ANNUAL REPORT

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Wildlife Research Section
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Project:	**9291-250-2596 -Annual Bald Eagle Surveys in Florida**
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Abstract: An annual statewide survey of a subsample of bald eagle nesting territories in Florida was conducted between November and March. Surveys were flown using fixed-winged aircraft. All nesting and productivity data were compiled and analyzed to generate annual population estimates that are used to determine the Florida eagle population trend. The number of estimated bald eagle nesting territories in 2009 was 1,340. The number of young produced this year was estimated at 1,796, this was an increase of 301 from 2008. The productivity rates for 2009 (based on 110 nests for which results were determined) were 1.34 per active territory and 1.62 per successful nest. The numbers for the 2008/2009 nesting survey represent an estimated population of between 3,565 (breeding adults, non-breeders, and subadults) and 5,360 (breeding adults, non-breeders, subadults, and young produced in 2009). The continuation of this survey is critical for the conservation and management of the bald eagle in Florida. This will enable us to monitor the population of this recently delisted species.

Bald Eagle Nest

INTRODUCTION

Florida supports one of the largest populations of breeding bald eagles (*Haliaeetus leucocephalus*) in the 48 continental United States. About 70% of the occupied nesting territories in the Southeast U.S. are in Florida. As development of Florida's coastal and freshwater environments increases, the direct and indirect effects of pollution, habitat disturbance, and habitat loss on nesting eagles will accelerate. Bald eagles will be among the first species to respond to these impacts because of the avoidance by many eagles of human-developed areas as nesting sites. There is an ongoing need for knowing the locations of eagle nests for site and developmental planning by both the private sector and governmental agencies.

In 2006, a Memorandum of Understanding was signed by the Florida Fish and Wildlife Conservation Commission (FWC), the Wildlife Foundation of Florida, and the U.S. Fish and Wildlife Service to establish a conservation fund for the management and conservation of the bald eagle in Florida. Specifically, this MOU provides funding for the FWC's aerial survey program to locate new and existing nests, manage and disseminate data for public use, and present the resulting data within the year the data were collected on the eagle website.

FWC staff and others have monitored bald eagle nesting territories in Florida since 1972. A nesting territory is defined as the area associated with one breeding pair of bald eagles which contains one or more nests (FWC 2008). Information gathered during the past 35 years includes the locations of over a thousand eagle nesting territories, breeding productivity, core nesting areas, reproductive success, and population estimates.

The USFWS Post-Delisting Monitoring Plan (USFWS 2007) recommends that bald eagle nests be monitored every 5 years for three eagle generations (24 years) on a nationwide basis. Monitoring eagle nests and nesting territories in Florida at a five-year interval may not provide adequate information to verify that the Florida population is being maintained. Additionally, annual surveys provide information about the status of all known active and alternate eagle nests in the state, and provide a basis for declaring nests to be lost or abandoned. To ensure that the conservation objectives of this management plan are being maintained, the FWC recommends that annual surveying continue until 2032 (FWC 2008). In addition to acquiring current information about the status of eagle nests, biologists characterize the habitat and land-use changes within each nesting territory in Florida. This information may help to identify the factors that affect population changes, movement patterns, habitat changes, and other trends.

The primary objective of this project is to gather data on the location, activity status, and productivity of bald eagle nests in Florida as part of the FWC Bald Eagle Population Monitoring. These data can be used for the management and conservation of the eagle in Florida and to determine if the eagle population in Florida is experiencing a loss of nesting sites or reproductive suppression. The state approved the Bald Eagle Management Plan (BEMP) and removed the eagle from the state imperiled species list in April 2008. An implementation team was formed to work together to carry out the plan according to specific goals and objectives.

BEMP MONITORING

The continuation of FWC surveys of all known eagle nests and nesting territories is dependent on securing funding and resources. If funding or resources are limited, then the FWC may choose to survey only a sample of the eagle nests and nesting territories statewide annually, and to develop methods to estimate the overall population and productivity. This season we tested a sub-sampling approach that will reduce the workload on the pilot and individuals conducting the survey as well as survey costs. Although we are capable of monitoring every nest in the state, we would be sacrificing some productivity data for information about nest status. The type of flying that is required to complete this survey is dangerous and flying multiple days in a row creates a situation that is not advisable. As the number of nests in the state increases, the harder it becomes to do a statewide annual survey. This sub-sample approach allows for a reduced survey while continuing to monitor the status of bald eagle nesting territories and productivity statewide on an annual basis.

