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Mapping patient intake: A geospatial analysis of admitted wildlife rehabilitation patients

Molly C. Simonis, Rebecca A. Crow, Debra K. Oexmann

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Trillium Tail at Bruckner Nature Center, Troy, Ohio.

ABSTRACT: Wildlife research is very important to the rehabilitation community, especially post-release studies. However, to begin to examine post-release, we must first understand where our patients are geographically in order to recognize where potential conflicts might arise. This paper presents an analysis of patient intake at Brukner Nature Center's Wildlife Rehabilitation Unit from 2006–2013. Initial patient location was mapped using Geographic Information System (GIS) technology provided through a student license for ESRI's ArcMap10.2. Results show the majority of wildlife patients were found in urban areas surrounding the center. This study provides Brukner Nature Center with baseline rehabilitation research for future admit, release, managerial, and potential collaborative studies in the future.

KEYWORDS: wildlife, wildlife rehabilitation, GIS, human-wildlife interaction, Brukner Nature Center, geospatial analysis, urban wildlife, wildlife conservation

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Introduction

Brukner Nature Center (BNC) is a privately-funded, nonprofit organization dedicated to promoting the appreciation and understanding of wildlife conservation through education, preservation, and rehabilitation. Located in Troy, Ohio, BNC opened to the public in May of 1974 by way of local philanthropist Clayton J. Brukner. The 235 acres of Ohio native habitats surround an interpretive building that houses interactive displays, a tree-top bird vista, and more than 50 permanently injured wildlife ambassadors. BNC offers a wide variety of educational, wildlife-oriented programs and events to the public, extending their mission beyond the grounds.

BNC also operates as the largest licensed wildlife rehabilitation facility in southwest Ohio. The purpose of BNC's Wildlife Rehabilitation Unit is to educate people regarding the natural history of Ohio's wildlife, to offer help and advice when wildlife and people conflict, and to care for, rehabilitate, and release native Ohio wildlife expected to survive in the natural environment. On average, one thousand animals are brought in by car-

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ing individuals from about twenty Ohio counties each year. As a nonprofit organization with limited time and resources, BNC focuses on species it can best care for and networks with other wildlife organizations to find help for those they cannot help. As a larger patient intake unit, the daily care for all rehabilitation animals is provided by staff and volunteers and is coordinated by BNC's Curator of Wildlife.

The rehabilitation unit follows Minimum Standards for Wildlife Rehabilitation in Ohio[1] as well as an invasive non-native species policy outlined by the Ohio Department of Natural Resources (ODNR) Division of Wildlife (ODW) (ODNR, 2014). Standards also include recommendations from the National Wildlife Rehabilitation Association (NWRA), the International Wildlife Rehabilitation Council (IWRC), and the Ohio Wildlife Rehabilitators' Association (OWRA) for nutritional, record keeping, and facility requirements. Permit requirements are fulfilled annually in year-end reports to US Fish and Wildlife Service (USFWS) for avian species and to ODNR for mammalian, reptilian, and amphibian species.

Veterinary standards are provided by Troy Animal Hospital and Bird Clinic of Troy, Ohio. Owner Dr. Lonnie L. Davis, DVM, ABVP, and associate veterinarian Dr. Julie Peterson, DVM, provide diagnostics, treatment, and recommendations for the medical treatment of BNC's rehabilitation patients.

Geographic Information System (GIS) technologies are computer program systems used for locating and examining various types of geographic data. The software provides users with the ability to analyze and interpret data through mapping. GIS is helpful for solving problems and answering questions by looking at data with geographically referenced information. GIS allows for trend, pattern, and relationship identification in a way that is quickly understood through visual representation.[2]

Geospatial representation studies of wildlife patients are limited in the rehabilitation field. Wildlife rehabilitators help to play a key role in conservation, and GIS technologies can help to illustrate their efforts. GIS is currently being widely used across a diverse range of preservation studies: loggerhead turtle hotspot mapping,[3] plotting mollusk assemblages in Poland,[4] mapping Brazilian coral reef habitat,[5] and black bear priority area identification in Texas,[6] to mention a few. This technology can be used on a broader scale as this study will demonstrate, or on a fine scale such as that used for endangered species habitat model studies.[7] With its many potential capabilities, GIS can be a useful tool in a rehabilitator's data analysis.

