DEVELOPMENT OF A GEOGRAPHIC INFORMATION SYSTEM TO ANALYZE CONSERVATION LAW ENFORCEMENT DATA IN MISSISSIPPI

By

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TO ANALYZE CONSERVATION LAW ENFORCEMENT

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Geographic information systems (GIS) have been used in wildlife and fisheries management and research for many years. However, these systems are not being used to their fullest potential in conservation law enforcement. At present, there are only 5 conservation law enforcement agencies in the United States using a GIS. This research outlines the development of a GIS for use in conservation law enforcement in Mississippi and preliminary analysis of citation data from fiscal years 1997 – 2000 on a county and state level. Geographic information systems can provide officers the means to become more pro-active and efficient at managing and protecting our wildlife resources. This may be achieved by retaining the institutional knowledge of all officers that have worked for an agency. With this knowledge base in place, wildlife resources can be protected effectively for years to come.

DEDICATION

I dedicate this research to my grandfather Toxey M. Puckett. His love of the outdoors was passed on to me at an early age. It nearly broke his heart when he thought I would not get a college degree and he never got to see me graduate from college or start this research. I know he would be proud of me.

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I would first like to thank Rich Minnis for allowing me to begin this research. It seems like every time we get to talking about this project we find more and more that can be done. I hope we can continue to work together on this for many years to come. I thank Dr. Burger for serving as my co-major professor on this project. It may have been hard to get a hold of you sometimes, but you were always willing to lend a helping hand and I appreciate that.

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Most of all I want to thank my family. Without your support I would not have been able to complete this journey. And most of all I want to thank my wife Lynn. You have worked so hard to get us where we are today. I have dragged you all over the

South and every time we moved you never complained. Just one more move and that's IT! I love you.

There really is a close-knit group of people in our department. I will miss you all. It has been like having an extended family: faculty, staff, and students. I appreciate every thing you have all done for me over the past 2 years. Ya'll come see us in Jackson. The door's always open.

Dacus

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CHAPTER I

INTRODUCTION, BACKGROUND INFORMATION, AND JUSTIFICATION

Introduction

Law enforcement is one of the oldest aspects of natural resource management (Sigler 1995). One of the oldest records of conservation law enforcement may be Marco Polo's chronicles of the laws that Kublai Khan initiated over his lands. According to Polo, Khan had placed into law that no one should harvest animals during the breeding season, and had soldiers enforce this law. This being the case it is probably the least researched of all aspects of wildlife management (Beattie et al. 1977). There has been a call for more research in the arena of wildlife law enforcement since the late 1960's (Giles 1970; Giles et al. 1971; and Beattie 1976*a*). However, Giles (1971) suggested that the lack of research might be a result of the lack of extra funds within the law enforcement divisions of the state agencies. Also, research has not been a priority for conservation law enforcement agencies. Their priorities have been primarily to prevent law violations, protect beneficial species during their breeding season, assure the sporting public a "fair share" of available game, and to require the purchase of licenses (Giles 1971).

Beattie et al. (1977) estimated that conservation law enforcement comprised 28% of natural resource agency budgets in the 1970's. In the Southeast, the average expenditure for law enforcement in 1997 was $12.7 million per state wildlife and fisheries agency (SEAFWA 1998). That equates to 23.6% of the total average agency budget of $53.7 million for the entire southeast or $203 million annually (SEAFWA 1998). With this kind of expenditures, it is easy to see the importance of wildlife law enforcement in the Southeastern United States and the rest of North America.

The public resource management agencies in each state are charged with the responsibility of conserving, protecting, and enhancing fish and wildlife and their habitats for the continuing benefit of the American people. This is done with the help of sound laws and regulations along with hard working conservation officers. Awareness of the importance of regulating human interaction with an impact on wildlife and fish populations becomes extremely apparent when one considers that approximately 77 million United States residents (16 and older) participated in wildlife related activities in 1996 (USDI/USDC 1977). These wildlife related activities ranged from hunting and fishing to wildlife watching.

Spatial technologies in the form of geographic information systems (GIS) and global position systems (GPS) have been available for a number of years. Jack Dangermond started Environmental Systems Research Inc. (ESRI), the world leader in GIS software and maker of ArcInfo and ArcView in 1969. The Department of Defense launched the first NAVSTAR GPS satellites in 1987, with a functional compliment available in 1995 (Kennedy 1996). Natural resource management has realized and incorporated the usefulness of these spatial technologies. GPS is now used commonly for

mapping and telemetry, while GIS is used in nearly all resource agencies. Similarly, the use of GIS to monitor calls for service, officer activity, and service type within municipal law enforcement agencies is increasing (Quist 1999; Anon 1991). The flexibility, ease of use, and economic benefit of applying this rapidly expanding technology has recently been realized by both disciplines (Minnis et al. 1999).

"Traditional" law enforcement also has adopted spatial technologies as useful for crime mapping and analysis (Harries 1999). In 1997, the National Institute of Justice realized the importance and capabilities of spatial technologies to law enforcement and developed the Mapping and Analysis for Public Safety, formerly known as the Crime Mapping Research Center. The literature is replete with examples of successful application of spatial technologies to law enforcement [e.g., GIS/GPS in Law Enforcement Master Bibliography (Albert 2000), the Crime Mapping Research Center's Crime Mapping Bibliography (1998), and Mapping & Crime Analysis Bibliography (Swartz 1997)]. While the literature is replete with applications of spatial technologies to natural resource management and "traditional" law enforcement, it is devoid of examples of spatial technologies being used in conservation law enforcement.

Virginia Polytechnic Institute was a leader in conservation law enforcement research in the 1970's and analyzed the spatial and temporal occurrences of white-tailed deer (*Odocoileus virginianus*) head-lighting cases in Virginia (Kaminsky 1974). Harelson (1992) presented probably the first documented case of GIS being used in wildlife law enforcement. The purpose was to document the geographic distribution of waterfowl arrests in Wisconsin and to enhance waterfowl enforcement. Minnis et al. (1999) examined the effectiveness of using GIS as an evaluation tool for conservation

law enforcement. While the literature is limited in examples using spatial technologies to solve conservation law enforcement problems, it is replete with articles expressing problems of a spatial nature e.g., officer deployment in Texas (Thomas et al. 1999).

Background Information

Johnson (1990) defines a GIS as computer-based system for the manipulation and analysis of spatially distributed data. Also, a GIS can be a computerized mapping system that permits information layering to produce detailed descriptions of conditions and analyses of relationships among variables. The information in the GIS is based on drawing different spatial data on suitable media and overlaying them on one another to find interrelated points (Harries 1999). This model of a GIS in not new, there is evidence of this model being used at the 11th century Angkor Wat temple complex in what is today Cambodia (Foresman 1998).

Another system that is often used in conjunction with GIS is the global positioning system or GPS. A GPS is a set of satellites that are used to provide precise locations on the surface of the earth (Hurn 1989). GPS allows the user to record detailed information about any object while collecting highly accurate positional data (Ralston 1999). These 2 systems, GIS and GPS, can be and are used together, but they also can be used independently. The fact that they can be used together, or independently, has caused some confusion when developing the GIS for use in Mississippi. Some officers and supervisors inadvertently will refer to GPS when they are discussing GIS, and vice versa. Spatial technologies is a term that encompasses GIS and GPS.

Justification

Survey of Conservation Law Enforcement Agencies in the United States

A 3 page, 16-question survey was developed to assess the current status of spatial technology usage in conservation law enforcement in the United States (Appendix 1). Questions were developed to illicit the current of use of spatial technologies and to determine the potential future usage of these technologies. Additionally, questions were developed to understand how agencies are using, or are interested in using, data derived from spatial technologies to aid officers and administrators in law enforcement activities.

Surveys were mailed to the chief (or other top official) of the natural resource law enforcement agency in all 50 states, as well as the United States Fish and Wildlife Service law enforcement division. Because several states had multiple agencies, e.g. natural resources and marine resources, 57 surveys were mailed in December 2000. Postcard reminders were mailed to non-respondent states after 2 weeks. A second survey was mailed to non-respondent states 3 weeks after the postcard reminder. Phone-call follow-ups were attempted 3 weeks after the second survey was mailed. This survey methodology followed Dillman (1987).

Data were entered into a Microsoft Excel© (Microsoft Corp., Redmon, WA, Ver. 2000) spreadsheet, checked for entry errors, and summarized. The question regarding the number of officers currently possessing a GPS unit was standardized to a percentage of the total number of commissioned officers per agency. The statistical package SPSS 8.0 (Statistical Package for the Social Sciences ver. 8.0. 1998. Chicago, IL) was used for data summary.

Results

There were 51 respondents, representing wildlife and fisheries agencies in 46 U.S. states. Of those completing the survey, 37.3% (n=19) were Chiefs of Law Enforcement, 27.5% (n=14) were Assistant Chiefs of Law Enforcement, 3.9% (n=2) were District Supervisors, 2.0% (n=1) were conservation officers, and 29.4% (n=15) held other positions. The agencies represented in this survey had a combined total of approximately 7,140 field conservation officers. Slightly less than half (48.6%) of these officers have GPS units in their possession for official use. Most respondents (84.3%) indicated that their officers were issued GPS units by their state agency, whereas 15.7% (n=51) indicated that their officers were not issued GPS units (Table1.1) Respondents indicated that 37.5% of officers not issued GPS units by their agency obtained GPS units from other sources.

When asked how these GPS units were used (Question 6, Appendix I), 80.4% (n=46) indicated that they were used to locate hunting/boating accident sites, 69.6% to locate wildlife and fisheries projects/activities, 56.5% to locate citations, 28.3% to locate officers, 10.9% to monitor officer movement, and 50.0% for other uses (Table 1.2). Other uses included search and rescue (n=6), navigation (n=7), evidence/crime scene marking (n=9), marking boundaries, shipwrecks, and water hazards (n=3).

Most of the agencies responding (n=44) plan to provide GPS units to officers in the future (90.9%). Of those planning to provide future units, 42.5% (n=40) currently provide units, 22.5% plan to provide units in one to 3 years, 10% plan to provide units in 3 – 5 years, and there were 10 non-respondents to this question. When asked how the future units will be used (Question 8, Appendix I), 80.0% (n=40) indicated that they will

be used to locate hunting/boating accident sites, 75.0% to locate citations, 67.5% to locate wildlife and fisheries projects/activities, 42.5% to locate officers, 32.5% to monitor officer movement, and 45.0% for other uses i.e., search and rescue, navigation, and locating boundaries (Table 1.2).

Many agencies (68.6%, n=51) input citation data into a database to manage their officers' citations, but 31.4% do not. When asked at what organizational level the citation data was maintained (Question 10, Appendix I), 45.7% (n=35) were at the state level, 8.6% district level, 17.1% county level, and the remaining 25.7% were maintained at some other level. Only 9.8% (n=51) of the agencies use a GIS to map specific citation locations. The overwhelming majority (90.2%) do not.

When asked to rate usefulness of GIS to the agency (Question 15, Appendix I), respondents (n=45) were split on evaluating officer deployment with 44.4% finding it more useful to their agency and 48.9% finding it less useful (Figure 1.1). Only 26.7% of agencies responding thought GIS would be useful in determining officer habits and evaluating newly implemented programs, whereas 62.2% and 55.6% found it would be less useful, respectively (Figure 1.2). Conversely, 63.0% (n=46) of agencies responding thought GIS would be useful to evaluate citation distribution by county or district and by citation type, whereas 21.8% thought it would be least useful (Figure 1.3). Agencies (n=45) gave mixed responses on effectiveness of examining location of citations in relationship to land ownership (31.1% more useful and 37.8% less useful) and in evaluating the relationship between citation locations and harvest information (26.7% more useful and 40.0% less) (Figure 1.4). Determining and evaluating wildlife/water related accident locations was viewed as the most useful by the responding agencies

(n=47, 58.7% more useful and 21.7% less) (Figure 1.5). Six agencies suggested other uses including: determining "exact" locations and have a point of reference for offshore enforcement, locating water hazards and road kill deer locations, determining patrol area and work load (note, this is officer deployment), evaluating complaint locations for future patrol strategies, and locating and marking probable violation sites such as baiting locations and marijuana patches.

Discussion

The mixed results from this survey is evidence that conservation law enforcement agencies do not realize the potential of GIS and the benefits that agencies can gain from its use. Officer deployment has long been an issue in conservation law enforcement (Giles et al 1971, Beattie et al 1977, Cowles 1979, Thomas et al 1999). Yet almost one-half (48.9%) of the respondents see a GIS less useful to their agency in evaluating officer deployment. Sixty-three percent of respondents perceive a GIS most useful in evaluating citation distribution by county/district. This is quite peculiar because citation distribution is one of the aspects to consider when evaluating officer deployment.

Most of the agencies (68.6%) input citation information into a database, but only 9.8% of agencies use a GIS for mapping specific citation locations. One reason could be that not all of the agencies that input citation information have “exact” citation locations, e.g., GPS coordinates. However, a GIS can still be used if there is a county code or county name input with the citation information to create citation distribution maps at the state or district level by county. Additionally, there are ways to obtain “exact” locations of the citation as presented by Dacus et al (2001).

An important point is that all of the potential analyses presented above can be conducted with the same dataset and can be conducted quite easily after the GIS is in place. The most time consuming aspect of any GIS is the development of the GIS and determining what analyses should be conducted (Johnson 1990).

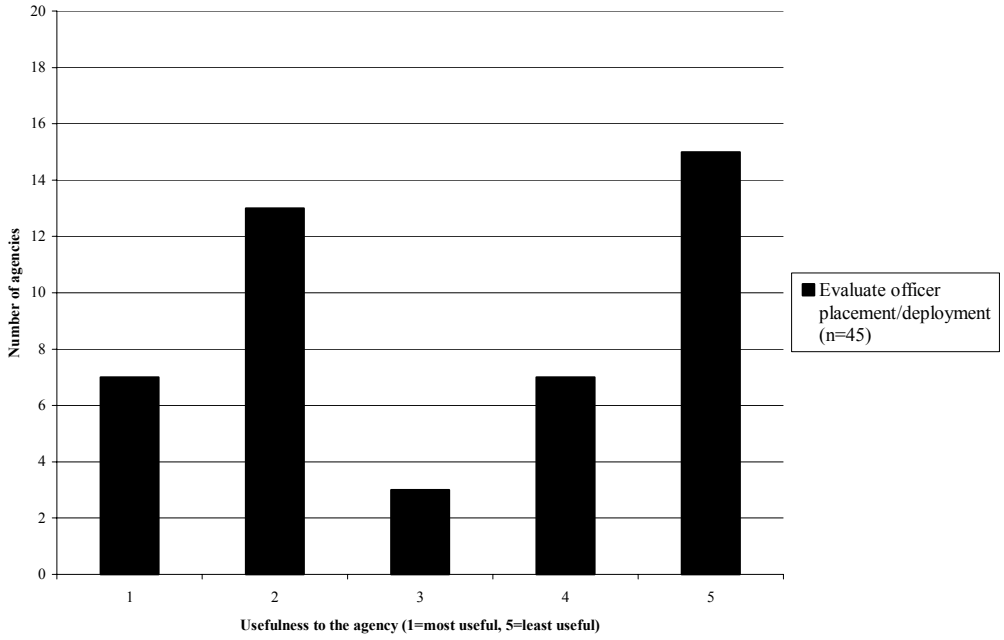

Figure 1.1 Usefulness of a GIS to an agency in determining officer deployment as rated by the agencies responding to the survey (Question 15).

