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# STATUS AND DISTRIBUTION OF THE GREAT BLUE HERON IN INDIANA

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ABSTRACT: A statewide survey of the size and distribution of great blue heron nesting colonies was conducted in 1987 by the Indiana Department of Natural Resources. A total of 58 active nesting colonies was surveyed in 40 counties throughout Indiana. Nesting colonies were not evenly distributed throughout the State in proportion to the land area of the physiographic regions in which they occurred. Significantly ($p < 0.05$) more were identified in the Great Lakes Physiographic Region (N = 23), and fewer occurred in the Lexington Plain (N = 10) and Highland Rim (N = 2) Regions. However, mean colony size did not differ significantly ($p > 0.05$) between the 4 physiographic regions in which heron colonies occurred. Colonies occurring in riparian habitats ($\bar{x} = 89.4$ nests) were significantly ($p < 0.05$) larger than mean colony size in upland habitats ($\bar{x} = 55.2$). Physiography and the associated relative abundance of wetland foraging habitat between regions may be the most important limiting factor affecting the distribution and size of great blue heron nesting colonies in Indiana. There was a positive correlation between the number of years a colony site had been active and the colony size ($r = 0.68$, $p < 0.001$), suggesting relative instability in occupancy of the smaller colonies (e.g., < 25 nests). Both the total number of colonies and the mean colony size have increased from similar statewide surveys between 1983 and 1985 and 1985 and the present survey results in 1987, suggesting an increasing statewide population. A conservation strategy is proposed to provide protection and monitoring for the largest (e.g., > 200 nests) colonies to ensure maintenance of the great blue heron population in Indiana.

## INTRODUCTION

The great blue heron (*Ardea herodias*) is a conspicuous inhabitant of Indiana's wetlands. Its habit of nesting colonially makes it vulnerable to habitat alterations; a relatively minor habitat disturbance can impact a large proportion of a population. The great blue heron is primarily piscivorous and, thus, susceptible to the accumulation of environmental contaminants (Faber, *et al.*, 1972; Call, *et al.*, 1976; Ohlendorf, *et al.*, 1978, 1980; LaPorte, 1982). Nesting herons are also vulnerable to human disturbance (Werschkul, *et al.*, 1976; Ryder, 1980) as well as destruction of either nesting or wetland foraging habitat (Bjorklund, 1975; Graber, *et al.*, 1978; Thompson, 1979).

The vulnerability of great blue herons has prompted an interest in understanding regional population trends. Population declines have been documented in Illinois (Graber, *et al.*, 1978), Alberta (Markham and Brechtel, 1979), Tennessee (Pitts, 1977), and five Midwestern States along the upper Mississippi River (Thompson, 1979). More recent studies, however, have documented stable or increasing great blue heron populations in New York (McCrimmon, 1981), Quebec (DesGranges and LaPorte, 1981), and Tennessee (Fleming, *et al.*, 1984).

An understanding of the distribution and size of great blue heron colonies was essential to obtain an accurate perspective on the population in Indiana. Baseline data were also needed to formulate a conservation program in Indiana to ensure the long-term integrity of this sensitive species.

The Indiana Department of Natural Resources (INDR) Nongame and Endangered Wildlife Program (NEWP) conducted the first statewide great blue heron survey in 1983 (Iverson, 1984). This survey was repeated in 1985 (Iverson, 1985) to evaluate the status and population trends over a 2-year period.