This study uses GIS technologies to give spatial reference to patient intake information and helps to visualize where wildlife patients are originating. It also represents areas that have been influenced by BNC's rehabilitators, who provide education on the natural history of native Ohio wildlife to every animal donor and wildlife caller. This baseline information can pave the way for many other research opportunities within BNC's organization, as well as collaborative projects.

The purpose of this study is to determine where admitted orphaned and injured wildlife is originating in relation to BNC's Wildlife Rehabilitation Unit. The study uses patient information between the years of 2006 and 2013 to reach a conclusion.

Methods

For each patient admitted to BNC's Wildlife Rehabilitation Unit, a Wild Patient Donor Form is filled out by the animal donor. These forms collect location information including the donor's home address and county where the patient was found. If an animal is not found at the donor's address, more detailed information on where the patient was found can be provided in the History/Nature of Injury section of the form.

From that donor form, each patient is assigned a case number. Numbers are assigned from #1 on January 1 of each year and continue through December 31. Patient case numbers are repeated each year. All case information was recorded by a BNC staff member or volunteer into an annual Microsoft® Excel workbook. In addition to donor provided information, patient disposition was recorded in the file as well.

Each annual workbook from 2006–2013 was then cleaned to eliminate data not of interest for this study (i.e., donor phone number, donations, and comments). Each patient entry was assigned a unique identification number and organized by county and intake year. The data was counted and recorded to show the admitted number of animals from each county annually for 2006–2013 (Table 1). This table was imported into ESRI's ArcMap 10.2 and combined with Ohio county shapefiles by county name in a process called joining. The Ohio county shapefiles were created through a selection process within the program using the US Census Bureau's Topologically Integrated Geographic Encoding and Referencing (TIGER) files from the 2010 census survey. In the US County shapefile, only counties within the state of Ohio were selected and then saved as its own shapefile. Fig. 1 was created by displaying counties where rehabilitation patients originated within the years 2006–2013. Fig. 2 was created by

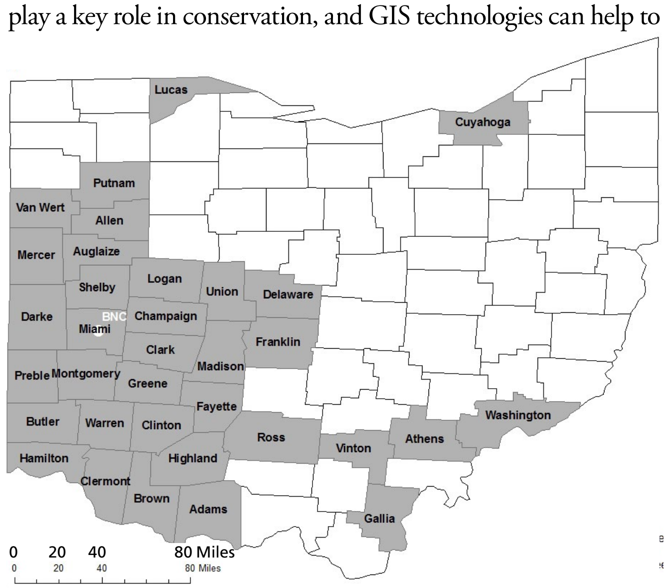

FIGURE 1. Ohio counties where BNC's Wildlife Rehabilitation Unit's patients have originated from the years of 2006–2013.