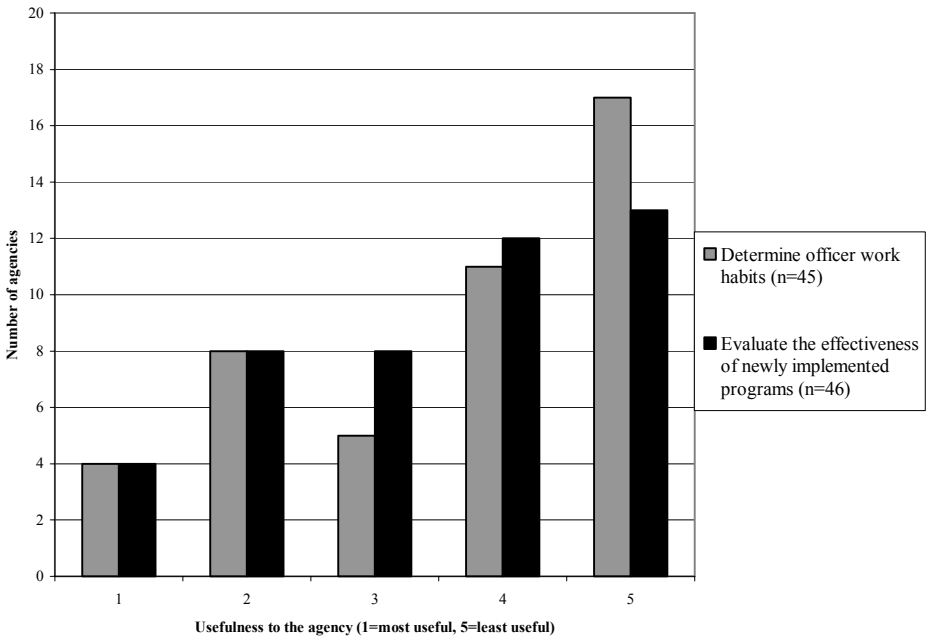

Figure 1.2 Usefulness of a GIS to an agency in determining officer habits and evaluating newly implemented programs as rated by the agencies responding to the survey (Question 15).

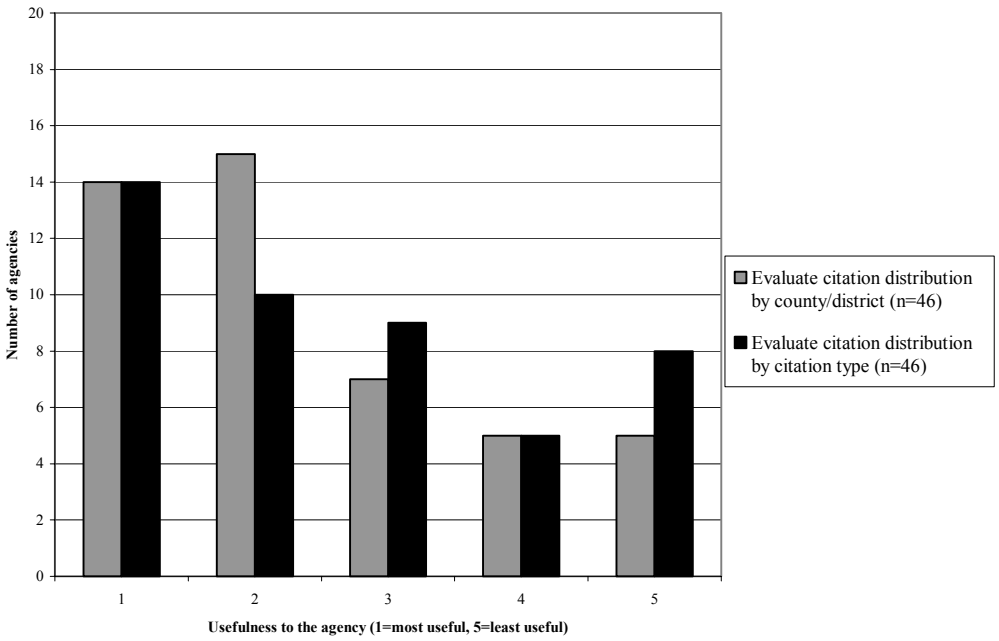

Figure 1.3 Usefulness of a GIS to an agency to evaluate citation distribution by county or district and by citation type as rated by the agencies responding to the survey (Question 15).

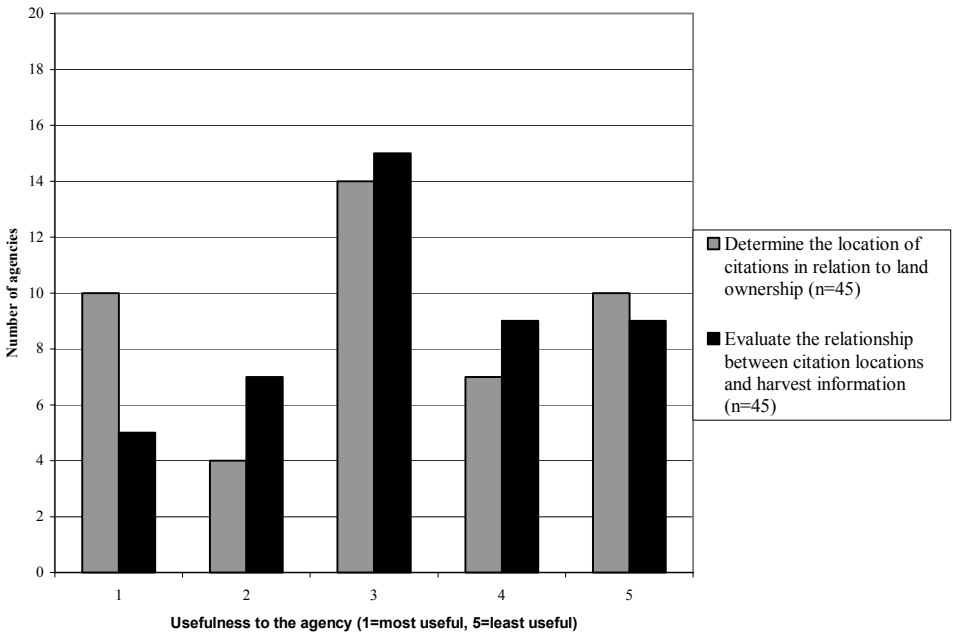

Figure 1.4 Usefulness of a GIS to an agency to examine the location of citations in relationship to land ownership and in evaluating the relationship between citation locations and harvest information as rated by the agencies responding to the survey (Question 15).

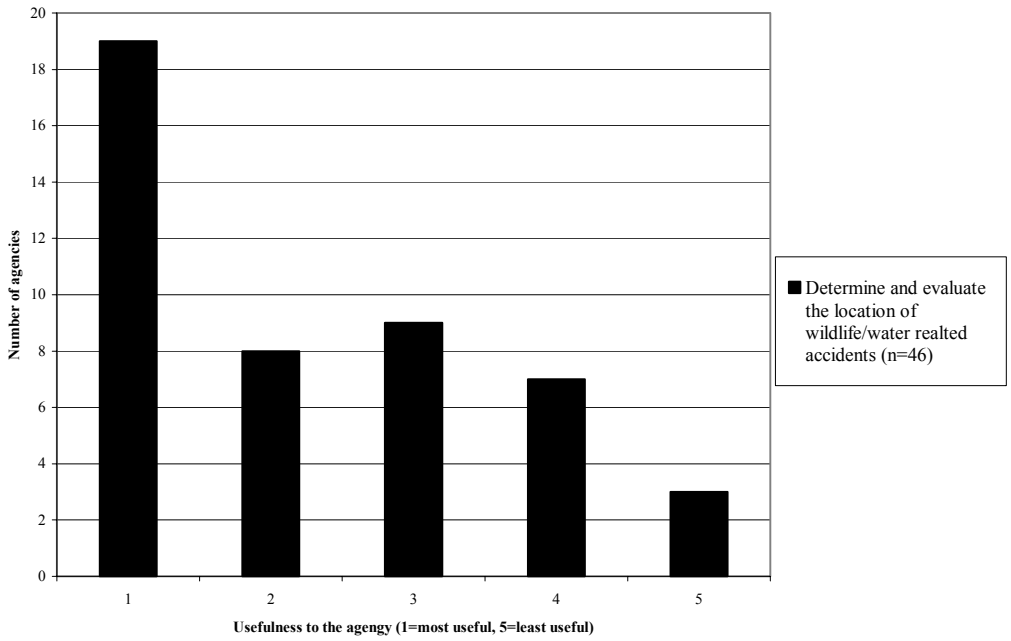

Figure 1.5 Usefulness of a GIS to an agency in determining and evaluating wildlife/water related accident locations as rated by the agencies responding to the survey (Question 15).

Table 1.1 Summary of GPS use in 2000 by law enforcement divisions of natural resource agencies in the United States

State	Department/Division	# of Field Level Officers	Issue GPS*	Officers Issued GPS Units	% of Officers with GPS Units
AL	Wildlife & Freshwater Fisheries Enforcement Section	147	0	---	0.0%
AL	Marine Police Division	63	1	25	39.7%
AK	Fish and Wildlife Protection	89	1	89	100.0%
AR	Game and Fish Commision	160	1	80	50.0%
AZ	Game and Fish Dept.	160	1	64	40.0%
CA	Dept. of Fish and Game	430	1	300	69.8%
CT	Dept. of Environmental Protection	47	1	47	100.0%
DL	Division of Fish and Wildlife	27	1	13	48.1%
FL	Fish and Wildlife Conservation Commission	418	1	250	59.8%
GA	Wildlife Resources Division	252	1	35	13.9%
HI	Division of Conservation and Resources Enforcement	40	1	24	60.0%
IA	Fish & Wildlife Division	88	1	30	34.1%
ID	Dept. of Fish and Game	105	1	35	33.3%
IL	Dept. of Natural Resources	113	1	20	17.7%
IN	Dept. of Natural Resources	215	1	215	100.0%
KS	Dept. of Wildlife and Parks	65	0	0	0.0%
KY	Dept. of Fish and Wildlife	163	1	163	100.0%
LA	Dept. of Wildlife and Fisheries	225	1	100	44.4%
ME	Dept. Inland Fisheries & Wildlife	95	1	120	126.3%
ME	Dept. of Marine Resources	50	1	48	96.0%
MD	Natural Resources Police	189	1	189	100.0%
MI	Dept. of Natural Resources	222	1	200	90.1%
MN	Dept. of Natural Resources	140	0	---	0.0%
MS	Dept. of Wildlife, Fisheries and Parks	337	1	218	64.7%
MO	Dept. of Conservation Protection Division	170	1	13	7.6%
MT	Fish, Wildlife & Parks	84	1	80	95.2%
NE	Game and Parks Commission	48	0	0	0.0%
NV	Division of Wildlife	37	1	19	51.4%
NH	Fish and Game Dept.	44	1	30	68.2%
NJ	Division of Fish and Wildlife	49	1	17	34.7%
NM	Dept. of Game and Fish	66	1	25	37.9%
NY	Dept. of Environmental Conservation	259	0	---	0.0%
NC	Wildlife Resources Commission,	202	1	202	100.0%
ND	Game and Fish Dept.	30	1	30	100.0%
OH	Dept. of Natural Resources	125	1	5	4.0%
OK	Dept. of Wildlife Conservation	125	0	---	0.0%
OR	State Police, Fish and Wildlife Division	128	1	20	15.6%
PA	Fish and Boat Commission	99	0	---	0.0%
PA	Game Commission	135	1	55	40.7%
SC	Dept. of Natural Resources	210	1	210	100.0%
TN	Wildlife Resources Agency	176	0	---	0.0%
TX	Parks and Wildlife	400	1	150	37.5%
UT	Division of Wildlife Resources	74	1	30	40.5%
VT	Fish and Wildlife Dept.	39	1	39	100.0%
VA	Dept. of Game & Inland Fisheries	192	1	20	10.4%
VA	Marine Resources Commission	68	1	25	36.8%
WA	Dept. of Fish and Wildlife	164	1	20	12.2%
WV	Division of Natural Resources	97	1	18	18.6%
WI	Dept. of Natural Resources	153	1	85	55.6%
WY	Game and Fish Dept.	70	1	70	100.0%
USFWS	Southeast Region	56	1	42	75.0%
	Totals	7140	43	3470	48.6%

* 1 = yes, 0 = no

Table 1.2 Current and future uses of GPS units by conservation officers in the United States.

State	Department/Division	Locate Projects	Locate Citations	Monitor Officer	Locate Officer	Locate Accident	Other
AL	Wildlife & Freshwater Fisheries Enforcement Section	C				C	
AL	Marine Police Division		CF		CF	CF	CF
AK	Fish and Wildlife Protection	CF					CF
AR	Game and Fish Commision	CF				CF	
AZ	Game and Fish Dept.	CF	CF	CF	CF	CF	CF
CA	Dept. of Fish and Game	C	C	C	C	C	
CT	Dept. of Environmental Protection	CF	CF		CF	CF	
DE	Division of Fish and Wildlife	CF	F	CF	CF	CF	
FL	Fish and Wildlife Conservation Commission	CF	CF			CF	
GA	Wildlife Resources Division		C			C	
HI	Division of Conservation and Resources Enforcement	CF	CF		CF		CF
IA	Fish & Wildlife Division	CF	F			CF	
ID	Dept. of Fish and Game	CF	CF			CF	
IL	Dept. of Natural Resources	CF	CF	F	F	CF	
IN	Dept. of Natural Resources	C	C		C	C	
KS	Dept. of Wildlife and Parks	F	F			F	F
KY	Dept. of Fish and Wildlife		CF			CF	CF
LA	Dept. of Wildlife and Fisheries	CF	CF	F	F	CF	
ME	Dept. Inland Fisheries & Wildlife	C				C	C
ME	Dept. of Marine Resources	CF	CF			CF	CF
MD	Natural Resources Police	CF	CF		CF	CF	CF
MI	Dept. of Natural Resources	CF			CF	CF	CF
MN	Dept. of Natural Resources	F	F			F	
MS	Dept. of Wildlife, Fisheries and Parks	F	CF	F	CF	CF	
MO	Dept. of Conservation Protection Division	CF				CF	
MT	Fish, Wildlife & Parks	C	C			C	C
NE	Game and Parks Commission		F		F	F	
NV	Division of Wildlife	CF	F	F	F	CF	C
NH	Fish and Game Dept.	C				C	CF
NJ	Division of Fish and Wildlife		CF	F		C	
NM	Dept. of Game and Fish	C	C				
NY	Dept. of Environmental Conservation		F	F		F	
NC	Wildlife Resources Commission,	C			C	C	
ND	Game and Fish Dept.	CF	CF			CF	
OH	Dept. of Natural Resources	CF		F	F		C
OK	Dept. of Wildlife Conservation	F	F	F			
OR	State Police, Fish and Wildlife Division	CF		CF	CF	CF	CF
PA	Fish and Boat Commission						
PA	Game Commission	C	F			CF	
SC	Dept. of Natural Resources		C			C	C
TN	Wildlife Resources Agency	F	F		F	F	
TX	Parks and Wildlife		CF			CF	CF
UT	Division of Wildlife Resources		CF				CF
VT	Fish and Wildlife Dept.	CF	CF	CF	CF	CF	CF
VA	Dept. of Game & Inland Fisheries					CF	CF
VA	Marine Resources Commission					CF	CF
WA	Dept. of Fish and Wildlife		CF	F	CF	F	
WV	Division of Natural Resources		CF			CF	
WI	Dept. of Natural Resources	CF				CF	CF
WY	Game and Fish Dept.	C				C	C
USFWS	Southeast Region	CF	CF				CF

C = Current uses of GPS units

F = Future uses of GPS units

CHAPTER II

DEVELOPMENT OF A GEOGRAPHIC INFORMATION SYSTEM FOR USE IN CONSERVATION LAW ENFORCEMENT

Introduction

Geographic information systems (GIS) have been used in wildlife and fisheries management and research for many years (Johnson 1990). This same technology also is being used in municipal police departments across the United States. However, these systems are not being used to their fullest potential in conservation law enforcement. Harelson (1992) presented probably the first documented case of GIS being used by a wildlife law enforcement agency. The purpose was to characterize the geographic distribution of waterfowl arrests in Wisconsin and to enhance waterfowl enforcement.