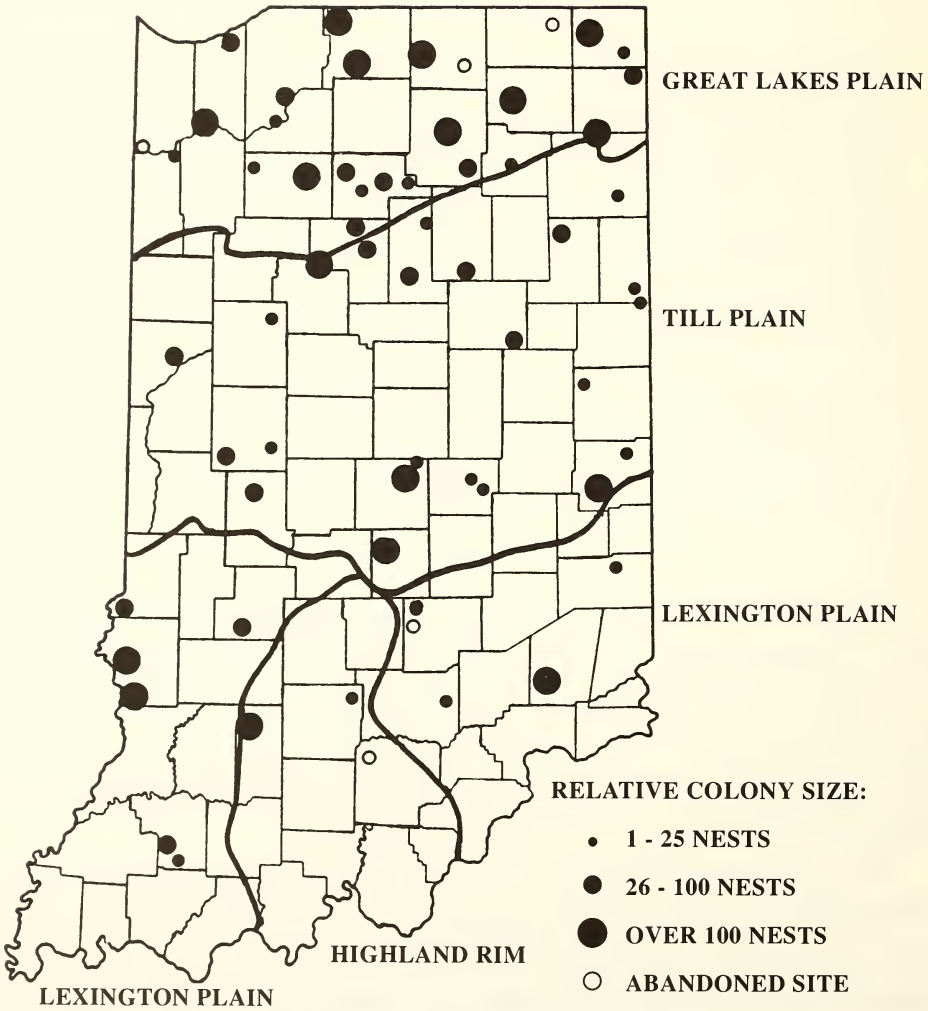


Figure 1. Distribution and relative size of great blue heron nesting colonies in Indiana, 1987. Major physiographic regions are illustrated. Abandoned sites marked are only those abandoned since 1985.

The results of the 1987 statewide great blue heron survey are reported in this paper. These results are compared with the previous surveys to evaluate population trends over the 4-year period. Distributional patterns and habitat associations of nesting colonies are analyzed, and conservation strategies are recommended.

## MATERIALS AND METHODS

All colonies reported in the 1985 statewide survey were included in the 1987 survey as were new colonies reported to the NEWP. Initial identification of great blue heron nesting sites included in the 1983 survey was accomplished by a review of the literature and the personal records of Russell Mumford (pers. comm.) as well as by inquiries to State biologists and conservation groups (Iverson, 1984). Information concerning new colonies was solicited through agency newsletters and newspaper articles.

The same methodology that was used in the previous two surveys was employed in 1987. A nesting colony was operationally defined as one or more nesting pairs of herons. Nests over 400 meters apart were considered separate colonies (McCrimmon, 1981).