BEMP CONSERVATION GOALS AND OBJECTIVES

The goal of the BEMP is to establish conservation actions that will maintain a stable or increasing population of bald eagles in Florida in perpetuity. To achieve this goal, a decline of 10% of the number of eagle nesting territories in Florida over a period of 24 years (three eagle generations) must be prevented through science-based management, regulations, public education, and law enforcement. The FWC anticipates that without continued protection of eagle nesting habitats, the number of nesting territories in Florida could decline by 10% or more over the next 24 years, which could trigger a relisting effort. The FWC has therefore set a conservation goal for bald eagles that is higher than the minimum threshold to avoid a need for relisting.

Conservation objectives are benchmarks used to measure progress toward the conservation goal. The following conservation objectives have been met or exceeded in Florida, and maintaining these objectives will help to ensure that the conservation goal is sustained. Annual nest surveys conducted by FWC biologists since 1972 provide the data used to establish the following objectives. Determining annual reproductive success will provide the information needed to monitor the population and to measure the success of the objectives. The FWC listing process has five criteria—three based on population size or trend, one on geographic range, and one on quantitative analysis of the probability of extinction (see Sullivan *et al.* 2006). The first three conservation objectives below provide a means by which changes in population size or trend can be detected, while the fourth objective is intended to ensure that the bald eagle maintains its current geographic distribution. Maintaining a stable or increasing population of eagles throughout their current distribution will ensure a healthy bald eagle population in Florida, and will prevent the need to relist eagles under FWC's imperiled-species regulations. The following conservation objectives will be calculated annually from five-year running averages, beginning with data collected during the period 2002–2006. We use five-year averages to avoid the possibility that one or two years of poor reproductive success might trigger a relisting effort. These numbers are subject to revision based on changes in monitoring data and/or methods.

1. Maintain a minimum of 1020 active territories per year over the next 24 years
2. Maintain an average of 68% of the active territories producing ≥1 nestling per year.
3. Maintain an average reproductive success of ≥1.5 fledglings per active nest over five years.
4. Maintain the current area of occupancy (>770 mi^2) and extent of occurrence (52,979 mi^2) of bald eagles statewide.

SURVEY OBJECTIVES

1. Complete an annual sub-sampling survey of newly reported, previously known, and potential locations of bald eagle nests in Florida.
2. Electronically enter and verify data on the locality and nest status in a format compatible with the FWC's Bald Eagle Nest Locator database.
3. Determine if we are meeting the objectives (1 and 2) of the Bald Eagle Management Plan (BEMP).

METHODS

A statewide survey of eagles was conducted during the 2008/09 nesting season using fixed-winged aircraft. The survey protocol followed Nesbitt et al. (1990) and included the following specifications: airspeed 60-80 knots (111-120 kph), altitude 300-500 feet (90-150 m), distance >1000 feet (>300 m) from the nest to avoid disturbance, and no flights during inclement weather or winds >20 knots (37 kph).

The biologists verified nest locations with the use of a WAAS-enabled Global Positioning System (WGPS) unit. Locations were recorded in longitude and latitude to hundredths of a minute and stored and displayed in NAD83 datum. A system called "X Marks the Spot," developed by Dr. Paul Kubilis of the FWC, was employed to record the location of new nest sites. This method consists of flying over the nest from two separate directions at an angle >60 degrees

and marking a waypoint over the nest with each pass. This technique provides three separate points (two waypoints and the crossing point of the two over-flights). This method necessitates that the WGPS be capable of recording a flight log, and each flight must be downloaded before the next flight.

The following 8 categories of survey data was recorded by the biologists for each nest:

1. date,
2. observer,
3. nest number,
4. latitude and longitude,
5. status of nest (active, inactive, destroyed, etc.),
6. productivity (number of eggs, nestlings, fledglings),
6. species of nest tree,
7. condition of nest tree (alive, dead, damaged, etc.), and
8. observations (presence of adults, incubation, etc.).