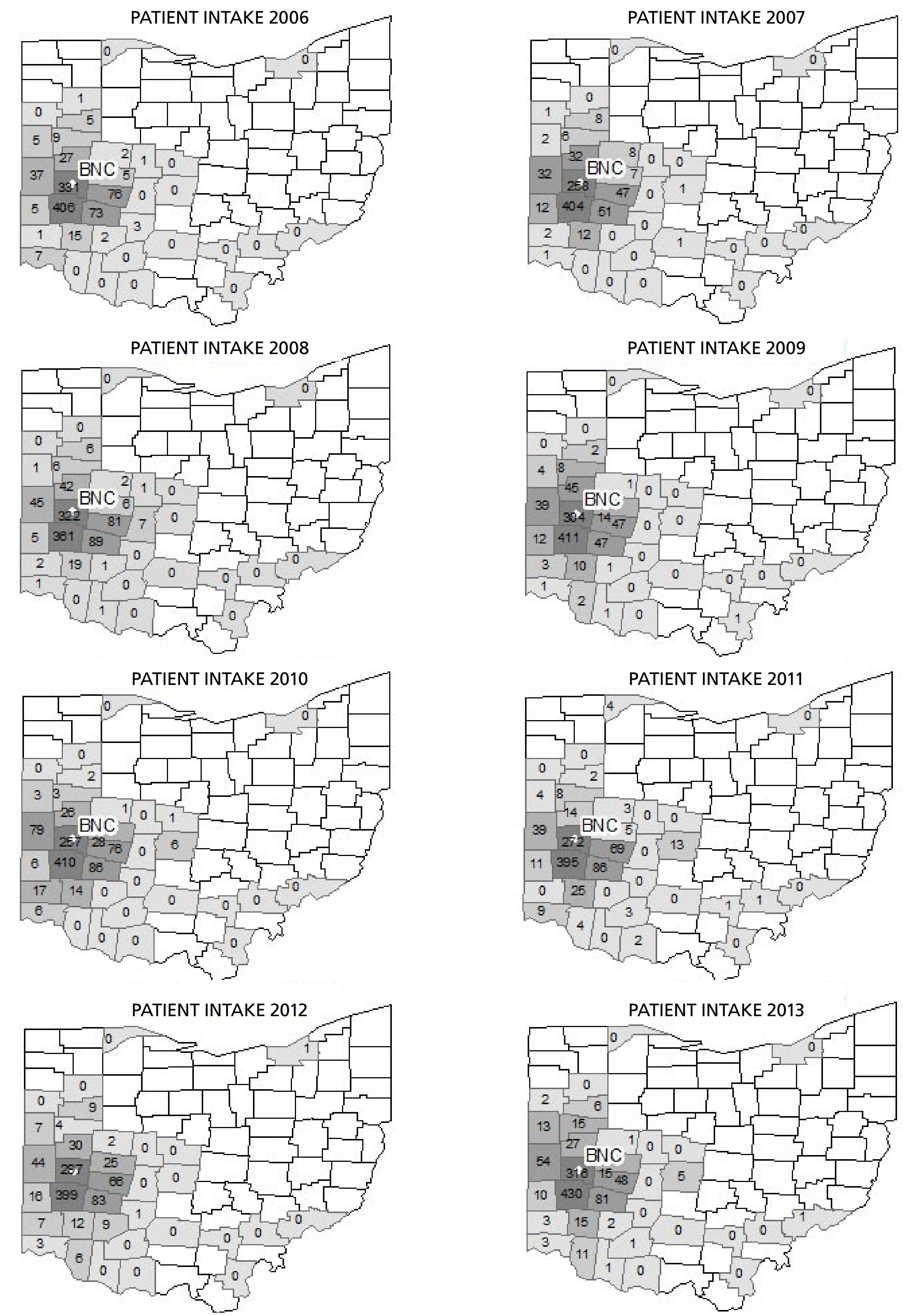

FIGURE 2. The number of patients admitted into BNC's Wildlife Rehabilitation Unit in relation to their counties of origin. Every wildlife admittance country active at least once from 2006–2013 is represented.

displaying the number of patients admitted each year from these counties between 2006 and 2013. Counties with darker gray shades indicate larger intake numbers.

