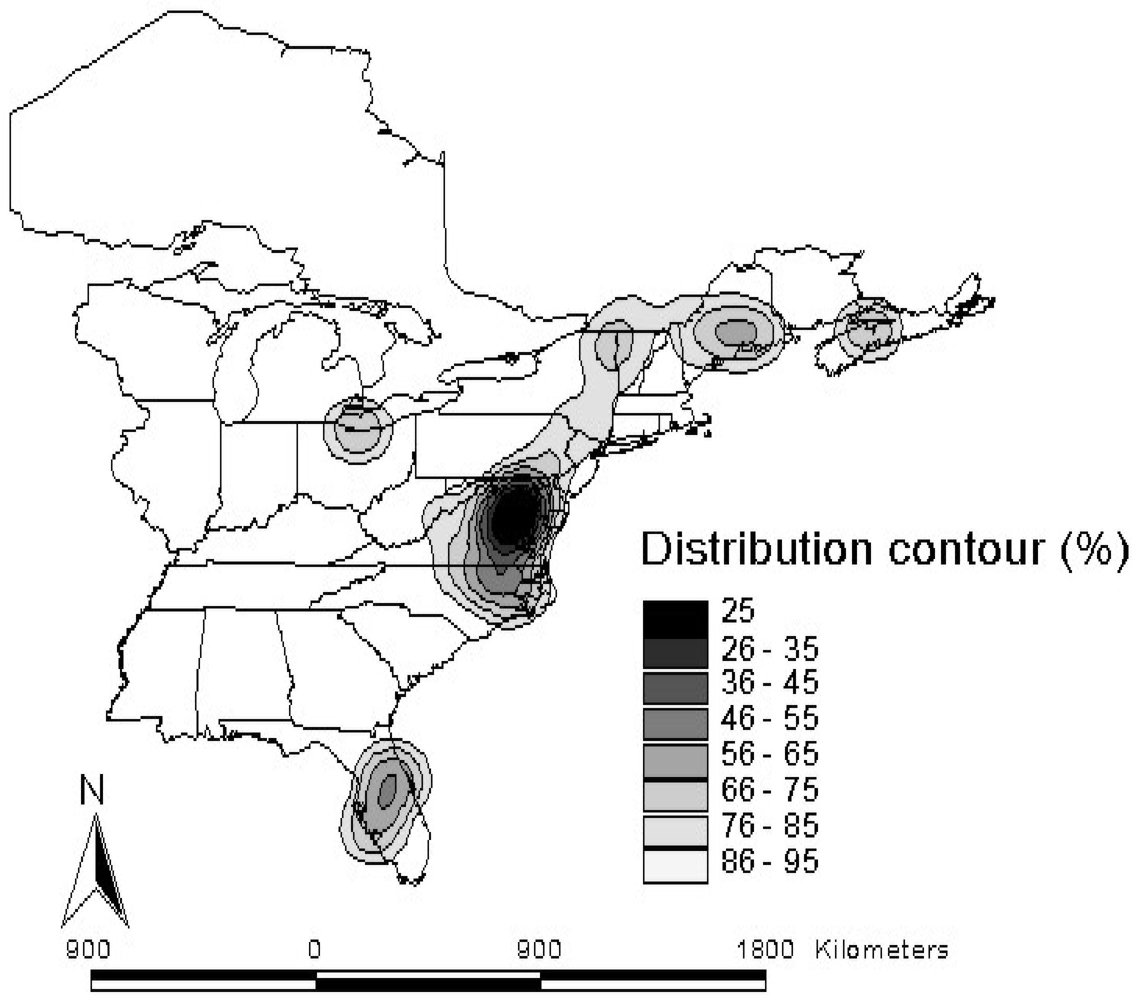


Figure 7. From 1 June to 1 September, PTT-tagged sub-adult west central Florida bald eagles were concentrated between the Chesapeake Bay and St. Lawrence River. Data are from 63 bald eagles radio-tagged as nestlings from 1997 - 2001.