Colonies were surveyed by qualified volunteers from the second to fourth week of April depending upon latitude in the State. The survey period was as late as possible in the spring to allow most herons to initiate nesting attempts for the current season. Great blue herons generally begin nesting in late March, with incubation well under way by late April at this latitude (Graber, *et al.*, 1978; Taylor, *et al.*, 1982). However, surveys need to be conducted before leaf out (McCrimmon, 1981). The foliage begins to severely limit visibility starting in mid-late April. Fall counts (Taylor, *et al.*, 1982) were conducted after leaf fall to obtain accurate nest counts when a colony had not been located or surveyed before leaf out or when new colonies were reported or discovered after the spring census period.

The total number of nest structures and active nests (e.g., well-formed, in good repair, with excrement, or occupied by adults or young) within the colony was tallied. Determination of nest activity is relatively subjective. Therefore, data for total nests are presented as in previous reports (Iverson, 1984, 1986). This approach may overestimate the actual nesting population size since not all nets may be active. However, the error is consistent among observers and between years. Taylor, *et al.* (1982) reported that nesting material from inactive nests was commonly "stolen" by adults involved in nest building or repair, suggesting that few inactive nests remain intact to the survey period.

Numbers of nests per individual tree and tree species were also determined. The habitat associated with the colony was categorized as upland or riparian (i,e, in a floodplain or adjacent to a perennial stream or river). Other birds, such as the great egret (*Casmerodius albus*) and black-crowned night-heron (*Nycticorax nycticorax*), known to nest in association with great blue herons (Butler, 1898; Keller, 1966) were noted. An attempt was made to identify the owner of the colony nesting site in order to determine the approximate number of years the colony had been active.

For statistical analysis of distributional patterns, each colony nesting site was assigned to one of the four broad physiographic regions (Homoya, *et al.*, 1985; Robbins, *et al.*, 1986) of the State. Data were analyzed using Chi-square analysis, the Wilcoxon rank-sum test, the Sign test, and one-way analysis of variance (ANOVA). Significance levels were set at 5%, unless otherwise indicated.

Table 1. Name, legal description, and total number of nests in great blue heron colonies censused in 1987.

| County | Colony Name | Township | Range | Section | Colony Size |
|---|---|---|---|---|---|
| Adams | Berne | 25N | 15E | 16 | 16 |
| Allen | Poe | 29N | 13E | 23 | 21 |
| Allen | Garrett | 32N | 12E | 3 | 104 |
| Bartholomew | Lick Creek* | 10N | 5E | 30 | 0 |
| Bartholomew | Ninevah* | 10N | 5E | 7 | 20 |
| Cass | Burrows | 26N | 1W | 3 | 133 |
| Cass | Charley Reserve | 28N | 3E | 31 | 65 |
| Cass | Twelve Mile | 27N | 3E | 7 | 27 |
| Dekalb | Edon | 35N | 14E | 1 | 53 |
| Elkhart | Goshen | 36N | 6E | 34 | 0 |
| Elkhart | Wararusa | 36N | 4E | 15 | 115 |
| Franklin | Brookville | 12N | 13E | 34 | 4 |
| Fulton | Akron | 31N | 4E | 29 | 40 |
| Fulton | Culver | 31N | 1E | 5 | 44 |
| Fulton | New Castle | 31N | 4E | 28 | 4 |
| Fulton | Rochester | 31N | 3E | 29 | 13 |
| Grant | Upland | 23N | 9E | 26 | 26 |
| Hancock | Pendleton | 17N | 7E | 24 | 12 |
| Hancock | Willow Branch | 17N | 7E | 36 | 11 |
| Jay | New Corydon | 24N | 15E | 3 | 20 |
| Jackson | Chestnut Ridge* | 6N | 6E | 35 | 1 |
| Johnson | Bargerville | 14N | 3E | 32 | 225 |