There are 3 rules to consider when developing a GIS for use in conservation law enforcement: 1) determine the needs as an agency; 2) obtain software that will satisfy the agency needs; and 3) select hardware that will run the selected software (Miller 1995). These steps sound easy, but they can lead to much confusion. Determining the needs of a conservation law enforcement agency can be the most difficult of these steps. This is primarily due to the lack of information available on GIS uses in conservation law enforcement.

At present, there are only 5 conservation law enforcement agencies in the United States using a GIS and 2 agencies that plan to implement a GIS in the next 5 years (Dacus et al 2001; Figure 2.1). The Mississippi Department of Wildlife, Fisheries and Parks (MDWFP) in conjunction with the Department of Wildlife and Fisheries at Mississippi State University (MSU) is involved in the development of this GIS. This chapter focuses on the issues of developing a GIS in Mississippi for use in conservation law enforcement.

There are 2 components of any GIS: a tabular component and a spatial component. The tabular component contains attributes that can be used to query the GIS, i.e., Citation database. The spatial component contains the location information of the GIS, i.e., spatial database. Citations lend themselves to spatial analysis because they occur at a specific location. The only thing missing from the citation data in Mississippi is a positional location, i.e., x and y coordinates. Global positioning system (GPS) units are one method that can be used to add this spatial component. Having officers plot the citation locations on paper maps and digitizing the points is another method that can be used to add the spatial component to the database. This spatial component can be used to develop a dataset that can be linked to existing data already provided on written citations, i.e. species, violation type, violator's names, etc. With the spatial data linked to the citation data, the officers can display spatial distribution of violations by type, offender, date, etc. However, in Mississippi all officers do not have GPS units. Currently only 64.7% of the field level officers have GPS units in their possession for official use (Dacus et al 2001). And there is only 1 district out of 7 that currently records the coordinates of

their citation locations. This lack of GPS units leads to the first obstacle to overcome in the development of a GIS, no precise location of where the citation was written.

In Mississippi, citation information has been recorded in a database since 1 July 1996 (herein referred to as Citation database). There are 45,017 citations in the Citation database. This past citation information was to be included in the development of this GIS. The problem with using this historic information was no location information had been recorded on the citations. Because this historic data was to be included in the GIS, the location was the key component that was missing and necessary in developing the GIS. During the development there were many obstacles to overcome.

Methods

Data collection

Meetings were held with all conservation officers in Mississippi to introduce them to the GIS, explain the advantages/benefits they will receive from this GIS, and to manually plot citation locations on paper maps. Maps of citation distribution per district (Figure 2.2) and citation distribution maps by species (Figure 2.3) are 2 examples of benefits from the GIS that were shown to the officers. It was explained to the officers that they would receive personalized maps of their home county/sub-district plotting all citations with their citations highlighted in a different color (Figure 2.4).

A listing of citations that had been written between 1 July 1996 and 30 June 2000 was given to each officer. They were asked to plot the citations on 1:100,000 scale county topographic maps. The maps were created using Sure!Maps RASTER digital scanned data (Sure!Maps RASTER. 1998. Horizons Technology, Inc. San Diego, CA).

Maps were created in decimal degrees (latitude/longitude) World Geodetic Systems 1984 (WGS 84). Next to each point plotted on the map, officers also were asked to write the citation number that corresponded to the point. All research operated under and complied with MSU Institutional Review Board for the Protection of Human Subjects in Research (MSU) Protocol No. 00-265.

Data Entry

The citation locations were manually digitized into ArcView 3.2 (ArcView GIS Version 3.2. 2000. Environment Systems Research Institute, Inc. Redlands, CA) using heads-up digitizing from Sure!Maps RASTER scanned data to create the spatial database. The background maps in the GIS were the county topographic maps created with Sure!Maps. Once a citation was located on the paper map it was digitized into the GIS at the same location as the plotted point. When more than one citation was written at the same location individual points were input into the spatial database for each citation. The citation numbers were then entered into the table as an identifier to each point.

Citations on bodies of water were approximated. Lakes and rivers do not have good landmarks that can be readily located on maps. There are however, stretches or reaches in the river that can be used to plot groups of citations. There also are coves or other areas of a lake that can be distinguished when plotting these citations. Even though these citation locations are not exact, they can still be used in analysis and to determine problem areas associated with bodies of water. Citation locations also were approximated on some state wildlife management areas (WMA) and on some national wildlife refuges. In some cases lists of citations were received from officers with a note

describing what WMA or what section of a WMA these citations were written. On these WMA's, the random point generator in Arc View Animal Movements (Hooge and Eichenlaub 1997) was used to randomly place locations for these citations. Then the transfer/convert function in ArcView X-Tools (DeLaune 2000) was used to place the citations in the spatial database.

There were 35,622 citations digitized into the spatial database which indicates approximately 9,300 citations from the Citation database were not plotted. Reasons for these not being plotted included officers that wrote the citations were no longer employed by the MDWFP, officers could not remember where the citations were written, and in one case (Union county) maps with plotted citations were not returned.

Manual digitizing for a 15 county section of Mississippi containing 6,400 citations took approximately 26.5 hours. This does not account for the time it takes the officers to plot the citations on the paper maps, nor to correct the data entry errors. Also, data entry of citation information at the state or district office is not included in this time estimate (Dacus et al 2001).

Citation Database Modifications

Once the data were entered, modifications to the Citation database were needed because the data entry of citations in the state and district offices was not consistent over years. In the original Citation database from the MDWFP there were 35 fields (Table 2.1). A new species description field was needed because the species code list used by officers changed in 1999. A new field was created using a combination of the 2 different species code lists. Also, the MDWFP operates on a fiscal year (1 July – 30 June), not a

calendar year, so a fiscal year field was needed. Finally, the officers' badge numbers were not consistent. The badge number is associated with the county, not necessarily with the officer. If an officer relocated between counties or was promoted to a supervisory position, the badge number would change. Five new fields were created to correct these problems (Table 2.2).

Data Correction

Errors in the spatial database ranged from transposition of numbers on the officer's side (on the paper maps), transposition of numbers when entered into the spatial database, citation numbers entered incorrectly due to the inability to read the officers handwriting, and citation numbers plotted at more than one location on the paper maps. The inability to read the officers handwriting caused problems and added time to the process, however most numbers could be determined. This problem could often be corrected by looking at a list of citations that were not plotted and comparing the citation numbers in the Citation database to the citations plotted to determine the correct citation number (Dacus et al 2001).

To check for these errors the Citation database was linked to the spatial database. A new shape file was created from records that linked to the spatial database. Using Select by Theme, this new shape file was used to select the records in the spatial database that linked to the Citation database. The selection was reversed and a shape file was created of these locations that did not link to the Citation database. Each location that did not match the citation database was located on the paper maps to determine the cause of the error.

The final error check was performed to find duplicate records in the spatial database. A summary table was created in ArcView to find duplicate entries. This summary table was used to query the spatial database. There were 6 citation numbers in 3 different locations and 688 in 2 different locations, for a total of 1,394 incorrect locations. Once again, each of these citations had to be located on the paper maps to determine the error. In the event that both numbers were written in 2 counties, the one in which the citation was written (according to the Citation database) was assumed to be correct and the other location was evaluated. If the errant location could not be corrected it was deleted from the spatial database. Also, if the citations were in the same county and the error could not be determined, one was deleted and the other assumed to be correct. This determination was made by looking at the information in the Citation database relative to the plotted points near the errant points, e.g., time and date. At the end of this process there were 35,058 locations in the spatial database and 9,959 (22.1%) not plotted. All of the locations in the spatial database were assumed to be correct.

Discussion

Associated Error

The base maps created with Sure!Maps RASTER have inherent error associated with them. These maps were created from U.S Geological Survey (USGS) maps which meet USGS National Mapping Standards. In accordance with these standards, the horizontal accuracy is no more than 166 feet on a 1:100,000 scale map.

Even if the officers plotted the citation locations within 2-3 miles of the actual location of the arrest location, at the state, district, or sub-district scale the distribution of

error is negligible. When examining the data on a state, district, sub-district, or county level this inherent error does not limit the data for analysis due to the scale at which the analyses are conducted. The points plotted by the officers are assumed to be in the correct location.

Advantages of Using Historic Citation Data

Plotting this historic citation data makes it available to conduct research and to evaluate past enforcement activities. Minnis et al. (1999) described potential uses for a GIS in wildlife law enforcement. These uses range from contrasting a state-wide assessment of waterfowl citations versus waterfowl harvest numbers, to identifying "gaps" between districts, to evaluating an "officer's sphere of influence" (Dacus et al 2001).

There are numerous other potential uses and advantages to using this historic data in a GIS. One important advantage is this historic data can provide feedback about past enforcement activities, which allows officers to be more proactive in future enforcement activities by being able to see past problem areas. New officers see an immediate benefit from citation maps of their county or management area because they can look at a visual representation of where the citations occurred; thus reducing the learning curve for these officers. This also can benefit officers who have been assigned to a new area in the same manner. They do not have to spend weeks, months, or even years learning where problem areas exist. With the GIS maps of citation distribution, these officers can quickly acclimate to the new territory.

Limitations and Challenges when Using Historic Citation Data

Plotting the historic data on topographic maps can be challenging for a couple of reasons. The main problem is how cluttered and congested these paper topographic maps can be after officers plot his/her citations (Figure 2.5). There are occasions when more than one citation is written at the same location. In cases such as this, officers place one point where the citations were written and then list out all of the citation numbers written at that location beside the point. This led to problems identifying which points some of the numbers were associated with, especially when there were no lines drawn from the point to the list of citation numbers. It is important for officers to write out the citation numbers, as this is the linking variable between the spatial database and the citation database that contains all of the citation information, i.e., offender's name, address, violation code, species code, etc.

Another limitation is the approximation of locations of citations on bodies of water, some WMA's, and national wildlife refuges. Citations that were written on WMA's and/or national wildlife refuges were problematic for other reasons. Some officers knew the citation was written in a certain area of the WMA but not an exact location. Some citations written by United States Fish and Wildlife Service (USFWS) personnel on national wildlife refuges were given to MDWFP Conservation Officers. These citations were plotted in a general section of the refuge and not in an exact location. The Yellow Creek Box area on Figure 2.5 is an example of this.

The time involved in plotting the citations on paper maps and then using heads-up-digitizing to enter the citations into the GIS is another limitation. Dacus et al (2001)

stated that the initial set up of the GIS takes much longer than the upkeep and maintenance of the system. With the initial database in place, regular maintenance of the system will include digitizing much fewer points.

The last problem in plotting the historic citation data on paper maps was that some citations could not be used. The main reason for citations not being plotted was that the officer that wrote the citation was no longer with the agency. In this scenario, the officer's partner plotted all of the citations they were familiar with, but this left approximately 9300 citations that could not be plotted. This accounted for the largest number of citations that could not be incorporated into the database. Also, there were some citations that the officer could not remember the exact location. All of these citations can still be used for analysis on a county or district level, but not for analysis concerning the individual officer.

Summary

Some of the errors and disadvantages discussed above can be eliminated in future updates of the GIS. Errors involving officers plotting citations on paper maps, digitizing errors, and approximation of locations on bodies of water and WMA's can be eliminated if all officers are issued GPS units. The coordinates taken with the GPS unit can be written on the citation and entered into the Citation database. In addition to limiting the errors in the dataset, this would reduce the amount of time involved when updating the spatial database.

The most important consideration when developing a GIS for use in conservation law enforcement is the standardization of the data to be collected by the officers (Dacus

et al 2001). This can be as simple as making sure all officers use the same citation format and codes, i.e., species and violation codes; and can be as specific as making sure all officers collect citation locations in the same coordinate system and datum. Dacus et al. (2001) recommend data in Mississippi be collected in decimal degrees (latitude/longitude) World Geodetic Systems 1984 (WGS 84). All GPS units come preset to latitude/longitude WGS 84 as a default. WGS 84 is believed to be the most accurate datum for the entire world. The only change that needs to be made on the GPS unit is to change the coordinates from degrees, minutes, and seconds to decimal degrees. These data can be converted at a later time to a different projection, if so desired, with little effort.

Analysis on a large scale, i.e., state, district, or sub-district level, can be accomplished with the data in this spatial database. One type of analysis that could not be accomplished is looking at citation distribution on bodies of water and on some of the WMA's in the state. Officers may remember a general location of the arrest on lakes and reservoirs, but without GPS coordinates performing any type of analysis on these areas is not suggested.

Analysis at the officer level cannot be evaluated on a consistent basis. Some officers could not plot all of the citations that they wrote and all officers did not write the same number of citations in each year. Without these citations, evaluation of an officer's sphere of influence would be incomplete and therefore inaccurate. However, the use of maps by the officers for self-evaluation is a possibility. With these maps the officers can

determine for themselves what area is not being covered in a county/sub-district and ask the question: “why are there no citations in this area?”

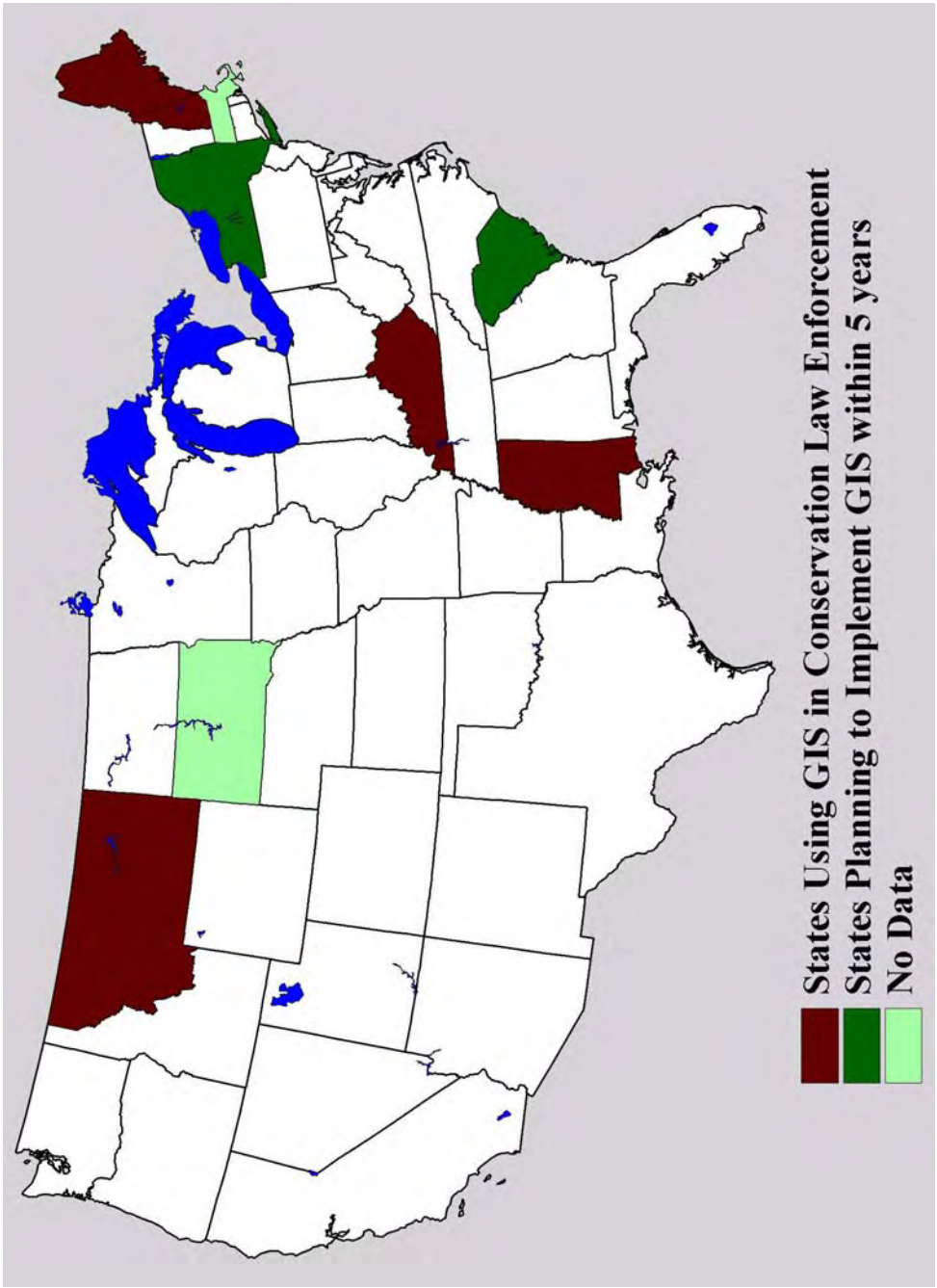

Figure 2.1. Conservation law enforcement agencies with a GIS in place in January 2000 and agencies planning to implement a GIS within the next 5 years.