This year we began using a new survey protocol based on a stratified sampling method with coverage of 1/3 of the known nests each year (Figure 1). A subset of the known active nest were revisited to get a statewide production estimate. Using these data, an extrapolated population estimate was derived with the use of an algorithm based on data collected during the preceding 35 years of activity and production surveys (see Appendix 1). Any reported new nests within the sample area were checked and we continued to locate previously unknown nesting territories by surveying areas in suitable habitat that was not covered or inadequately covered in previous surveys. All nesting and productivity data collected during this study will be compiled annually and analyzed to interpret population trends.

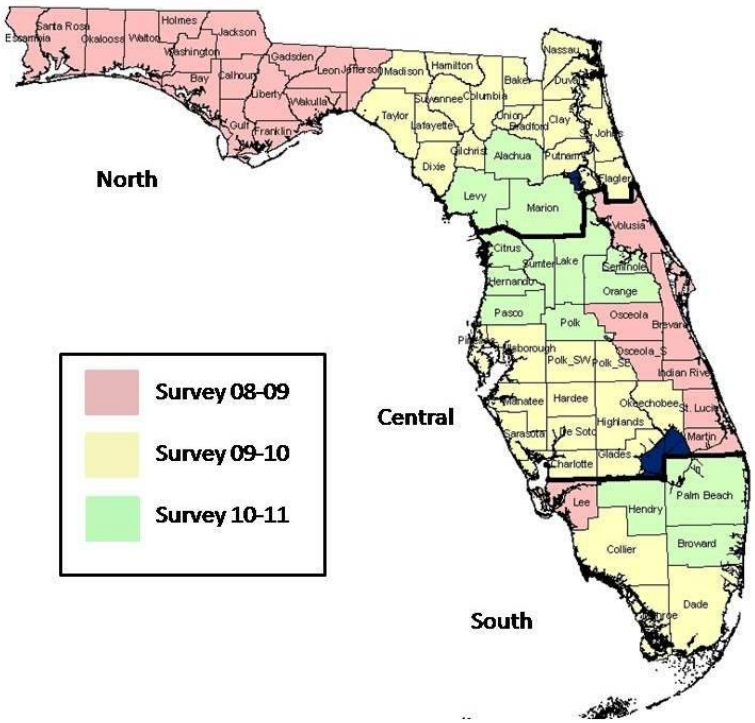

Figure 1. Schedule of areas to be surveyed over the next three nesting seasons.

USFWS Post-Delisting Monitoring

In addition to the annual survey, FWC participated in the nationwide USFWS post-delisting monitoring. The USFWS Monitoring Plan utilizes a modified "dual frame method" (Haines and Pollock 1998). The dual frame method combines the efficiency and cost effective advantages of a list sampling frame (i.e., the current list of all known nest locations based on the previous 5 nesting seasons from the traditional survey database; this is a low cost survey method albeit often found to be incomplete) and area frame sampling (i.e., designates randomly selected plots to be surveyed for nests for geographic boundaries or regions of interest; this has been shown to be very efficient for sampling albeit more costly to cover a large area as on a statewide basis). The area frame sampling implements a double-observer procedure for estimating number of nests missed during the traditional or list sampling frame survey method. We flew a total of 45 plots, including 16 area plots, 18 combined plots, and 11 list plots. The dual frame method of analysis uses the sample information from both the list frame and the area frame to arrive at a more precise estimate of nest density across the entire study area. To conduct the analysis, nests identified in the area frame sampling are separated into the two categories: the overlap (nests in the plots that also occur in the list frame or traditional survey) and non-overlap (nests that are newly found in the plots) domains. The non-overlap nests are identified, and are used to estimate the total number of nests not in the list frame. Because these reconciled nests are only the ones not in the list sample, the list and area estimates are independent, so the variances from the list and area samples can be added. The cost of obtaining an estimate of the total number of nests with the same standard error can be halved. The sum of the estimates from the area frame and the list frame are used to determine a total number of occupied eagle nests statewide. This methodology has been demonstrated to identify essentially 100% of the nests in the area surveyed (Mark Otto, USFWS unpublished report). Results from this sampling are being analyzed by USFWS.