| County | Colony Name | Township | Range | Section | Colony Size |
|---|---|---|---|---|---|
| Kosciusko | North Manchester | 30N | 6E | 12 | 43 |
| Kosciusko | Rosbrugh | 33N | 6E | 30 | 173 |
| Lagrange | Mongo | 37N | 11E | 17 | 0 |
| Lake | LaSalle* | 31N | 9W | 6 | 0 |
| LaPorte | Kankakee | 33N | 3W | 10 | 38 |
| Lawrence | Norman | 6N | 2E | 19 | 2 |
| Marion | Fort Harrison* | 17N | 5E | 30 | 108 |
| Marion | McCordsville | 17N | 5E | 29 | 14 |
| Martin | Crane | 5N | 4W | 18 | 202 |
| Miami | Bunker Hill | 26N | 4E | 25 | 63 |
| Miami | Roann | 28N | 5E | 10 | 4 |
| Montgomery | Alamo* | 17N | 6W | 11 | 34 |
| Montgomery | Beckville | 18N | 3W | 11 | 21 |
| Newton | Shelby | 32N | 8W | 26 | 7 |
| Noble | Cromwell | 34N | 8E | 28 | 166 |
| Owen | Arney | 9N | 5W | 32 | 85 |
| Pike | Augusta | 2S | 7W | 12 | 7 |
| Pike | Petersburg | 1S | 8W | 34 | 76 |
| Porter | Hebron | 33N | 7W | 25 | 131 |
| Porter | Indiana Dunes* | 37N | 5W | 26 | 86 |
| Pulaski | Bass Lake* | 31N | 2W | 13 | 125 |
| Pulaski | Jasper/Pulaski | 31N | 4W | 7 | 17 |
| Putnam | Big Walnut | 16N | 3W | 32 | 71 |

| County | Colony Name | Township | Range | Section | Colony Size |
|---|---|---|---|---|---|
| Randolph | Redkey* | 21N | 12E | 23 | 3 |
| Ripley | Holton* | 7N | 10E | 35 | 164 |
| St. Joseph | Galien | 38N | 1W | 11 | 112 |
| St. Joseph | Lilovich* | 35N | 1E | 12 | 212 |
| Starke | English Lake* | 33N | 3W | 29 | 5 |
| Steuben | Flint | 37N | 12E | 10 | 395 |
| Steuben | Hamilton | 37N | 14E | 33 | 10 |
| Sullivan | Heathsville | 6N | 10W | 34 | 125 |
| Sullivan | Merom | 7N | 11W | 1 | 186 |
| Tippecanoe | Brookston | 24N | 3W | 21 | 22 |
| Vigo | Hutton | 10N | 11W | 30 | 99 |
| Wabash | LaFontaine | 26N | 7E | 33 | 43 |
| Warren | Attica | 22N | 7W | 32 | 29 |
| Washington | Smedley | 3N | 3E | 30 | 0 |
| Wayne | Fountain City | 17N | 14E | 8 | 4 |
| Wayne | Pottershop | 15N | 13E | 16 | 205 |
| Wells | Zanesville | 28N | 11E | 8 | 45 |
| Whitley | Columbia City | 31N | 9E | 21 | 4 |

* Colony occurs on public property.

## RESULTS AND DISCUSSION

During 1987, 58 active great blue heron nesting colonies were identified (Table 1). Active colonies were located in 40 counties (Figure 1). This total represents a net increase of seven colonies over the 51 identified in the 1985 survey (Iverson, 1986). Five colonies active in 1985 were abandoned, two colonies active in 1983 (Iverson, 1984) but

Table 2. Number and average size of great blue heron colonies in Indiana during the 3 biennial surveys.

| | 1983 | 1985 | 1987 | Test[1] |
|---|---|---|---|---|
| All colonies | | | | |
| Mean colony size | 42.9 | 57.3 | 70.5 | NS |
| N of colonies | 43 | 51 | 58 | |
| Colonies active in all three surveys | | | | |
| Mean colony size | 45.6 | 63.9 | 83.2 | * |
| N of colonies | 36 | 36 | 36 | |

[1] One-way ANOVA.
* $p < 0.05$.
NS = Not sigificant for increase in each biennium.

abandoned in 1985 were active again in 1987, and 10 new colonies were added. It is difficult to determine when a new colony develops, and most of the "new" colonies reported here were probably overlooked in past surveys.