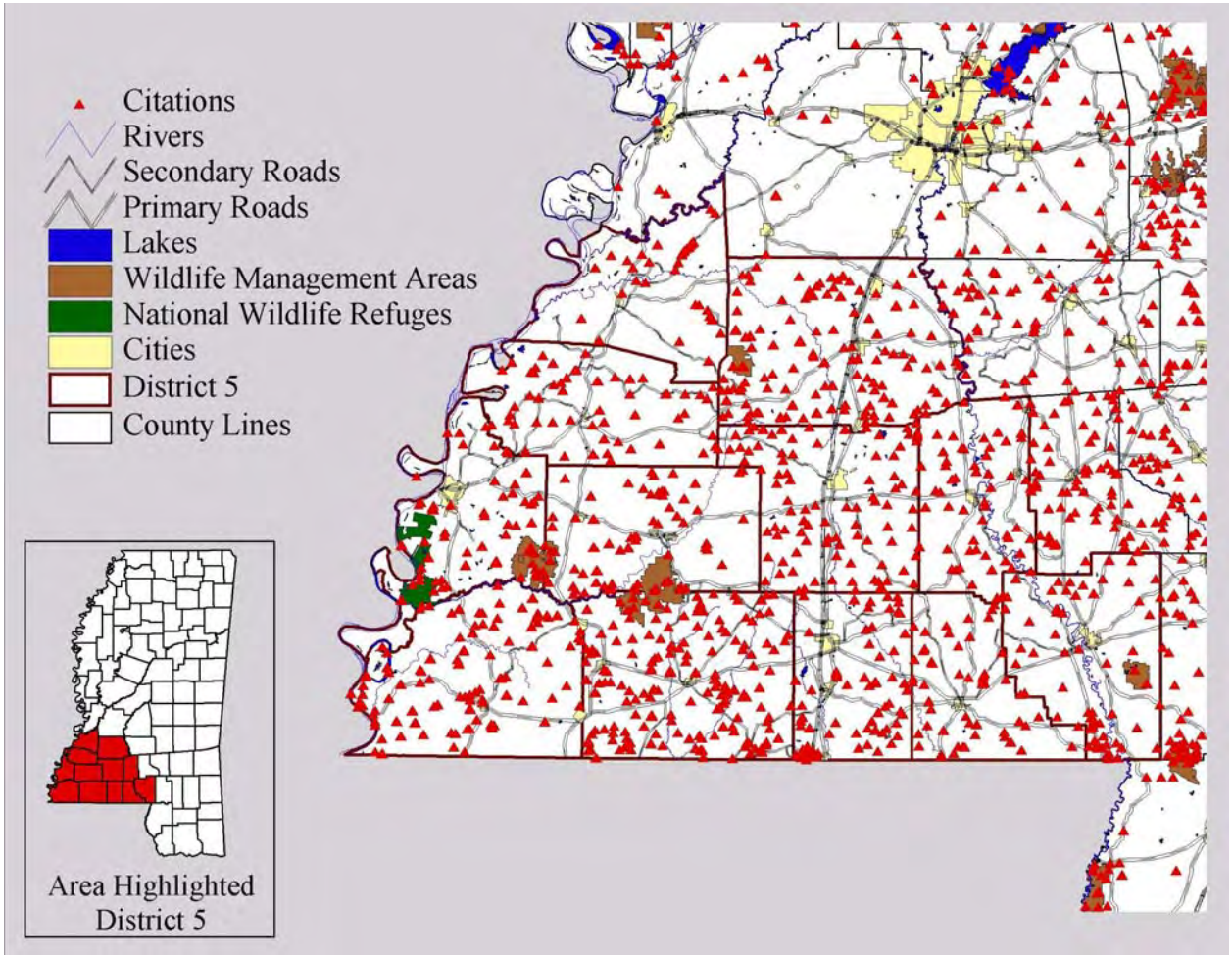

Figure 2.2. Maps of citation distribution of all citations written by Mississippi Department of Wildlife, Fisheries and Parks officers were provided to each district office.

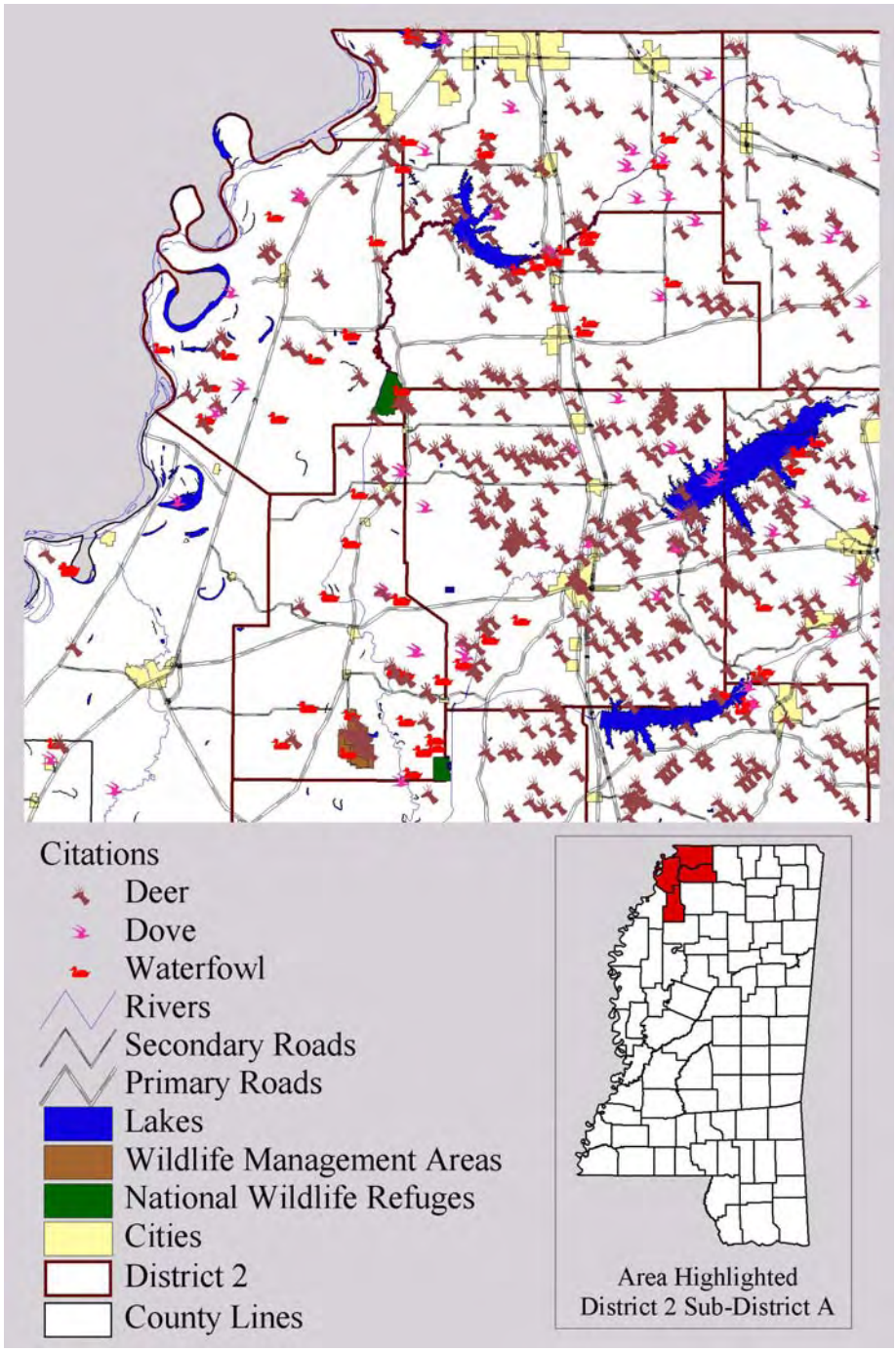

Figure 2.3. Example of a map provided to Conservation officers in District 2-A in Mississippi with citations coded by species. Only 3 species are used and their symbols are enlarged for clarity in this example.

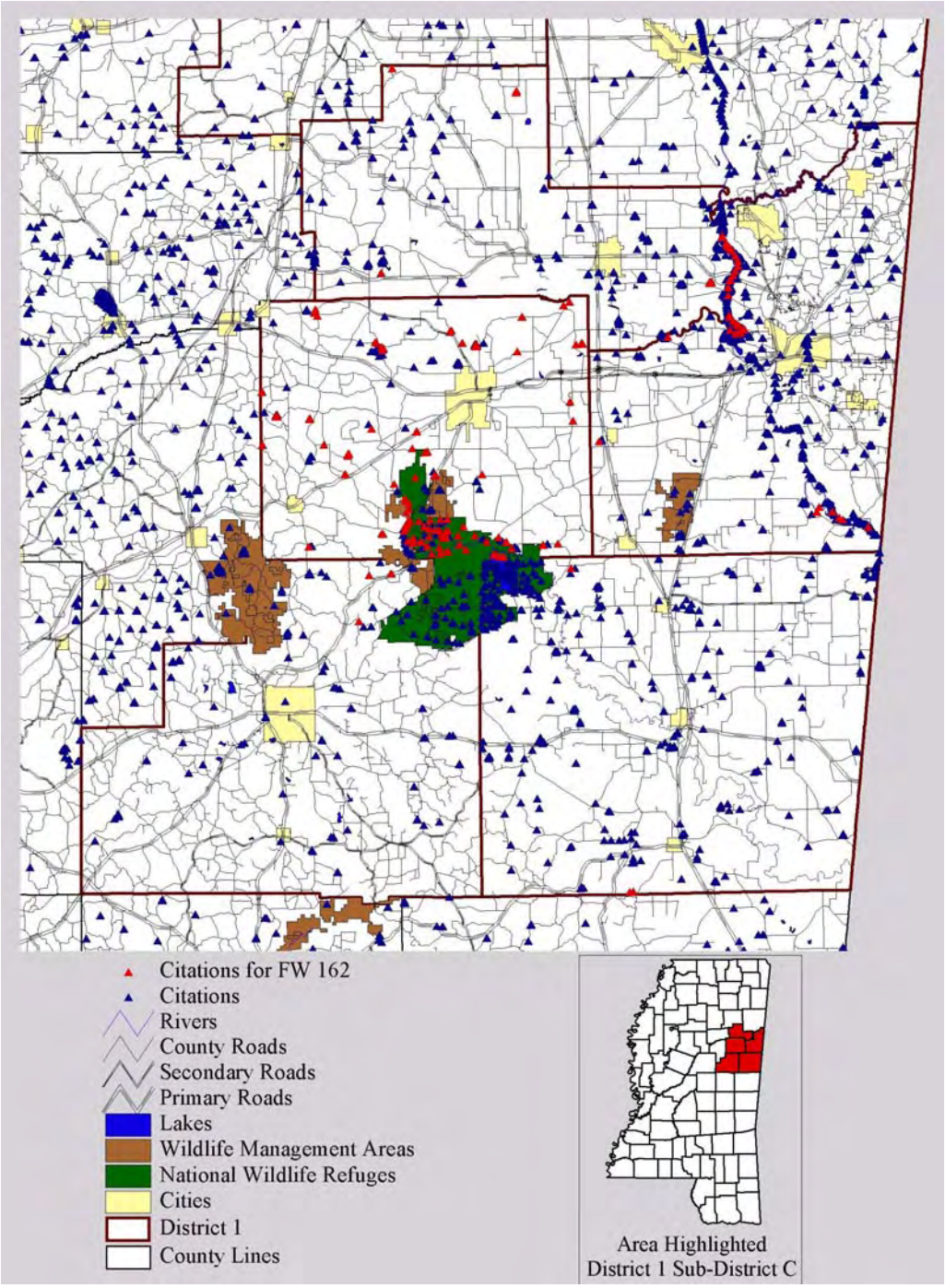

Figure 2.4. Example of a map provided to a Conservation Officers in District 1-C in Mississippi with all citations written during fiscal years 1997 – 2000 colored blue and citations written by FW162 during this same time period colored red.

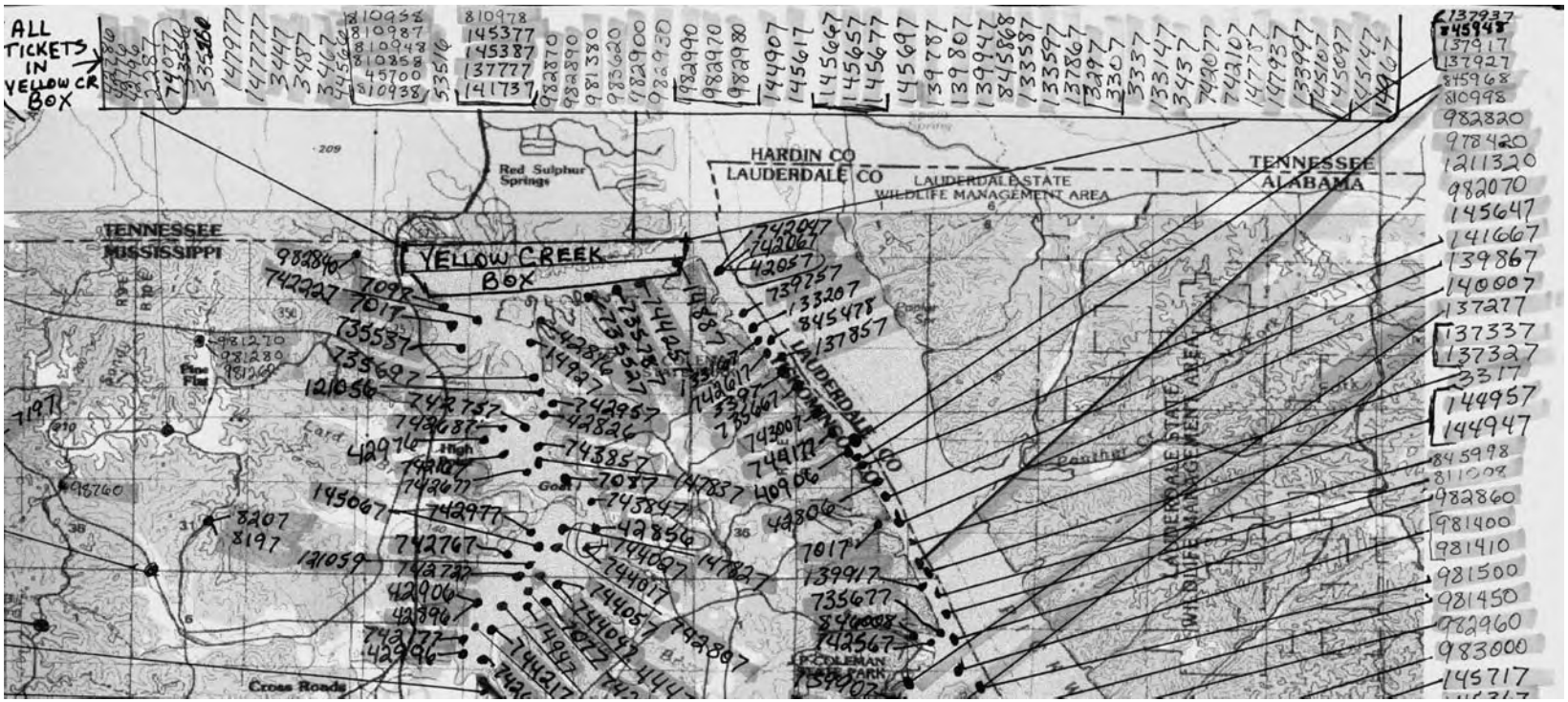

Figure 2.5. Example of how cluttered and congested paper maps can become when numerous citations are written in one area. The area in this figure is Pickwick Lake in northeast Mississippi on the Mississippi, Tennessee, Alabama border.