Annual Excel workbooks were then exported to a Microsoft® Access database and uploaded to Texas A&M (TAMU) GeoServices to obtain latitude and longitude data because ESRI's geocoding service is not provided on a student license. Geocoding is a process used to obtain a geographic coordinates from, in this instance, a street address. Once geocoded, the Microsoft® Access databases were exported into Excel and brought into ArcMap 10.2 for visualization and analysis. Fig. 3 displays all address points where wildlife patients originated within the eight years covered by this study. If more than one patient was admitted from the same address (i.e., mammalian litters, avian clutches, etc.), it was represented by a single geographic coordinate. For example, if five neonate eastern cottontails were admitted from Donor A's back yard due to a predator attack, the five cottontails are represented by one geographic point in Figs. 3 and 4. The number of patients admitted are held as an attribute in the joined table as representation, but not displayed. Fig. 4 then provides a closer view of where the majority of patients originated from with an Urban Areas layer and displayed as a transparent overlay. The Urban Areas layer was created from 2010 US Census Bureau's TIGER files, selected for the state of Ohio only, and saved as its own shapefile.

Results

Through Table 1 and Fig. 1, it is shown that BNC's Wildlife Rehabilitation Unit has touched 34 of 88 Ohio counties in an eight year period. Fig. 2 indicates most of BNC wildlife patients are originating from Montgomery County, with BNC's home county of Miami taking second rank. Other counties of larger intake origins are Clark, Darke, and Greene. A large cluster of intake patient points are displayed in Fig. 3 within Montgomery County and Miami County, supporting the previous annual county findings in Fig. 2. Lastly, Fig. 4 gives a visual relationship between wildlife patients and urban areas. Zoomed in, one can see patients originating in and around the Dayton, Ohio, vicinity, thus displaying the majority of wildlife patients facing conflicts in the same urban area.

Discussion

This study predominantly presents spatial trends in the Ohio counties with a greater number of wildlife admittance patients within a fifty-mile radius of BNC's property. However, results also display outlier patients in counties where few patients have originated from 2006–2013. These outliers are related to two patient scenarios: 1) patients were transferred from other rehabilitation facilities, and 2) patients were removed from their origin by the patient donor without knowledge of other rehabilitators at a closer distance to where the patient was discovered. Even though these anomalies are accounted for, they are rare and do not overly skew data trends.

Other limitations of this study can be attributed to human error. The total number of patients admitted each year when totaled in Table 1 did not exactly match numbers in annual permit reports. It was often found the patient's Wild Patient Donor Form was not complete. Other circumstances reveal that data entry by staff and volunteers was incomplete or lacked standardization. Although missing intake numbers each year varied from two to 21 patients, the trends identified in this study were not affected. While fewer than 1% of patients were unidentified, 99.2% of total patient intake is represented throughout this study giving 7,919 of 7,980 total patients a geographic location.

As a baseline analysis, this study can encourage many other collaborative research projects for BNC. These future projects could be conducted by BNC, or outside sources and organizations such as ODNR. Patient admittance origins from this study could benefit many state conservation studies currently in practice like those previously modeled for habitat planning[8] and wildlife action plans.[9] For example, with the species information connected to the geographic location of each patient, these maps and data could contribute by helping to delineate specific species ranges and the habitats in which they reside.

Although patient admittance information is what is investigated in this paper, all other attributes of donor information and patient disposition are attached to each point displayed in Figs. 3 and 4. Further study and research collaborations could use similar maps with different attributes explored. For example, displaying characteristics such as animal type and/or species could help with small and large scale biodiversity studies like those modeled in the southwestern US.[10] Presenting geospatial analyses of patients' injury or admittance reason could benefit wildlife disease research similar to studies of West Nile Virus in squirrels.[11] Furthermore, as this study implies a relationship between rehabilitation and human-wildlife interaction in more urbanized areas, showing these values paired with dispositions could contribute to public health studies and recommendations.[12] Lastly, these attributes could support studies that exhibit trends associated with urbanization and wildlife causes of death.[13] Any of these prospective research directions would be beneficial across multiple fields of interest when collaborated.[14]

Not only do the findings in this paper illustrate where wildlife patients are originating, but the results could also be interpreted as the extent of BNC's educational outreach. It is the mission of BNC's Rehabilitation Unit "to educate people regarding the natural history of Ohio's wildlife," and "to offer help and advice when wildlife and people conflict." During patient admittance, staff members educate the public, and it has been shown previously that facilities similar to BNC contribute greatly to the dissemination of information about wildlife, biodiversity, and environmental sciences.[15,16] Further study for this interpretation might indicate how BNC's outreach has educated the public, or changed perceptions of wildlife,[17] wildlife conservation,[18] and the resources available to help.[19]