A total of 4090 great blue heron nests was counted, ranging from 1-395 nests/colony (mean = 70.5 nests/colony). Forty percent more great blue heron nests were counted in 1987 than in 1985 (2923 nests). A significant upward trend was noted in mean colony size (Table 2) between 1983 and 1985 (Sign test, $p < 0.05$, N = 39) and between 1985 and 1987 (Sign test, $p < 0.05$, N = 46). A significant increase ($p < 0.05$) also occurred in mean colony size from 1983 to 1987 among the 36 colonies that were active during all three surveys. This latter increase may be a more meaningful comparison of change.

These data probably represent close to the actual great blue heron population size in Indiana as the number of newly discovered or reported colonies has continued to decline. The 1983 survey reported 42 active colonies (Iverson, 1984). Between the 1983 and the 1985 survey, 12 "new" colonies were reported (Iverson, 1986). Between 1985 and 1987, 10 "new" colonies were reported. Since the 1987 survey, only 2 reports of previously unknown colonies have been reported to the NEWP.

Comparisons of colony size between the 1985 and 1987 survey periods are considered valid in spite of two possible sources of experimental error. The first is possible observer error; the number of participants (N = 28), who surveyed one or more colonies. For 48 of the 58 colonies surveyed in 1987, the same individual conducted both the 1985 and 1987 census of that colony. Only three new participants were involved in the survey in 1987. Constancy and experience of participants minimized the possibility of observer error.

A second source of error is the use of fall counts for six colonies in 1987. Tests were conducted during both 1985 and 1987 to evaluate the relationship between spring and fall

counts in the same colony. Eight colonies were counted in both spring and fall by the same observer and the nest change among all colonies was less than 1% (the range was from 22% to -12%); four colonies increased, three decreased, and one remained unchanged. These tests indicate that little significant variation occurred between spring and fall counts at the statewide population level. Taylor, *et al.* (1982) also found minimal differences between spring and fall counts.

The data suggest that the great blue heron nesting population in Indiana is undergoing an upward trend as evidenced by an increase in the total number of nesting colonies and, more importantly, by an increase in mean colony size in successive surveys. A 1987 statewide heron survey conducted in Illinois also documented a 6% increase in the total number of great blue heron colonies from 1985 to 1987 and a 54% increase in the total number of nests (Kleen, 1987). Increasing population trends for both Indiana and Illinois agree with Federal Breeding Bird Survey data that demonstrate a significant increase in great blue herons in the Eastern Region and especially in the Great Lakes Plain physiographic region (Robbins, *et al.*, 1986).

Heron colonies were not evenly distributed throughout the State (Figure 1). Chi-square analysis of the number of colonies within each of the four physiographic regions indicated that colonies did not occur in proportion to the total region land area (Table 3). Over 43% of the total $x^2$ value was attributed to a greater than expected occurrence of colonies in the Great Lakes Region. Conversely, fewer colonies than expected occurred in both the Lexington Plain (23% of the total $x^2$) and the Highland Rim (29% of the $x^2$ value). Mean colony size did not differ significantly (1-way ANOVA) among the four regions (Table 3).

Average colony size varied between colonies in riparian and upland habitats among all colonies and among colonies within some physiographic regions. Colonies in riparian habitats were significantly larger than those in upland areas (Table 4). Colonies were also significantly larger in riparian habitats within the Till Plain. Mean colony sizes tended to be larger (though not significantly) in riparian habitats in the Lexington Plain and Highland Rim but smaller in the Great Lakes Plain. Beech (*Fagus grandifolia*) was the predominant tree species used for nesting by herons in upland sites, and sycamore (*Platanus occidetalis*) was the predominant tree used in riparian areas.