Table 2.1. Fields in the original Citation database from the Mississippi Department of Wildlife, Fisheries and Parks from 1 July 1996 – 30 June 2000.

Field Heading	Meaning
BIRTH_YR	Offender's birth year
BIRTH_MO	Offender's birth month
BIRTH_DAY	Offender's birth day
TICKET_YR	Year citation was written
TICKET_MO	Month citation was written
TICKET_DAY	Day citation was written
TICKET_TIM	Time citation was written
AM_PM	AM PM
COURT_DATE	Court Date
DOCKET_DAT	Docket Date
TEXT_DATE	Date
TICKET_NO	Citation number
DLN_ST	State on offender's drivers license
COUNTY	County in which the citation was written
DISTRICT	District in which the citation was written
SEX	Sex of the offender
RACE	Race of the offender
PENDING	Pending ruling
OFFENCE_CO	Offense code
SPECIES_CO	Species code
CITY	City on offenders driver's license
STATE	State on offender's drivers license
OFFICER_LA	Officer's last name
OFFICER_FI	Officer's first name
BADGE_NO	Officer's badge number
GUILTY	Guilty
GUILTY_AMT	Amount of fine
SUSPENDED	Suspended
SUSP_AMT	Amount of fine
NOT_GUILTY	Not Guilty
DISMISSED	Dismissed
PAGE_NO	Page number
DOCKET_NO	Docket number
TEXT_MESSA	Officer comments
OFFENSE_TE	Offense description

Table 2.2. New fields added to the Mississippi Department of Wildlife, Fisheries and Parks Citation database for analysis.

New Fields	Meaning
LAST	Last number in the citation number
CD_VERSION	Version of species codes
SPECIES_DE	Species Description
FISCALYR	Fiscal year
NEW_BADGE	Officer's new badge number

CHAPTER III

ANALYSIS OF CONSERVATION LAW ENFORCEMENT CITATION DATA IN MISSISSIPPI ON A COUNTY LEVEL

Introduction

In Mississippi there were 42,827 citations written by conservation officers between 1 July 1996 and 30 June 2000 (fiscal years 1997 – 2000). Some of the information included on the citations are species, type of offense, and county the offense occurred in. For a complete list of the data fields included in the Citation database see Tables 2.1 and 2.2. Mississippi is broken into 7 enforcement districts (Figure 3.1) and within these districts are sub-districts containing 3 – 5 counties. Officers within one district rarely, if ever, cross these sub-district or district lines. These sub-districts are autonomous units and are treated as such in the analysis.

A meeting was held with the Citation database coordinator, Assistant Chief of Law Enforcement, and the Director of Conservation and Education from the Mississippi Department of Wildlife, Fisheries and Parks (MDWFP) to discuss possible analyses which would benefit the agency. A prioritized list of analyses included: 1) officer sphere of influence, 2) distribution of citations by citation type by county, district, and statewide, 3) illegal harvest citation distribution per county, and 4) "gap" analysis to determine areas in Mississippi where citations were not being written. Chapter 4 addresses officer

sphere of influence and "gap" analysis. Distribution of citations by citation type by county and illegal harvest citation distribution per county are included in this chapter.

Distribution of Citations by Citation Type

There are 20 different codes used to designate the species on citations in Mississippi. For analysis purposes these were collapsed into 8 categories or species types (Table 3.1). The Citation database was separated by year to conduct annual evaluation. All of the citations have a county field included in the Citation database but they do not all have a specific location attached to them, i.e., no GPS coordinates. Even without the specific location, all citations can be incorporated into the GIS for graphical display and interpretation at the county level.

Methods

Pivot tables were created in Microsoft© EXCEL (Microsoft Corp., Redmon, WA) to generate the number of citations by species type for each county. These tables were subdivided by district and by year. All of the tables for each year are included in Appendix B. For analysis, the pivot tables were attached to the county's spatial data in the GIS using the county ID code as the linking variable.

Results

White-tailed deer (*Odocoileus virginianus*) citations made up most citations for all years accounting for 36.3% of the total citations for the study period. The category "other" was the second greatest for 3 of the 4 years, with sport fishing citations second greatest in 1997. "Other" citations included salt water fish, shell fish, commercial fish, and all non-wildlife related citations (Table 3.1). A summary of citations by year are

included in Table 3.2 and complete data tables for all species and all years can be found in Table B.1 – B.8.

All counties in Mississippi had at least one deer citation / year except fiscal year 2000. In this year there was one county without a deer citation. The maximum number of deer citations in a single county was 167 in Carroll County in 1998. The minimum was 0 in Tunica County in 2000. There were 15,555 deer citations from 1997 – 2000 with an average of 3,888.75 citations / year. Number of deer citations / county ranged from 1 – 106 in 1997, 4 – 167 in 1998, 6 – 146 in 1999, and 0 – 162 in 2000. Average number of deer citations / county was 36.99 in 1997, 51.77 in 1998, 50.60 in 1999, and 50.34 in 2000. Figure 3.2 shows the distribution of deer citations by county for 1997 – 2000.

There were 10,410 sport fishing citations from 1997 – 2000, with an average of 2,602.5 citations / year. Number of sport fishing citations / county ranged from 0 – 62 in 1997, 0 – 267 in 1998, 0 – 279 in 1999, and 0 – 562 in 2000. Average number of sport fishing citations / county was 11.89 in 1997, 35.11 in 1998, 39.18 in 1999, and 40.77 in 2000. There were 17 counties without a sport fishing citation in 1997, 7 in 1998, 6 in 1999, and 5 in 2000. Benton County was the only county that did not have a sport fishing citation for all 4 years. Figure 3.3 shows the distribution of sport fishing citations for 1997 – 2000.

There were 635 waterfowl citations from 1997 – 2000 with an average of 158.75 citations / year. Number of waterfowl citations / county ranged from 0 – 26 in 1997, 0 – 25 in 1998, 0 – 29 in 1999, and 0 – 13 in 2000. Average number of waterfowl citations / county was 1.51 in 1997, 1.39 in 1998, 3.83 in 1999, and 1.01 in 2000. There were 57

counties without a waterfowl citation in 1997, 56 in 1998, 37 in 1999, and 63 in 2000. Figure 3.4 shows the distribution of waterfowl citations for 1997 – 2000.

There were 1,721 dove (*Zenada macroura*) citations from 1997 – 2000 with an average of 430.25 citations / year. Number of dove citations / county ranged from 0 – 32 in 1997, 0 – 94 in 1998, 0 – 39 in 1999, and 0 – 31 in 2000. Average number of dove citations / county was 1.57 in 1997, 8.25 in 1998, 6.09 in 1999, and 5.07 in 2000. There were 58 counties without a dove citation in 1997, 24 in 1998, 22 in 1999, and 25 in 2000. Figure 3.5 shows the distribution of dove citations for 1997 – 2000.

There were 616 turkey (*Meleagris gallopavo silvestris*) citations from 1997 – 2000 with an average of 154 citations / year. Number of turkey citations / county ranged 0 – 15 in 1997, 0 – 21 in 1998, 0 – 18 in 1999, and 0 – 13 in 2000. Average number of turkey citations / county was 1.05 in 1997, 2.40 in 1998, 2.20 in 1999, and 1.87 in 2000. There were 51 counties without a turkey citation in 1997, 34 in 1998, 31 in 1999, and 38 in 2000. Figure 3.6 shows the distribution of turkey citations for 1997 – 2000. The maximum number of citations was written in Lafayette County in 1997, Greene County in 1998, Bolivar County in 1999, and Covington County in 2000.

Citations with a species code for coyote (*Canis latrans*), beaver (*Castor canadensis*), fox (*Urocyon cinereoargenteus* or *Vulpes vulpes*), frog (*Rana catesbeiana*), opossum (*Didelphis virginiana*), quail (*Colinus virginianus*), rabbit (*Sylvilagus* spp.), raccoon (*Procyon lotor*), squirrel (*Sciurus* spp.), bobcat (*Lynx rufus*), and non-game birds were grouped into small game. There were 1,532 small game citations from 1997 – 2000 with an average of 383 citations / year. Number of small game citations / county ranged 0 – 22 in 1997, 0 – 37 in 1998, 0 – 34 in 1999, and 0 – 40 in 2000. Average number of

small game citations / county was 3.55 in 1997, 4.78 in 1998, 5.68 in 1999, and 4.67 in 2000. Number of counties without small game citations was 30 in 1997, 21 in 1998, 15 in 1999, and 11 in 2000. Figure 3.7 shows the distribution of small game citations for 1997 – 2000.

Illegal Harvest Citation Distribution per County

Illegal harvest of wildlife species has been shown to be more prevalent than generally believed (Giles et al 1971). Extensive research on big game violators in Idaho yielded a formula to estimate illegal big game harvest from citations written (Vilkitis 1968). Vilkitis saw an average of 1.4 animals / trip in 25 spotlighting ventures. Simulated spotlighting incidents revealed animals in 66.7% of the ventures. He also reported that it required an average of 108 hours of spotlighting to kill one animal.

The illegal kill formula presented by Vilkitis (1968) based on citations is:

$$I = (m_1 * c_1+1)/(r_1+1)$$

Where illegal kill (I) is related to the total arrests for big game violators for the study period (m_1) in the same way as the total number of illegal kills created by the investigator (c_1) was related to the number of times the investigator was stopped by enforcement personnel (r_1). During Vilkitis' study there were 38 big game citations written, 31 animals collected during his spotlighting ventures, and he was not stopped by enforcement personnel. With his formula, he estimated 1,216 illegally harvested big game animals during the study period. According to his estimate, the law enforcement agents wrote one citation for every 32 big game animals taken illegally or cited 3.1% of the violators (Vilkitis 1968).

Actual spotlighting cases and illegal deer harvest research in other states used Vilkitis' 3.1% to estimate illegal deer harvest (Kaminsky 1974 and Glover 1982). Using data from Mississippi, conservation officers wrote 1,103 headlighting citations from 1997 – 2000. If this represents 3.1% of the actual violations then 35,580 headlighting violations may have occurred during this 4 year period. Even if only a percentage of these violations are successful, this may have a significant impact on wildlife populations. Furthermore, the Vilkitis' 3.1% estimate may be much less in Mississippi because of deer density.

It is important to evaluate illegal harvest citations to better understand where these types of citations were written and the potential impact illegal harvest may have on wildlife populations. In Mississippi there are a number of offense codes that are indicators of illegal harvest and a few codes that are actually illegal harvest. Baiting is an indicator of potential illegal harvest, whereas killing a jake turkey is an illegal harvest. The offense codes used by the MDWFP that can be considered indicators of illegal harvest (IIH) are baiting, headlighting deer, exceeding bag limit, killing doe out of season, killing deer or spotted fawn out of season, hunting deer with gun during archery season, hunting closed season, hunting with centerfire rifle during primitive weapon season, illegal buck (less than 4 points), hunting over bait (federal), killing spotted fawn, non-resident killing doe deer, killing jake turkey, killing turkey hen, killing turkey out of season, and shooting deer from a boat. Evaluation of these citations on a spatial basis may indicate areas of problem poaching and/or significant impacts on wildlife species. There were 2 turkey studies in Mississippi from 1999 – 2000 on 2 separate WMA's. Jones (2001) observed no instances of poaching as a mortality factor during his study.

Whereas Inglis (2001) found 6.83 – 10.02% of his mortality was attributed to illegal harvest.

Methods

Pivot tables were created in Microsoft© EXCEL to generate number of IIH citations by species type for each county. These tables were subdivided by district and by year. All of the tables for each year are included in Appendix C. The pivot tables were linked to the county layer in the GIS by county code.

Results

An analysis of citations of single species indicated that illegal harvest composed 48.1% (n=1,721) of all dove citations, 24.2% (n=616) of all turkey citations, 19.4% (n=15,555) of all deer citations, 4.9% (n=635) of all waterfowl citations, and 3.4% (n=1,532) of all small game citations. Illegal harvest citations comprised 9.5% (n=42,827) of all citations written for all years. However, illegal harvest citations comprised 20.3% (n=20,059) of all wildlife citations, i.e., deer, dove, small game, turkey, and waterfowl. Table 3.3 contains a summary of citations that are IIH by species by year.

Of the 24 counties where dove citations were written in 1997, only 5 counties had citations that were IIH; 31 of 58 counties had dove citations that were IIH in 1998; 35 of 60 counties had dove citations that were IIH; 35 of 60 counties had dove citations that were IIH in 1999; and 29 of 57 counties had dove citations that were IIH in 2000. The number of citations that were IIH for doves in these counties ranged from 3 - 14 in 1997, 1 – 59 in 1998, 1 – 32 in 1999, and 1- 24 in 2000 (Figure 3.8).

The number of citations that were IIH for turkey in counties with turkey citations ranged from 1 – 3 in 1997, 1 – 9 in 1998, 1 – 8 in 1999, and 1 – 7 in 2000 (Figure 3.9).

The number of counties with citations that were IIH for turkey was 9 in 1997, 25 in 1998, 24 in 1999, and 17 in 2000. The maximum number of citations that were IIH of turkey was in Grenada County in 1997, Greene County in 1998, Bolivar County in 1999, and Covington County in 2000. It should be noted that in 1998 – 2000 these counties also contained this greatest number of turkey citations.

There were only 7 counties in 1997, 4 in 1998, 4 in 1999, and 6 in 2000 that did not have citations that are IIH of deer. The number of citations that were IIH for deer in counties with deer citations ranged from 1 – 35 in 1997, 1 – 48 in 1998, 1 – 35 in 1999, and 1 – 48 in 2000 (Figure 3.10). The maximum number of citations that were IIH of deer was in Jasper County in 1997, Greene County in 1998, Jasper and Greene Counties in 1999, and Jasper County in 2000.

The number of counties with citations that were IIH of waterfowl was 4 in 1997, 3 in 1998, 7 in 1999, and 6 in 2000. The number of IIH citations in these counties was 1 in 1997, 1 – 2 in 1998, 1 – 4 in 1999, and 1 – 3 in 2000 (Figure 3.11).

The number of counties with citations that were IIH of small game was 3 in 1997, 8 in 1998, 12 in 1999, and 11 in 2000. The number of IIH citations in counties with small game citations ranged from 1 – 2 in 1997, 1 – 3 in 1998, 1 – 7 in 1999, and 1 – 3 in 2000 (Figure 3.12).