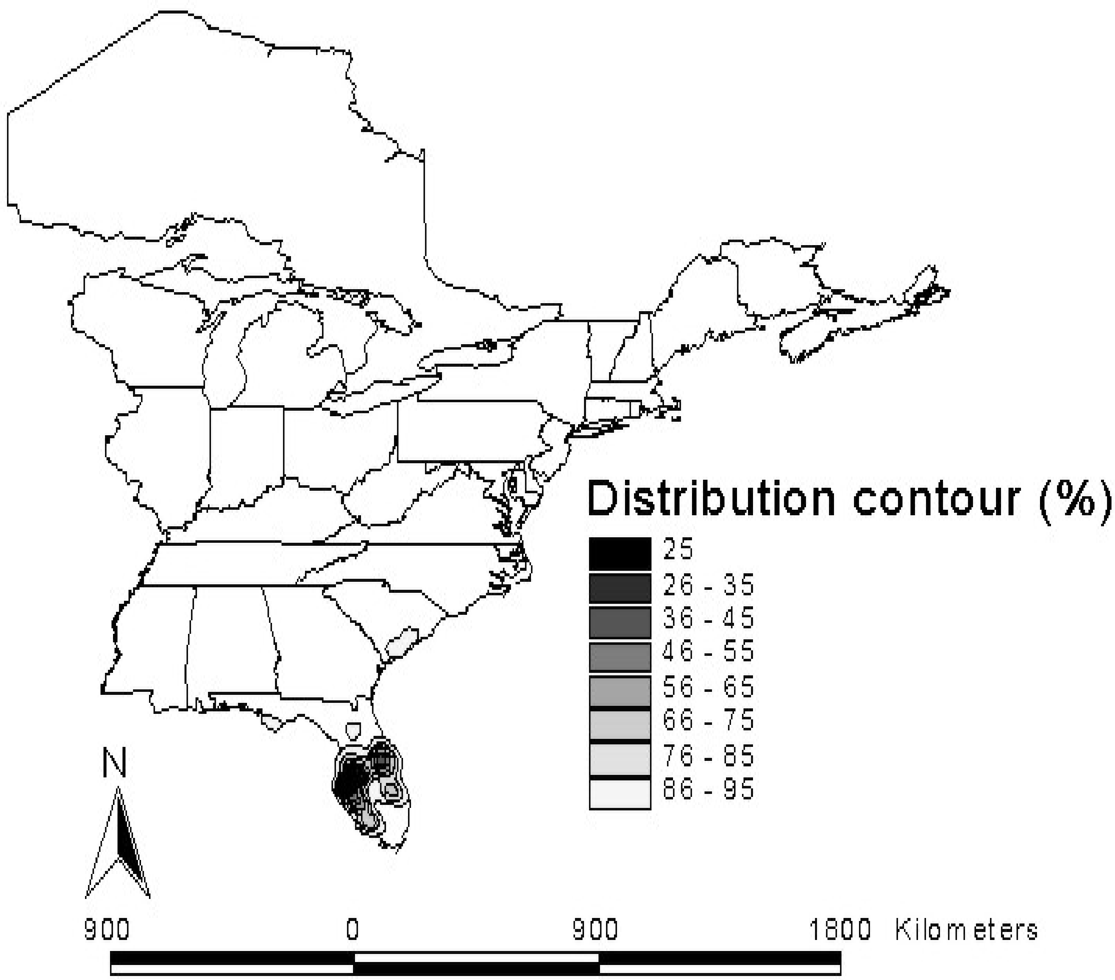
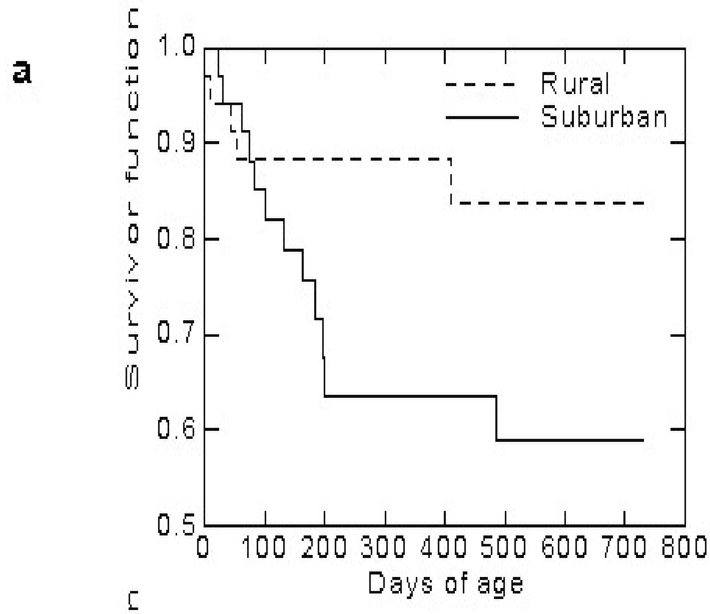


Figure 8. From 2 September to 30 May, PTT-tagged sub-adult west central Florida bald eagles were concentrated in western and central Florida. Data are from 63 PTT-tagged bald eagle nestlings from 1997 - 2001 that survived to disperse from the natal area.