Physiography and the associated relative abundance of wetland forging habitat between regions may be the most important limiting factor affecting the distribution and size of great blue heron nesting colonies in Indiana. Proportionately more colonies and generally larger colonies occurred within the Great Lakes Plain. This region has a large number of wetlands (e.g., bogs, fens, shallow emergent wetlands, and numerous lakes) that are of glacial origin (Homoya, 1985). The total surface area of these wetlands is also quite high. Herons are not dependent on riparian areas but can nest in upland woodlots and travel in all directions (up to 28 km; Parris and Grau, 1979) to forage in surrounding wetlands. Conversely, other regions of the State have fewer natural wetlands, and herons are more dependent on riparian areas for foraging. This pattern was evident in the Till Plain that is dominated by intensive agricultural development but transected by a number of rivers. Here, more colonies occurred in upland habitats, but those occurring in riparian areas were significantly larger. Gibbs, *et al.* (1987) demonstrated that great blue heron colony size was positively correlated with the abundance of nearby foraging habitat.

The number of years that a colony site had been active was known for 31 colonies. These ages are considered minimum values, since determination of the actual year that a colony became active is difficult. The oldest colony is the Rosbrugh colony in Kosciusko

Table 3. Distribution and mean size of great blue heron colonies in Indiana by physiographic region in 1987. A chi-square analysis was used to test for a proportional distribution of colonies based upon the area of the region ($x^2 = 13.9$; $df = 3$; $p < 0.01$).

| Physiographic Region | Area of Region (% of State) | Number of Colonies | Colony Size Mean |
|---|---|---|---|
| Great Lakes Plain | 24 | 23 | 85.3 |
| Till Plain | 33 | 23 | 50.3 |
| Lexington Plain | 30 | 10 | 76.7 |
| Highland Rim | 13 | 2 | 102.0 |
| Total | 100 | 58 | 70.5 |

County that has reportedly been active for over 150 years. A positive correlation exists between the number of years that a colony site has been active and the colony size ($r = 0.68$, $p < 0.001$); e.g., older colonies were larger, but the causal relationship is not understood. Some degree of stability inherent in larger colonies is suggested which would have important ramifications for conservation. Of the five colonies that were abandoned between 1985 and 1987, four were in the smallest colony size category (Table 5), suggesting a relative instability of smaller colonies. The three colonies that were abandoned between the 1983 and 1985 surveys were also in the smallest size class category (less than 25 nests). Ryder (1980) also reported that smaller colonies were more prone to abandonment.

Timber harvesting activity was the likely cause of abandonment for two colonies. Dead or dying timber was the cause of abandonment in one colony in 1987 and was implicated in the abandonment of two colonies in the 1985 survey (Iverson, 1986). Vermeer (1969) also attributed the decline and abandonment of heron colonies in Alberta to dead or dying timber supporting the nests. The LaSalle colony was the only large colony abandoned over the course of these three surveys. Public disturbance on this state-owned wildlife area was believed to be the reason for abandonment.

The colonial nesting habit of the great blue heron results in a large number of individuals concentrated into a relatively small area (e.g., 395 pairs in a 15 ha woodlot in the largest colony in Steuben County). This colony represents almost 10% of the entire statewide population. Over 70% of the nests in Indiana occur in the 17 largest colonies

Table 4. Average great blue heron colony size by habitat association within physiographic regions. The Wilcoxon Rank-Sum Test was used to test for differences between mean colony size by habitat type ($p > |z|$).

| Physiographic Region | Mean Colony Size Riparian | (N of Colonies) Upland | Test |
|---|---|---|---|
| Great Lakes Plain | 68.1 (9) | 96.4 (14) | $p = 0.66$ |
| Till Plain | 106.7 (7) | 25.6 (16) | $p = 0.01$ |
| Lexington Plain | 84.8 (9) | 4.0 (1) | $p = 0.22$ |
| Highland Rim | 202.0 (1) | 2.0 (1) | |
| Total | 89.4 (26) | 55.2 (32) | $p = 0.04$ |