RESULTS

The 2008/2009 statewide nesting bald eagle survey began on 18 December 2008 and the last survey flight was flown on 10 April 2009. The estimated number of active bald eagle nesting territories in Florida during the 2008/2009 statewide survey (excluding ENP) was 1,340 (Table 1). The number of young produced this year was estimated at 1,796; this was an increase of 301 over the number estimated for 2008. The productivity rates for 2009 (based on 110 nests for which results were determined) were 1.34 young per active territory and 1.62 per successful nest. The numbers of young per active territory and per successful nest were above both the preceding 10 year and 5 year means (Table 2). The numbers from the 2008/2009 nesting survey represent an estimated population of between 3,565 (breeding adults, non-breeders, and subadults) and 5,360 (breeding adults, non-breeders, subadults, and young produced in 2009). This survey did not include eagles nesting in Everglades National Park (traditionally 30 to 50 pairs) and if those numbers were included the estimated population would be increased by 120 to 200 eagles.

The population of nesting bald eagles in Florida in 2009 increased by 4.8% over the number of active territories reported in 2008 (Figure 2). This was greater than the mean increase of 2.31% for the preceding 10 years (a span which included 1 year of no growth and 1 year of negative growth) and in line with the rate over the previous 2 years. The average recent growth

rate (0.047 from 2007–2009), though reflective of secure population, is well below the average rate of 9% a year for the 5 years from 1991 through 1995. The trend line in the population growth rates remains level (Figure 3).

DISCUSSION

This was the first year that we surveyed a subset of the known bald eagle nesting territories. Because of this, geographic distribution and substrate use would be best assessed only every third year, after the entire state has been completely surveyed. The results of the survey indicate that the sub-sampling approach is adequate to address the management conservation objectives outlined in the Florida Bald Eagle Management Plan. We have met the first two BEMP conservation objectives this year.

The number of nesting pairs of bald eagles in Florida and their reproductive performance continues to exceed the minimum needed to meet regional population recovery goals. We should continue using the current sampling approach to monitor the population and thoroughly evaluate the suitability of this approach after the third year (2010/2011). In an effort to locate new nesting territories we should continue to identify and inventory suitable habitats that have been inadequately surveyed in the past.

TABLES AND FIGURES

Table 1. Results of bald eagle nesting activity in Florida 2003–2009 (excluding ENP).

Year	# Active	# Not Active	# Gone	# Unknown
2003	1116	352	355	21
2004	1077	237	469	61
2005	1158	171	453	61
2006	1166	174	499	89
2007	1218	228	491	79
2008	1278	225	457	75
2009[1]	1,340	253	410	39

[1] Numbers for 2008/2009 were estimated based on statistical analysis.

Table 2. Productivity results for bald eagles nesting in 1998–2008 and 2009.

Year	# Active Nests	# Young Produced	Young / Active Nest	Young / Successful Nest
1999	1,043	1220	1.17	1.50
2000	1,069	1,165	1.09	1.62
2001	1,102	1,311	1.19	1.60
2002	1,133	1,280	1.13	1.52
2003	1,133	1,280	1.14	1.54
2004	1,092	1,318	1.14	1.54
2005	1,133	1,473	1.30	1.59
2006	1,166	1,527	1.31	1.52
2007	1,218	1,303	1.07	1.46
2008	1,278	1,495	1.17	1.60
Mean preceding 10 years (SD)	**1,136.7 (69.9)**	**1,337.2 (120.9)**	**1.17 (0.08)**	**1.55 (0.05)**
Mean preceding 5 years (SD)	**1,177.4 (72.7)**	**1,423.2 (104.8)**	**1.20 (0.10)**	**1.54 (0.06)**
2009[1]	1,340	1,796	1.34[2]	1.62

[1] Numbers for 2008/2009 were estimated based on statistical analysis.
[2] Base on sampling protocol which assumes simple random sampling of all active nesting territories

Table 3. Number of active bald eagle nests by county in Florida 2004–2009.