Discussion

Counties with greater number of citations for each species group can be difficult to discern from the pivot tables. However, when the data are incorporated into a GIS, counties with high instances of citations for a specific species become clearer. A better understanding of the juxtaposition of counties with high or low citation numbers can be

seen with these GIS maps. This gives the agency a better understanding of where there are greater, or lesser, instances of certain citation types.

Maps similar to the ones presented in Figures 3.2 – 3.12 should be evaluated annually by supervisors and administrators to get an understanding of what counties may have greater or lesser instances of different citation types. Minnis et al (1999) stated that supervisors and administrators need a way to rapidly assess the effectiveness of a state-wide force and this can be done by showing citations on a county-by-county basis.

Similarly, state-wide programs can be evaluated with maps such as these by examining a view of 2 subsequent years' citations (Minnis et al 1999). Case in point is the waterfowl maps for 1998 and 1999 (Figure 3.3). In 1998 a waterfowl hunting and duck identification awareness program was implemented in District 1 after 2 officers were sent to Kentucky for a waterfowl identification and enforcement school in 1997. These officers then trained officers in waterfowl identification and a focus was put on waterfowl hunting for the upcoming hunting season. The increase in waterfowl enforcement from 1998 – 1999 is evident in the increase in numbers of citations in this part of the state. It is apparent from the maps that programs like this are beneficial to officers, but their effectiveness may not be long-lived, as indicated by the drastic drop off in some counties in 2000.

Other factors that should be considered when evaluating migratory species (e.g., waterfowl and dove) are weather patterns and availability of these species during the hunting seasons. Also, number of waterfowl and dove citations may be underrepresented because these 2 species groups fall under Federal, as well as, State jurisdiction. These

maps and tables only represent citations written by MDWFP conservation officers and not US Fish and Wildlife Service law enforcement officers.

The number of IIH citations for deer was the greatest in Jasper County for 3 of the 4 years and greatest in Greene County for 2 of the 4 years. These 2 counties should be examined on a smaller scale, i.e., look at the actual locations of the citations, to understand why these violations are so high in these counties. Another area of concern could be in District 3 in Carroll County which is on a district border. If the location of the citations are near the county/district border line there is a possibility that a greater number of violations are occurring in the county(s) across the district border in District 2, e.g., in Grenada and Montgomery Counties.

These data do not necessarily reflect effort or actual violation patterns. Note that while Jasper County has the greatest number of deer citations, there are no waterfowl citations, few turkey citations, few dove citations, and few sport fishing citations. Closer examination of areas such as this may yield reasons for the lack, or abundance, of specific species types. Another way of visualizing this would be to create maps with each county symbolized with a pie chart representing the percentage of different species types. This type of representation will give a better understanding of which species citations are being written in a given area. An example of this is Figure 3.13, where District 4 is symbolized in this manner for all 4 years.

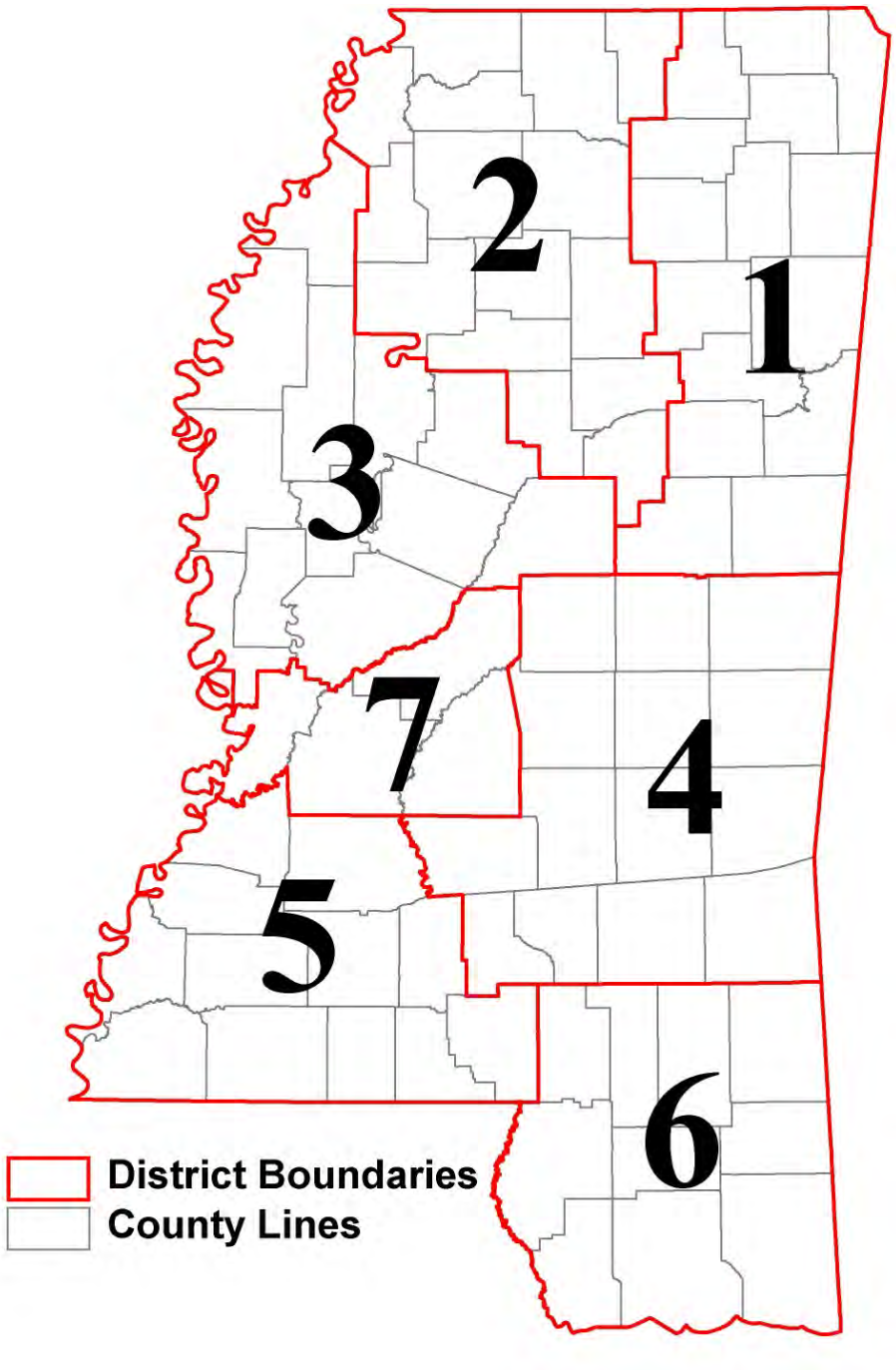

Figure 3.1. Mississippi was divided into 7 conservation law enforcement districts during the course of this study (1997 – 2000).

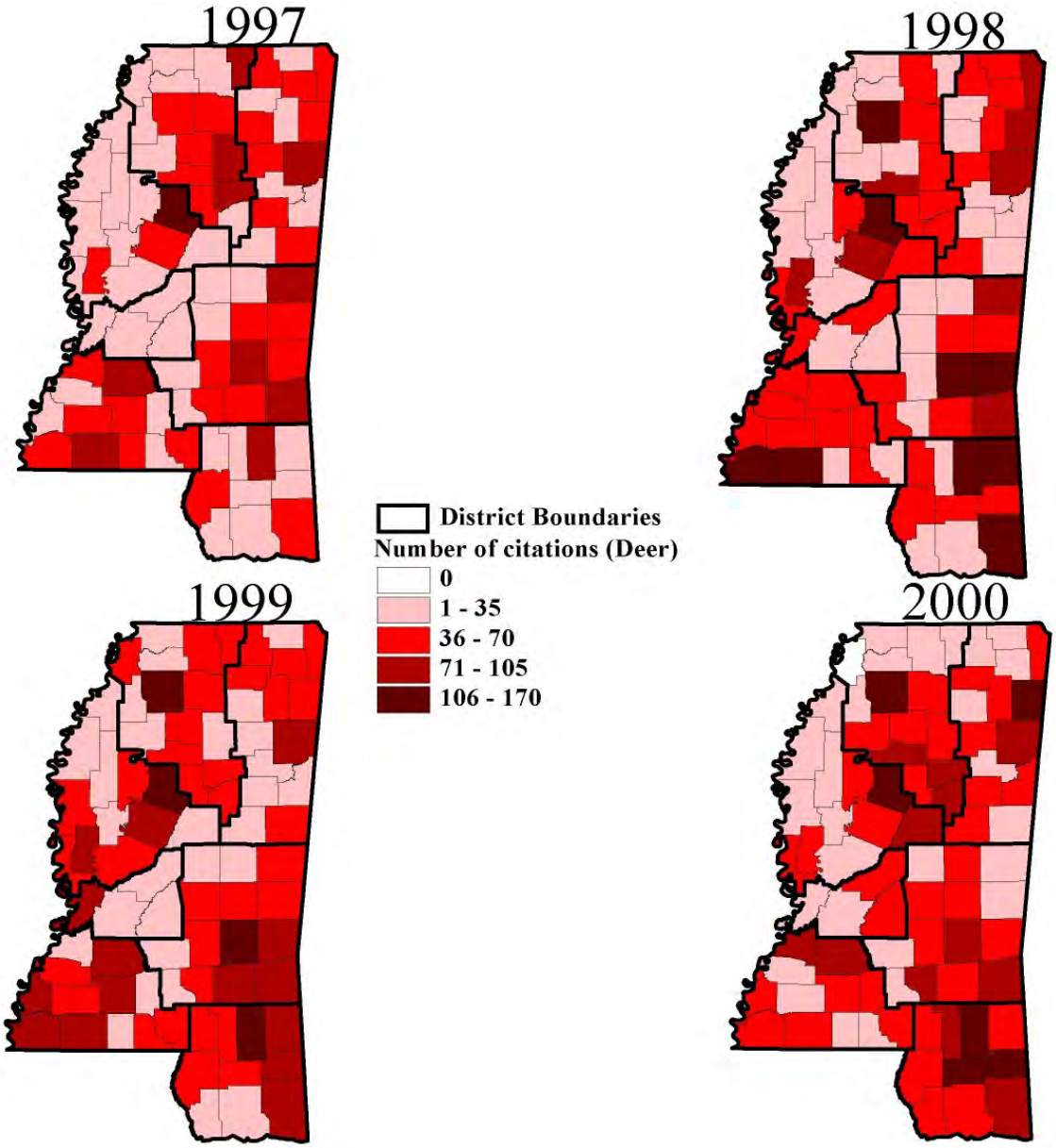

Figure 3.2 Distribution of deer citations in Mississippi during fiscal years 1997 – 2000.

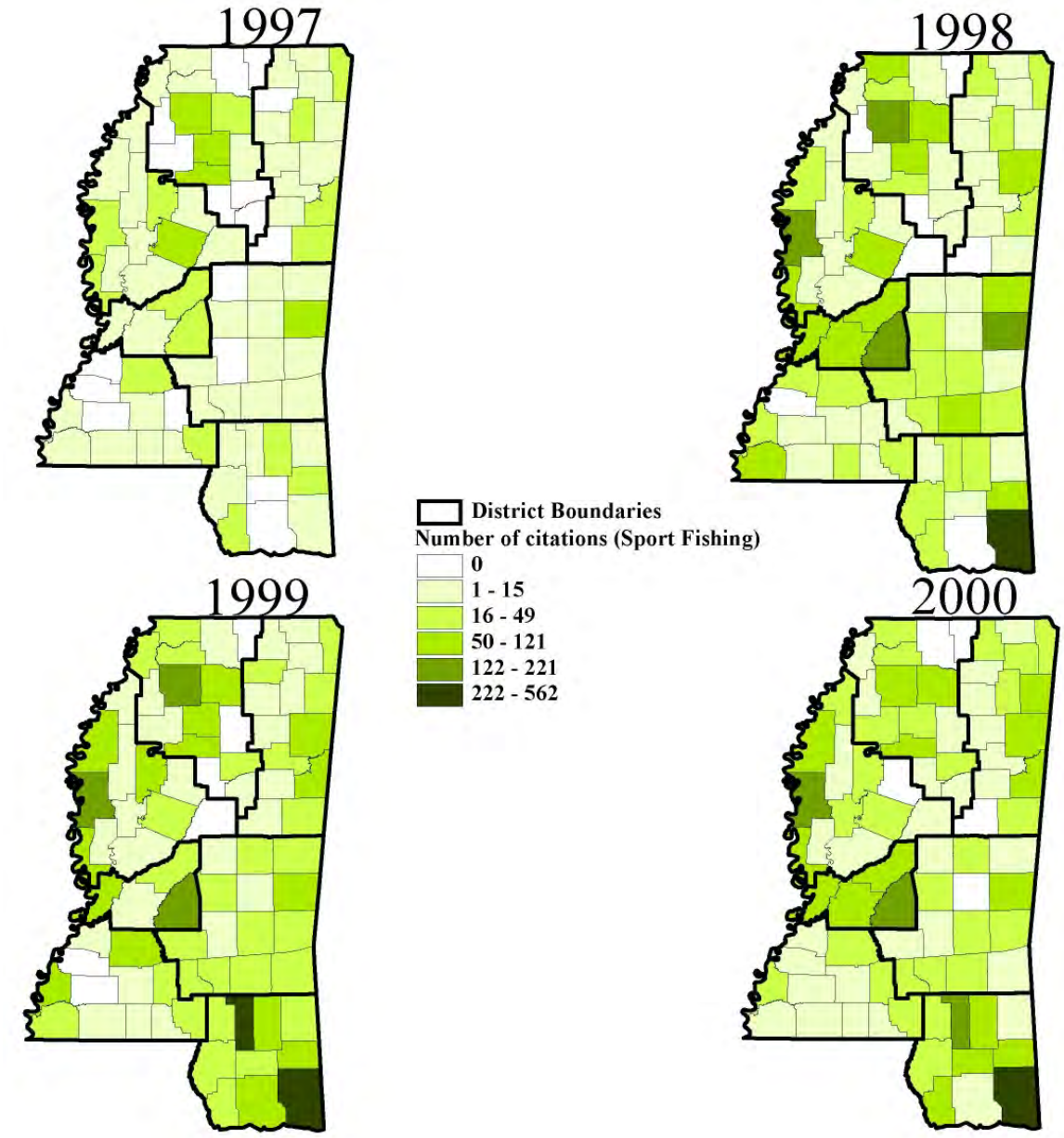

Figure 3.3 Distribution of sport fishing citations in Mississippi during fiscal years 1997 – 2000.