Table 5. Change in great blue heron colonies from 1985 to 1987 by colony size catagory.

| Colony Size Category N of Nests | Number Increased | Number Decreased | No Change | Number Abandoned | Total |
|---|---|---|---|---|---|
| Over 200 | 2 | 0 | 0 | 0 | 2 |
| 101 - 200 | 3 | 2 | 0 | 1 | 6 |
| 51 - 100 | 12 | 0 | 0 | 0 | 12 |
| 26 - 50 | 3 | 6 | 0 | 0 | 9 |
| 1 - 25 | 13 | 3 | 2 | 4 | 22 |
| Total | 33 | 11 | 2 | 5 | 51 |

(Table 6). Thus, disturbance at a few sites jeopardizes a large proportion of the statewide population.

Historically, black-crowned night-herons and great egrets commonly nested in mixed species colonies with the great blue heron (Butler, 1898). During this survey, no nests of black-crowned night-herons were located within or adjacent to great blue heron colonies. However, the night-heron nests somewhat later than the great blue heron (Graber, *et al.*, 1978), so nesting activity of night-herons might have been missed. One unsuccessful nesting attempt by a single pair of great egrets was recorded in the Kankakee colony in 1987. These observations are in sharp contrast to a statewide heron survey conducted in Illinois in 1987 that identified a total of 19 colonies containing both great blue herons and great egrets (Kleen, 1987).

A comparison of present great blue heron populations with historical levels is nearly impossible due to insufficient historical data. Keller (1966) provided the only available review of great blue heron colonies in Indiana. He cited a total of 45 colonies that existed at some time over a 68-year period from 1897 to 1965, the largest containing 130 nests. Butler (1898) mentioned reports of several large, mixed-species heronries (great blue heron, great egret, and black-crowned night-heron) containing thousands of herons at a site referred to as "cranetown" as well as another area called "Crane Haven." Both colonies occurred within the famous "Grand Marsh" of the Kankakee River. Such colonies would easily have outnumbered the current statewide population of about 400 herons, suggesting that the current great blue heron population is lower than in the past.

Table 6. Size distribution of great blue heron colonies in Indiana, 1987.

| Colony Size Category | Number of Colonies | Total Number of Nests | Percent of All Nests |
|---|---|---|---|
| Over 200 | 5 | 1239 | 30 |
| 101 - 200 | 12 | 1642 | 40 |
| 51 - 100 | 8 | 598 | 15 |
| 26 - 50 | 10 | 369 | 9 |
| 1 - 25 | 23 | 242 | 6 |

## CONSERVATION STRATEGY

To provide for the conservation of the great blue heron, several programs should be included in a conservation strategy. First, the statewide surveys should be continued on a regular basis in order to monitor the status of this species, to detect any decline in population, and to identify threats to individual nesting colonies.

Second, significant colonies should be protected from adverse effects that would jeopardize their continued existence. All colonies containing over 200 nests should be targeted for a greater degree of protection. Protection could involve entering each into The Nature Conservancy's Registry Program to alert the landowner that a significant natural resource exits on his property. Significant recognition of 30% of the statewide population could be accomplished through this strategy. If direct and irreversible threats to the continued existence of a colony exist, the site should be targeted for permanent protection through conservation easements or purchase. The IDNR NEWP purchased the Lilovich colony in 1987 after it was learned that the woodlot supporting this colony was to be logged.

Finally, a minimum population threshold level should be established which would trigger the implementation of intensive research should either abrupt or chronic decline in the statewide great blue heron population be detected. Research would focus on identification of factors implicated in population decline, such as chemical contaminants, public disturbance, timber harvesting, or land development. Once identified, management actions could be implemented to counter the causal factors.

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