Conclusion

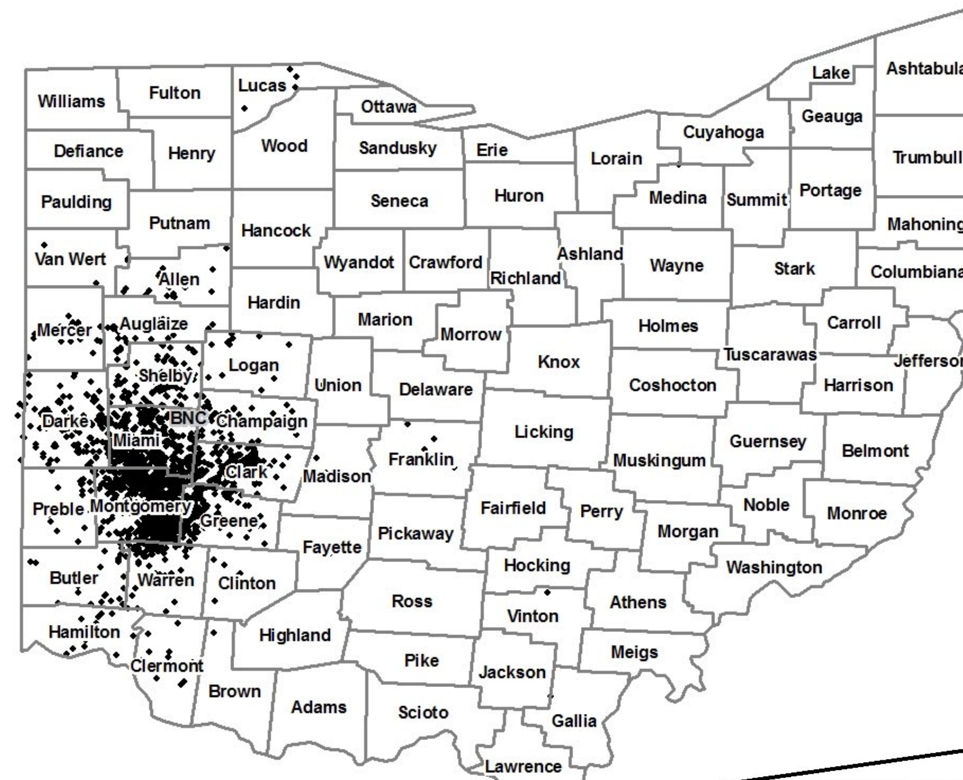

FIGURE 3. Geocoded addresses where patients were found based on patient donor forms from 2006–2013. Geocoding services were provided through Texas A&M University GeoServices.

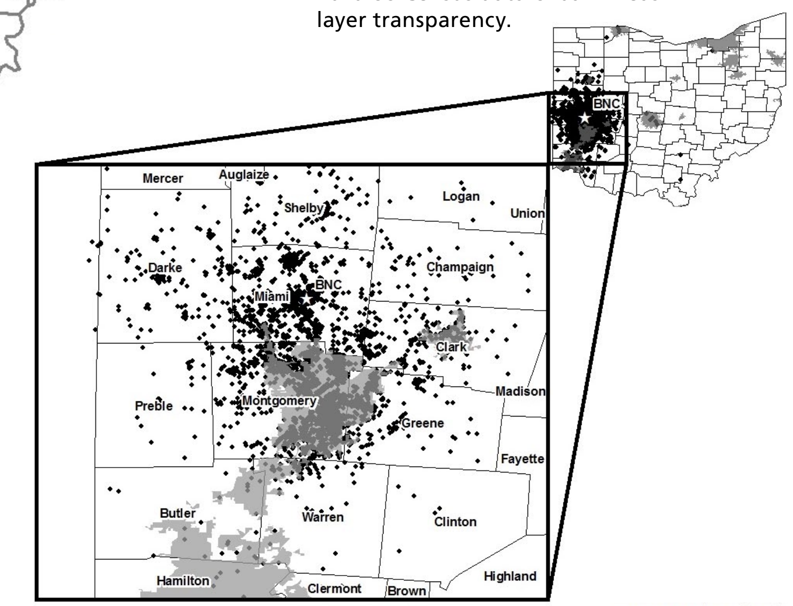

FIGURE 4. Geocoded patient addresses from 2006–2013 with a 2010 US Census data Urban Areas layer transparency.