COUNTY	YEAR					
	2009	**2008**	**2007**	**2006**	**2005**	**2004**
Alachua	53[1]	51	42	43	40	33
Baker	2[1]	1	1	0	0	0
Bay	12	11	12	9	12	7
Bradford	4[1]	4	3	3	3	2
Brevard	30	39	42	43	42	41
Broward	1[1]	1	0	0	0	0
Charlotte	43[1]	38	29	26	26	25
Citrus	24[1]	21	23	17	19	19
Clay	13[1]	11	9	7	10	10
Collier	21[1]	23	21	24	15	18
Columbia	2[1]	2	2	2	2	1
Dade	1[1]	1	1	1	1	1
De Soto	4[1]	4	3	4	1	6

Dixie	8[1]	7	9	6	8	8
Duval	11[1]	10	7	7	10	6
Escambia	1	1	1	1	1	0
Flagler	10[1]	10	9	9	8	6
Franklin	33	28	40	25	34	20
Gadsden	3	3	3	3	3	1
Gilchrist	1[1]	1	1	1	0	0
Glades	16[1]	14	17	15	16	12
Gulf	9	10	11	6	6	5
Hamilton	3[1]	3	1	1	2	1
Hardee	7[1]	5	5	2	3	3
Hendry	3[1]	5	5	6	4	2
Hernando	10[1]	12	13	16	14	10
Highlands	35[1]	37	32	37	30	25
Hillsborough	22[1]	20	19	17	16	20
Indian River	9	7	9	7	10	5
Jackson	4	5	4	4	4	3
Jefferson	5	2	3	4	4	4
Lake	66[1]	70	69	75	65	68
Lee	47	51	50	47	42	43
Leon	10	7	9	9	9	8
Levy	23[1]	24	27	28	26	22
Liberty	4	3	2	2	2	1
Manatee	23[1]	21	21	18	18	15
Marion	58[1]	51	46	38	36	34
Martin	15	15	13	16	10	11
Monroe	7[1]	7	6	6	1	1
Nassau	1[1]	1	0	0	0	0
Okaloosa	2	U	1	2	1	2
Okeechobee	18[1]	16	19	15	16	18
Orange	40[1]	38	35	34	29	30
Osceola	125	116	112	107	118	116
Palm Beach	8[1]	7	9	7	10	9
Pasco	19[1]	18	16	16	16	14
Pinellas	19[1]	17	16	16	16	20
Polk	116[1]	119	113	121	122	118
Putnam	77[1]	67	50	41	57	46
Santa Rosa	2	U	3	3	2	0
Sarasota	45[1]	41	37	33	34	31
Seminole	49[1]	49	51	52	47	46
St. Johns	28[1]	25	19	18	15	14
St. Lucie	7	8	8	10	11	9
Sumter	17[1]	15	15	12	16	14

Suwannee	3[1]	2	2	1	2	1
Taylor	17[1]	16	10	10	9	6
Union	1[1]	1	1	1	1	0
Volusia	70	73	60	66	70	67
Wakulla	19	11	18	14	11	15
Walton	3	U	2	1	1	3
Washington	1	1	1	1	1	1

[1] Numbers for 2008 /2009 were estimated based on statistical analysis (see Appendix 1).

Table 4. Nesting substrate used by bald eagle nesting in Florida 2004–2008.

Year	Australian Pine		Other		Oak		Sand Pine		Cypress		Pine		Artificial
	Live	*Dead*	*Live*	*Dead*	*Live*	*Dead*	*Live*	*Dead*	*Live*	*Dead*	*Live*	*Dead*	
2004	11	1	6	3	13	2	8	0	84	13	807	100	23
2005	12	0	5	2	12	2	6	1	86	8	918	80	20
2006	14	5	6	1	12	7	10	0	89	13	865	117	21
2007	17	6	7	3	14	1	8	1	84	12	862	165	27
2008	19	7	8	3	16	3	4	2	90	12	914	167	28
2009	The substrate samples will be tallied after the third year (2011) of surveys under the new sampling protocol												

Figure 2. Number of bald eagle nesting pairs in Florida 1998 – 2009.