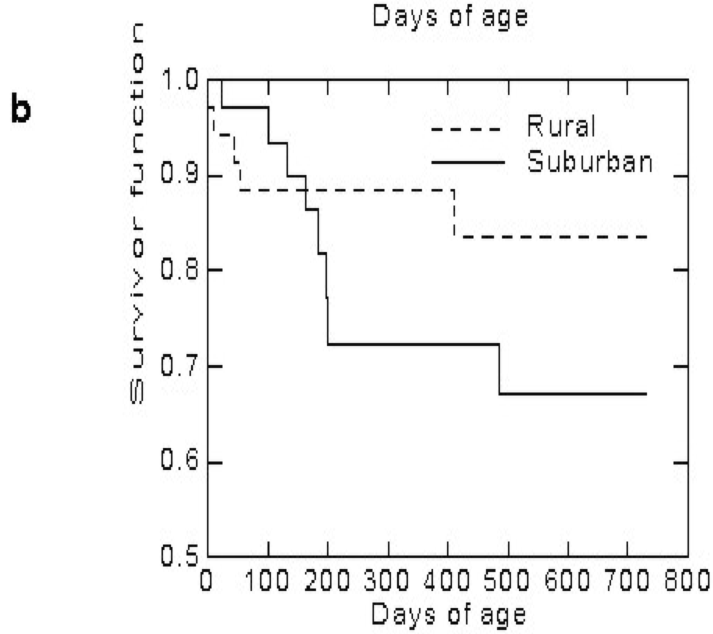


Figure 9. Kaplan - Meier survival functions show that survival of PTT-tagged suburban and rural west central Florida bald eagles began to diverge at 100 to 150 days of age, about the time northward migration started. Survival of suburban and rural eagles equalized again at about 200 days of age, about the time the fall return migration to Florida ended. This pattern is apparent whether PTTs of uncertain fate are treated as mortalities (a), or are censored as radio failures (b). Data are from 70 PTT-tagged nestling bald eagles from 1997 - 2001.

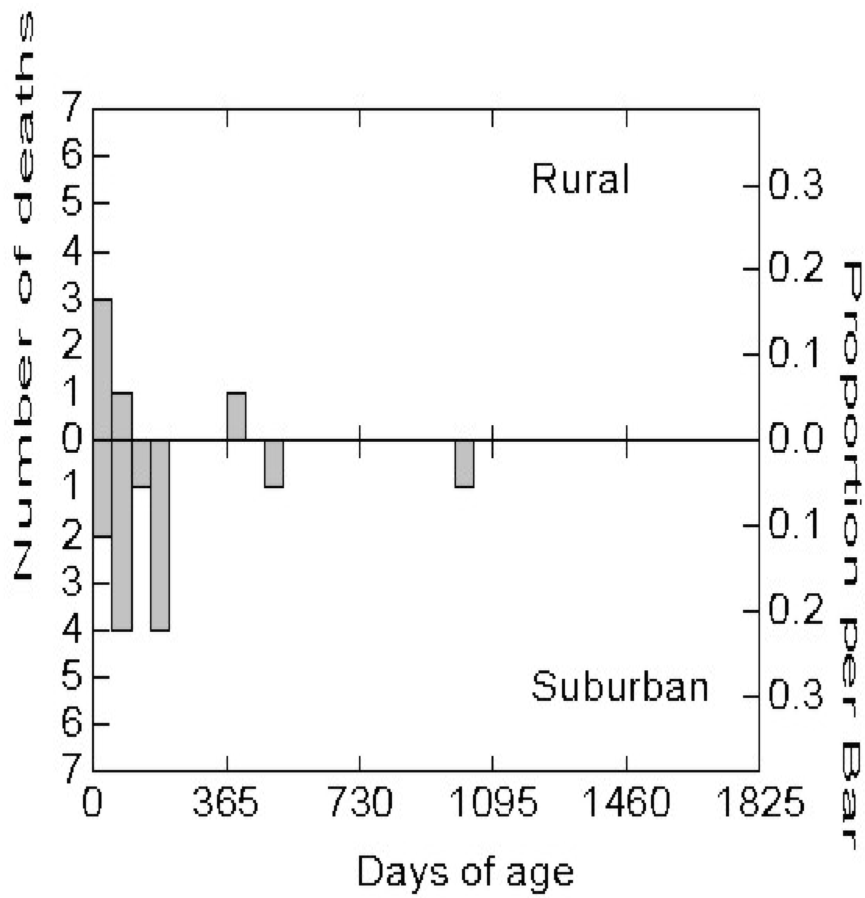


Figure 10. Most mortality of PTT-tagged rural bald eagle fledglings occurred in the natal area prior to dispersal, whereas most mortality of suburban bald eagles occurred after dispersal during migration. Data are from 70 bald eagles PTT-tagged in west central Florida as nestlings from 1997 - 2001.