Orphaned and injured wildlife being accepted in BNC's Wildlife Rehabilitation Unit each year is originating from the more urbanized areas near BNC. In particular, the largest number of animals being admitted each year is coming from the more developed areas in Ohio's Montgomery County. Seeing these attributes mapped through GIS software supports the mission of BNC's Rehabilitation Unit.

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About the Authors

Molly C. Simonis graduated from the University of Dayton with a BS in Environmental Biology in 2009. After an internship with Brukner Nature Center in college, she pursued professions in the veterinary field before returning as their Wildlife Research Fellow in 2014. Molly continues to pursue further education in conservation and GIS technologies.

Rebecca A. Crow graduated from the University of Toledo with a BA in Environmental Sciences in 2004. In 2005, she joined Brukner Nature Center where she is currently employed as the Curator of Wildlife. In addition, Rebecca has been affiliated with the Ohio Wildlife Rehabilitators' Association since 2007 and currently serves their Board of Trustees as President.

Debra K. Oexmann graduated from Miami University of Ohio with a BS in Zoology and a Masters in Environmental Sciences. She is currently the Executive Director of Brukner Nature Center where she has worked for the past 25 years.

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TABLE 1. THE ADMITTED NUMBER OF ANIMALS FROM EACH COUNTY ANNUALLY FOR 2006–2013.

COUNTY	INTAKE 2006	INTAKE 2007	INTAKE 2008	INTAKE 2009	INTAKE 2010	INTAKE 2011	INTAKE 2012	INTAKE 2013	TOTAL INTAKE
Adams	0	0	0	0	0	2	0	0	2
Allen	5	8	6	2	2	2	9	6	40
Athens	0	0	0	0	0	1	0	0	1
Auglaize	9	6	6	8	3	8	4	15	59
Brown	0	0	1	1	0	0	0	1	3
Butler	1	2	2	3	17	0	7	3	35
Champaign	5	7	6	14	28	5	25	15	105
Clark	76	47	81	47	76	69	66	48	510
Clermont	0	0	0	2	0	4	6	11	23
Clinton	2	0	1	1	0	0	9	2	15
Cuyahoga	0	0	0	0	0	0	1	0	1
Darke	37	32	45	39	79	39	44	54	369
Delaware	0	0	0	0	1	0	0	0	1
Fayette	3	0	0	0	0	0	1	0	4
Franklin	0	1	0	0	6	13	0	5	25
Gallia	0	0	0	1	0	0	0	0	1
Greene	73	51	89	47	86	86	83	81	596
Hamilton	7	1	1	1	6	9	3	3	31
Highland	0	0	0	0	0	3	0	1	4
Logan	2	8	2	1	1	3	2	1	20
Lucas	0	0	0	0	0	4	0	0	4
Madison	0	0	7	0	0	0	0	0	7
Mercer	5	2	1	4	3	4	7	13	39
Miami	331	258	322	304	257	272	297	316	2357
Montgomery	406	404	361	411	410	395	399	430	3216
Preble	5	12	5	12	6	11	16	10	77
Putnam	1	0	0	0	0	0	0	0	1
Ross	0	1	0	0	0	0	0	0	1
Shelby	27	32	42	45	26	14	30	27	243
Union	1	0	1	0	0	0	0	0	2
Van Wert	0	1	0	0	0	0	0	2	3
Vinton	0	0	0	0	0	1	0	0	1
Warren	15	12	19	10	14	25	12	15	122
Washington	0	0	0	0	0	0	0	1	1
Totals Intake	**1011**	**885**	**998**	**953**	**1021**	**970**	**1020**	**1060**	**7919**
Total Counties	**19**	**18**	**19**	**19**	**17**	**21**	**18**	**22**	**34**