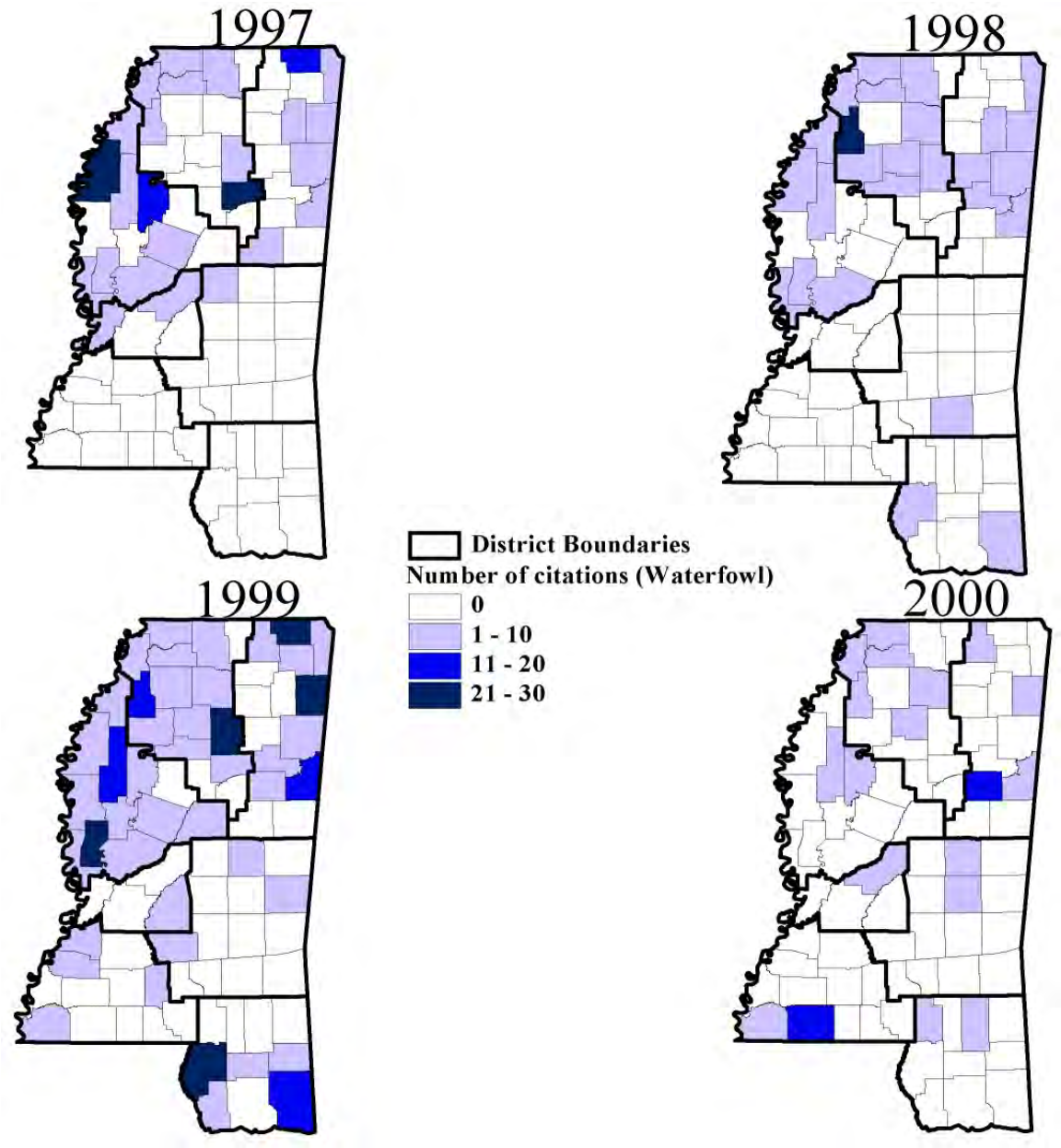

Figure 3.4 Distribution of waterfowl citations in Mississippi during fiscal years 1997 – 2000.

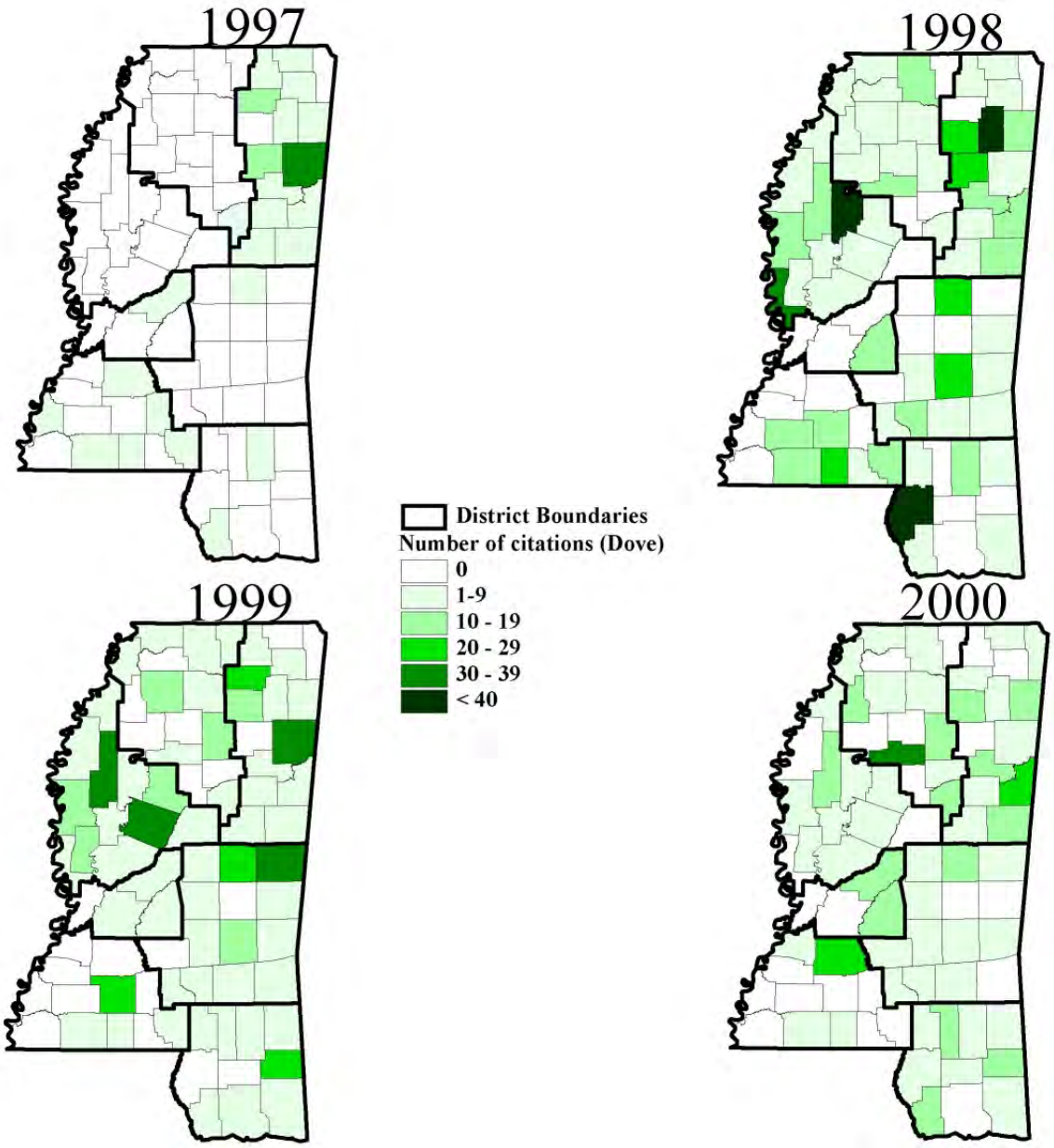

Figure 3.5 Distribution of dove citations in Mississippi during fiscal years 1997 – 2000.

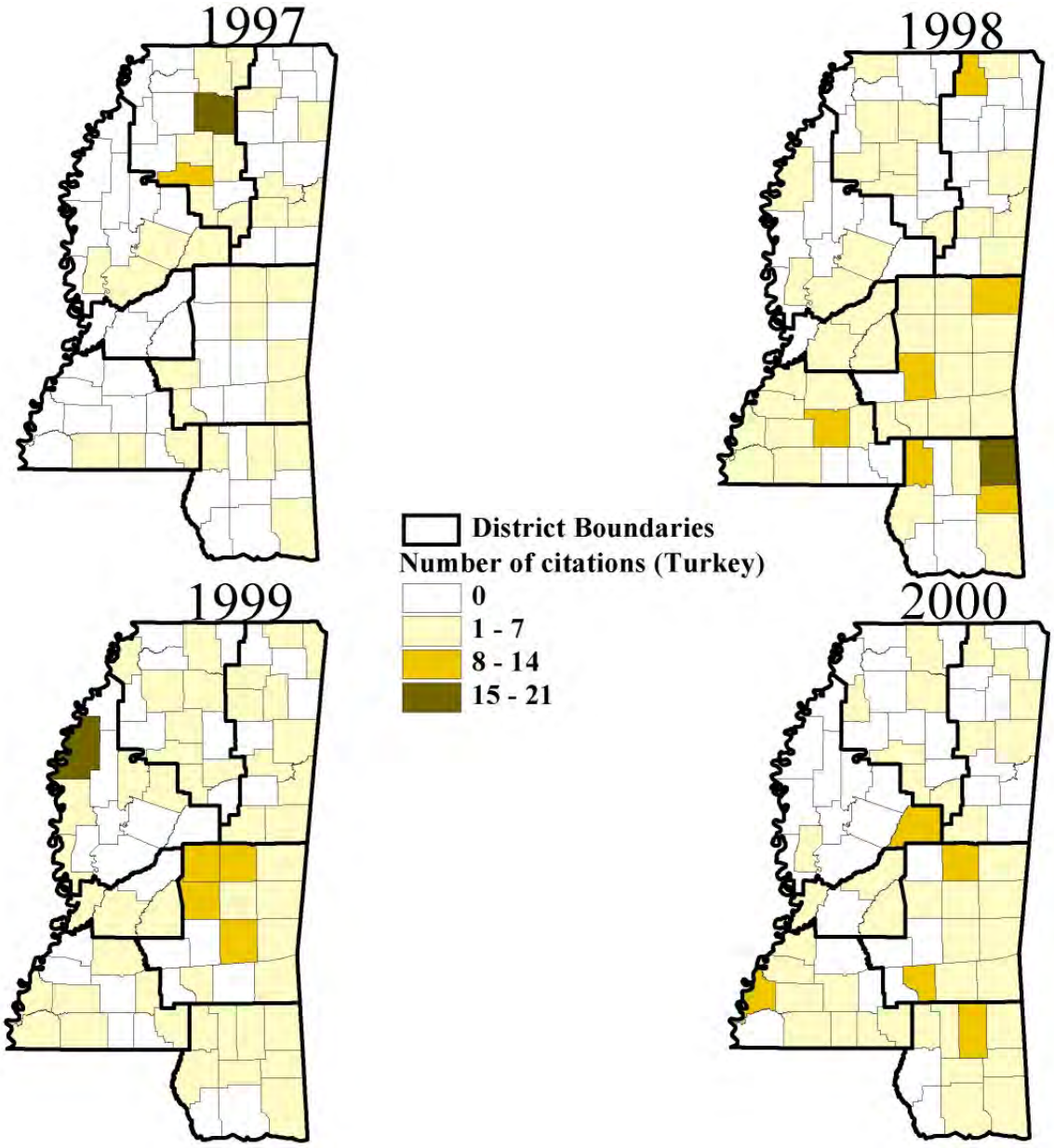

Figure 3.6 Distribution of turkey citations in Mississippi during fiscal years 1997 – 2000.

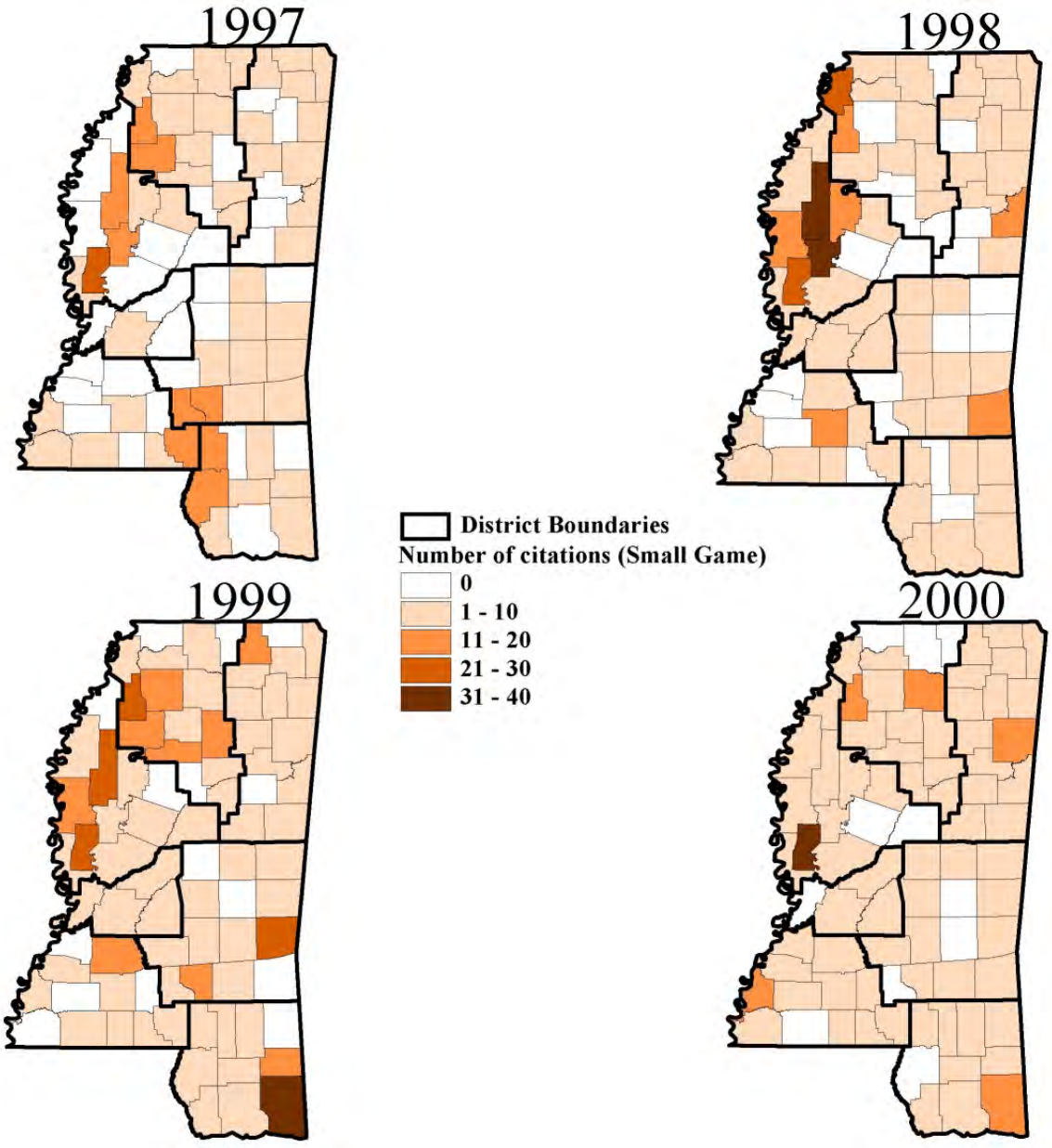

Figure 3.7 Distribution of small game in Mississippi during fiscal years 1997 – 2000. Small game includes bobcat, coyote/beaver, fox, frog, non-game bird, opossum, other furbearer, quail, rabbit, raccoon, and squirrel.