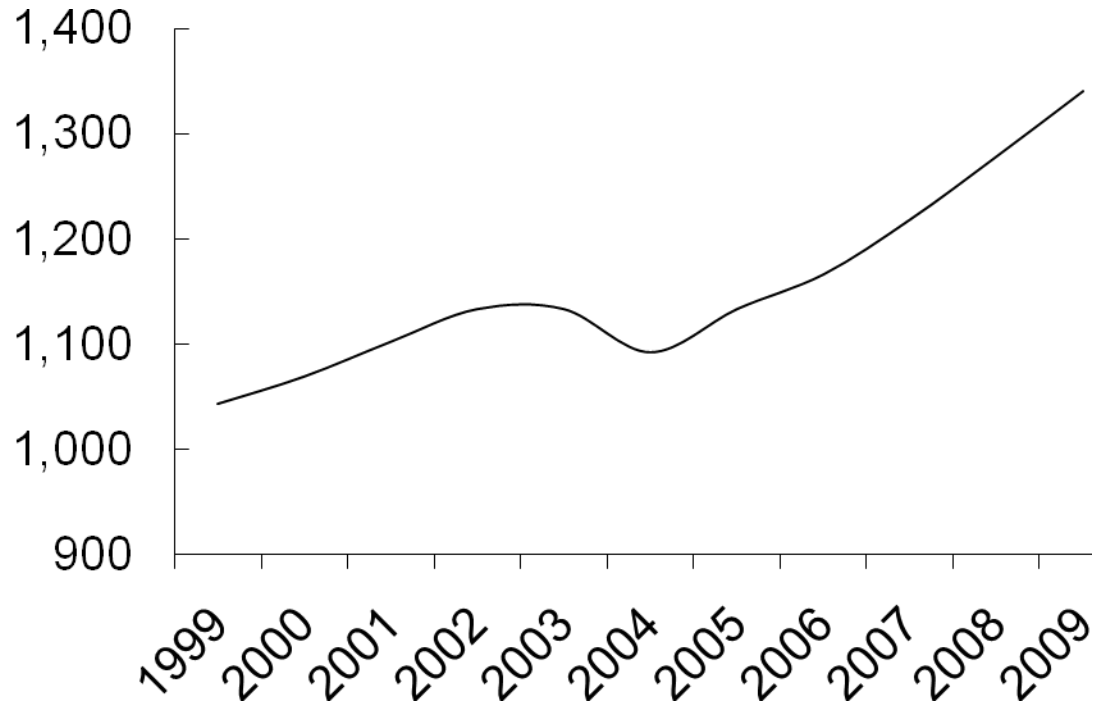

Figure 3. Rate of annual increase and trend line (- - -) of bald eagles nesting in Florida 2000 – 2009.

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APPENDIX

Manuscript – In preparation

STRATIFIED ROTATING PANEL SURVEY WITH REGRESSION IMPUTATION: A SAMPLING STRATEGY FOR ESTIMATING TOTAL NUMBER OF BALD EAGLE NESTING TERRITORIES AND PRODUCTIVITY IN FLORIDA

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Abstract: The bald eagle is an important species for conservation and so accurate estimation of its true abundance is desired for development of adequate conservation strategies. The state of Florida has traditionally performed annual aerial censuses of every county in the state with the intent of obtaining a yearly estimate of the total number of nesting territories. Economic constraints as well as the desire to obtain accurate information on annual productivity require a change in the approach previously used. We address precise estimation of total abundance of nesting territories and of productivity using panel surveys to replace the census. The sampling design is a three year rotation design in which panels of contiguous counties within the state of Florida are assigned to a particular year of the three year rotation. The estimation procedure for estimating total number of territories is model-based and relies on imputing the number of nesting territories that would have been observed in a county had it been in the sample rotation that year using regression methods. The results are then used in estimation of the total number of nesting territories in the state. We consider several approaches to fitting Poisson regression models, including maximum likelihood estimation of the parameters, least squares estimation (LSE), a modified LSE where standard errors of the predicted values are estimated by replacing the Mean Squared Error (MSE) in the standard formula with the predicted value from the regression, and a modified LSE where standard errors of the predicted values are derived assuming a Poisson distribution. The approaches are compared using data collected in censuses of all counties annually from 1990 to 2008. Overall, the LSE with modified standard errors behaved the best in terms of accurately reflecting the census results. Productivity was estimated using a Horvitz-Thompson estimator using the results of the panel survey as the sampling frame for active nesting territories from which to sample using an adaptive cluster sampling approach.