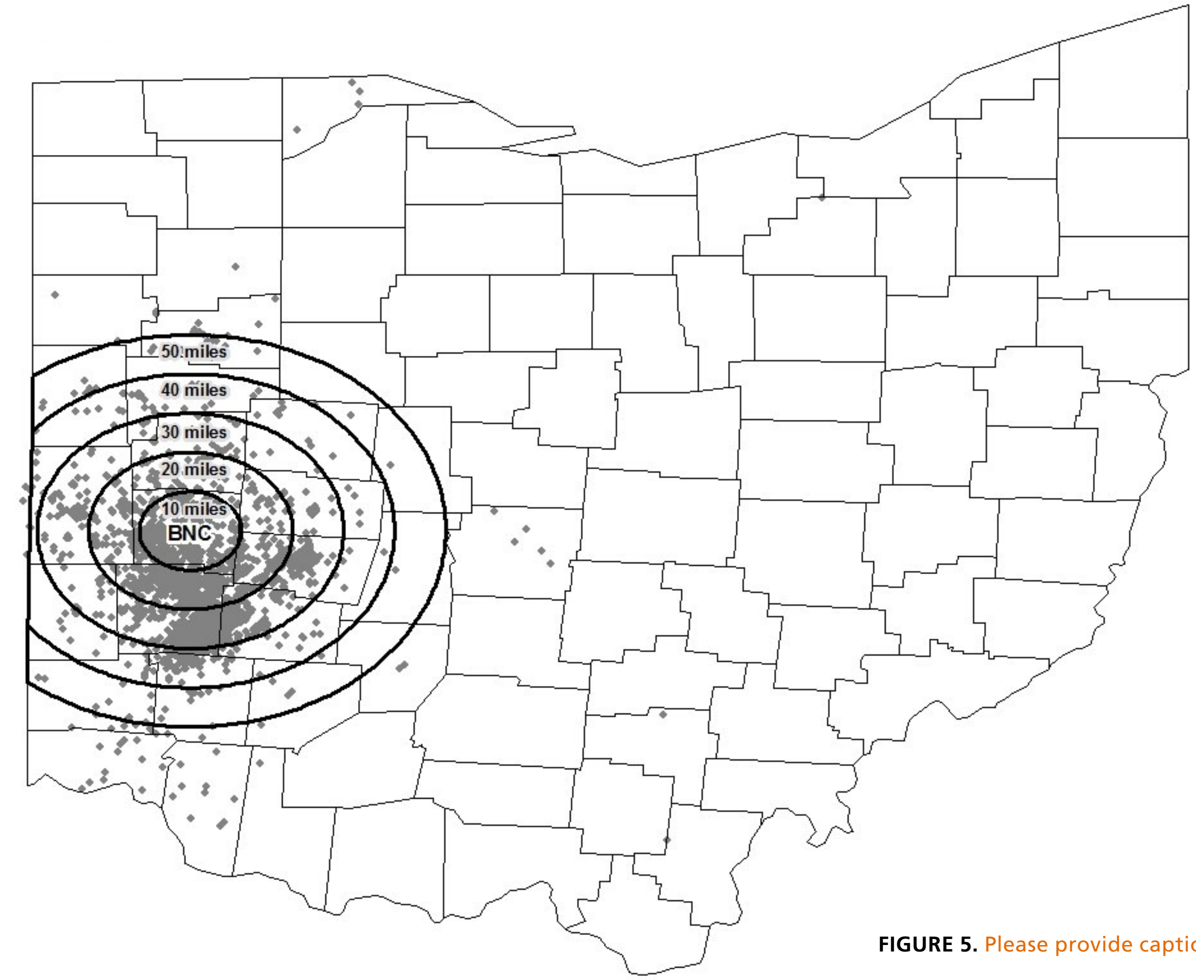

FIGURE 5. Please provide caption for this figure.

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