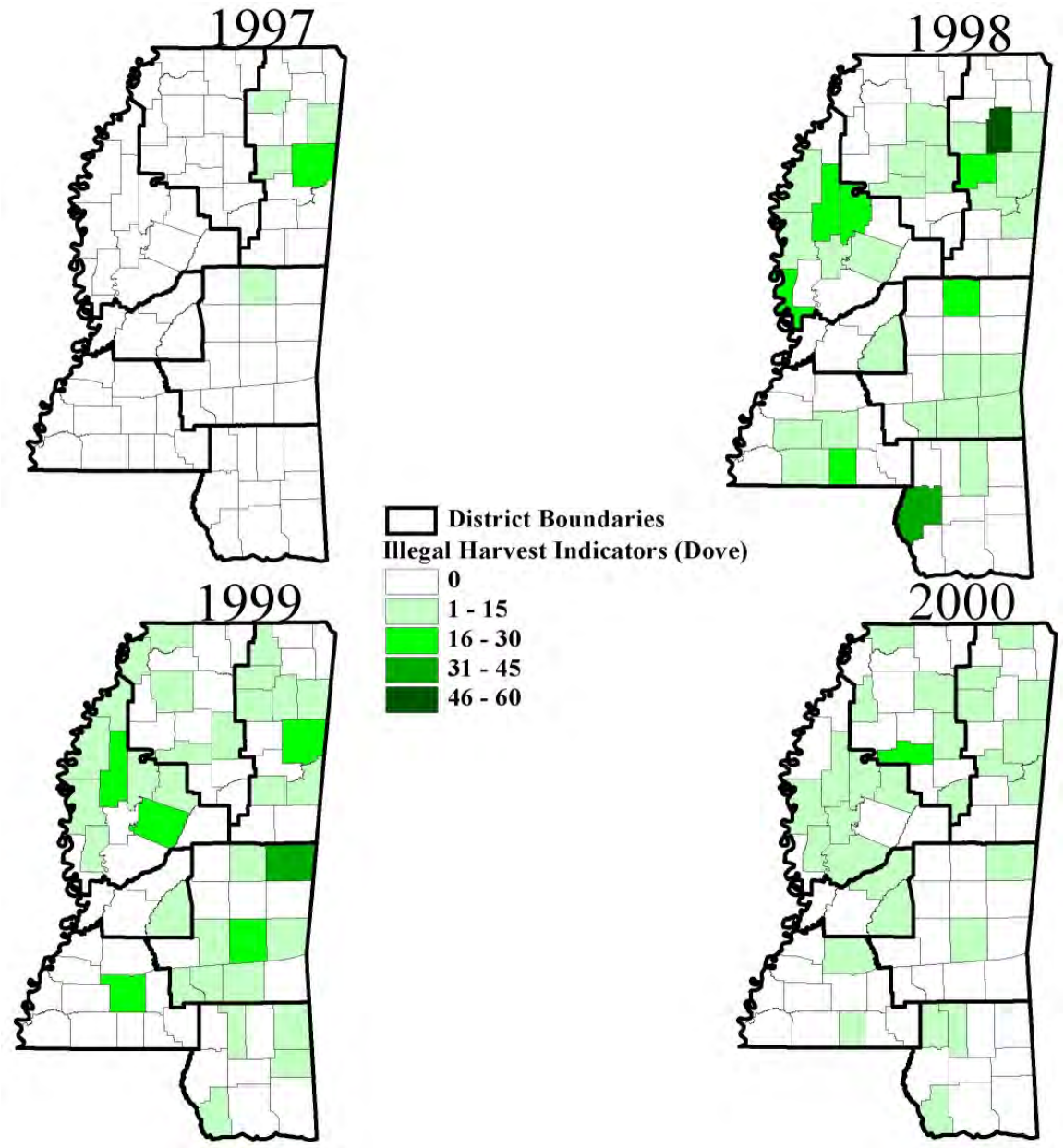

Figure 3.8 Distribution of dove citations in Mississippi during fiscal years 1997 – 2000 that are indicators of illegal harvest. The offense codes used as illegal harvest indicators are baiting, exceeding bag limit, hunting closed season, or hunting over bait (federal).

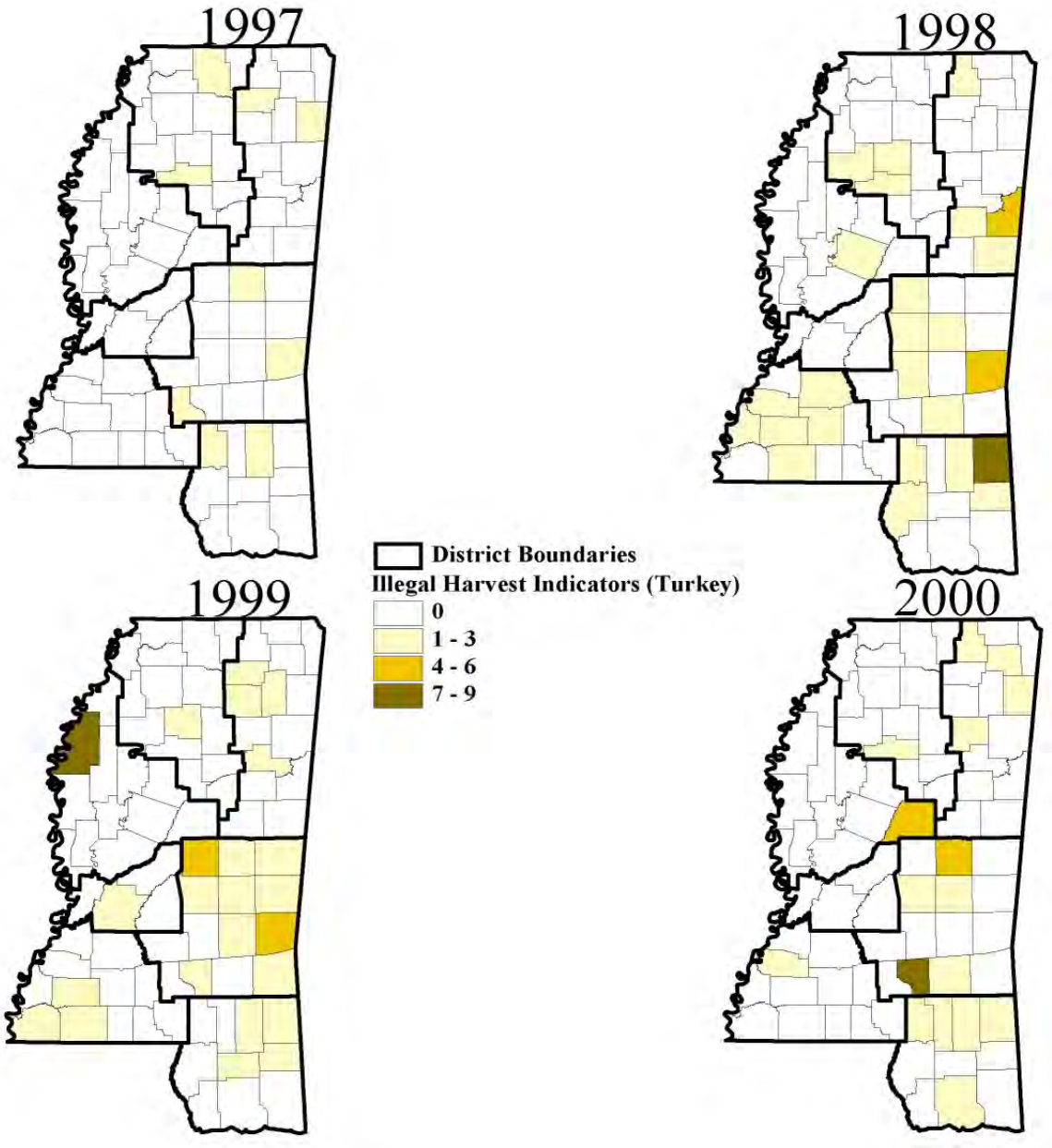

Figure 3.9. Distribution of turkey citations in Mississippi during fiscal years 1997 – 2000 that are indicators of illegal harvest. The offense codes used as illegal harvest indicators are baiting, exceeding bag limit, hunting closed season, hunting over bait, or killing jake turkey, killing turkey hen, killing turkey out of season.

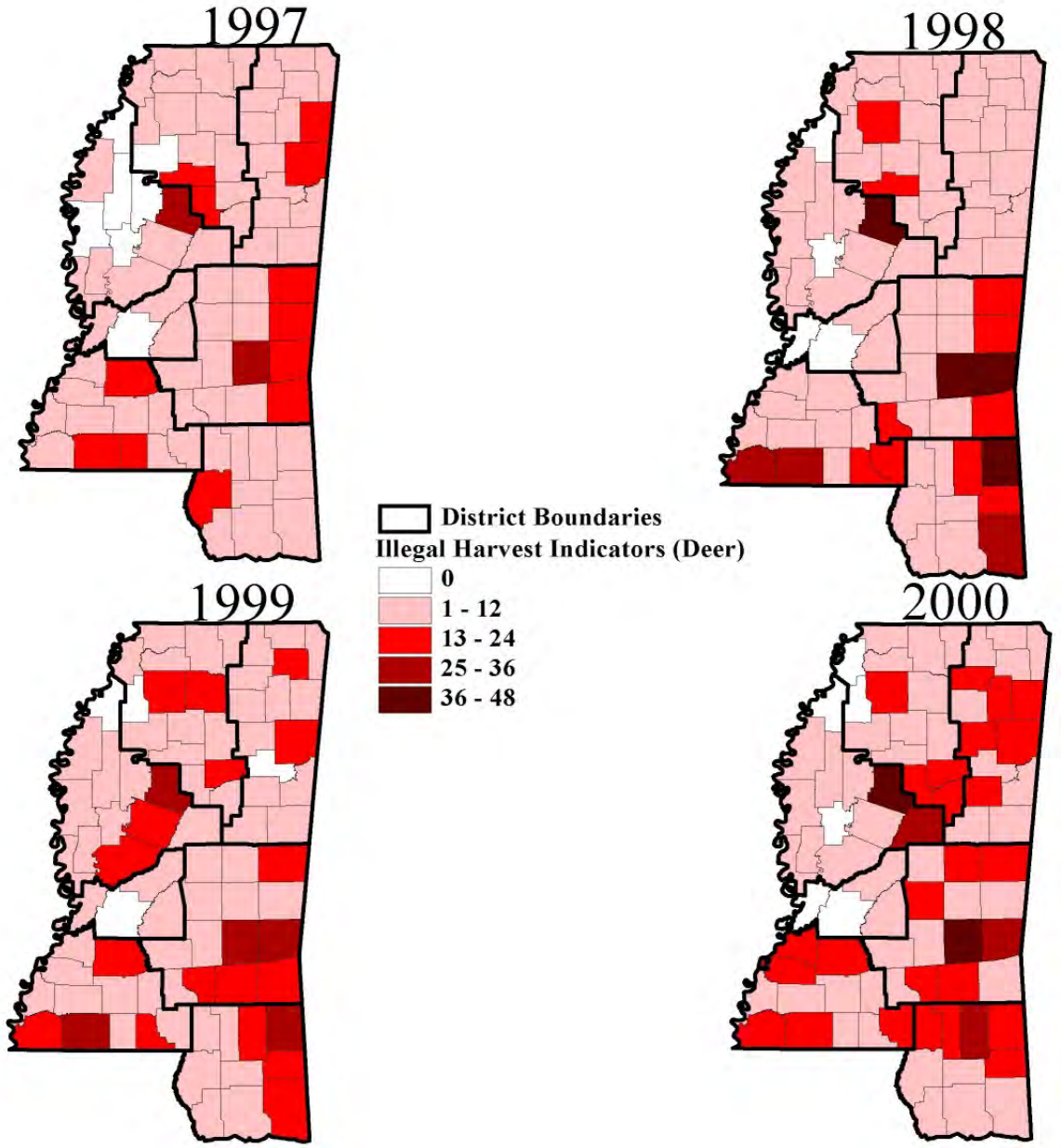

Figure 3.10. Distribution of white- tailed deer citations in Mississippi during fiscal years 1997 – 2000 that are indicators of illegal harvest. The offense codes used as illegal harvest indicators are baiting, head lighting deer, exceeding bag limit, killing doe out of season, killing deer or spotted fawn out of season, hunting deer with gun during archery season, hunting closed season, hunting with centerfire rifle during primitive weapon season, illegal buck (less than 4 points), hunting over bait (federal), killing spotted fawn, non-resident killing doe deer, or shooting deer from a boat.

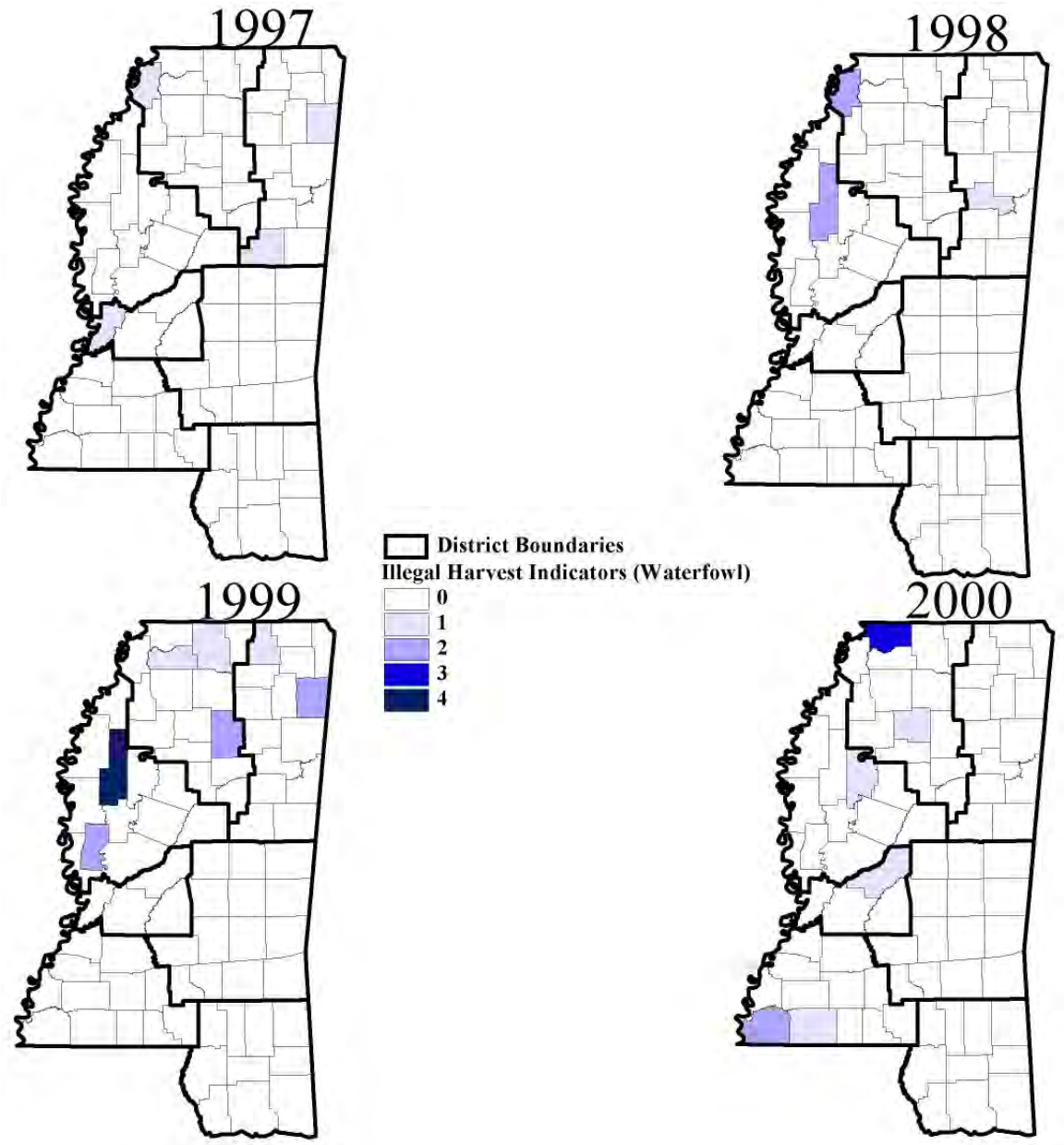

Figure 3.11. Distribution of waterfowl citations in Mississippi during fiscal years 1997 – 2000 that are indicators of illegal harvest. The offense codes used as illegal harvest indicators are baiting, exceeding bag limit, hunting closed season, or hunting over bait (federal).

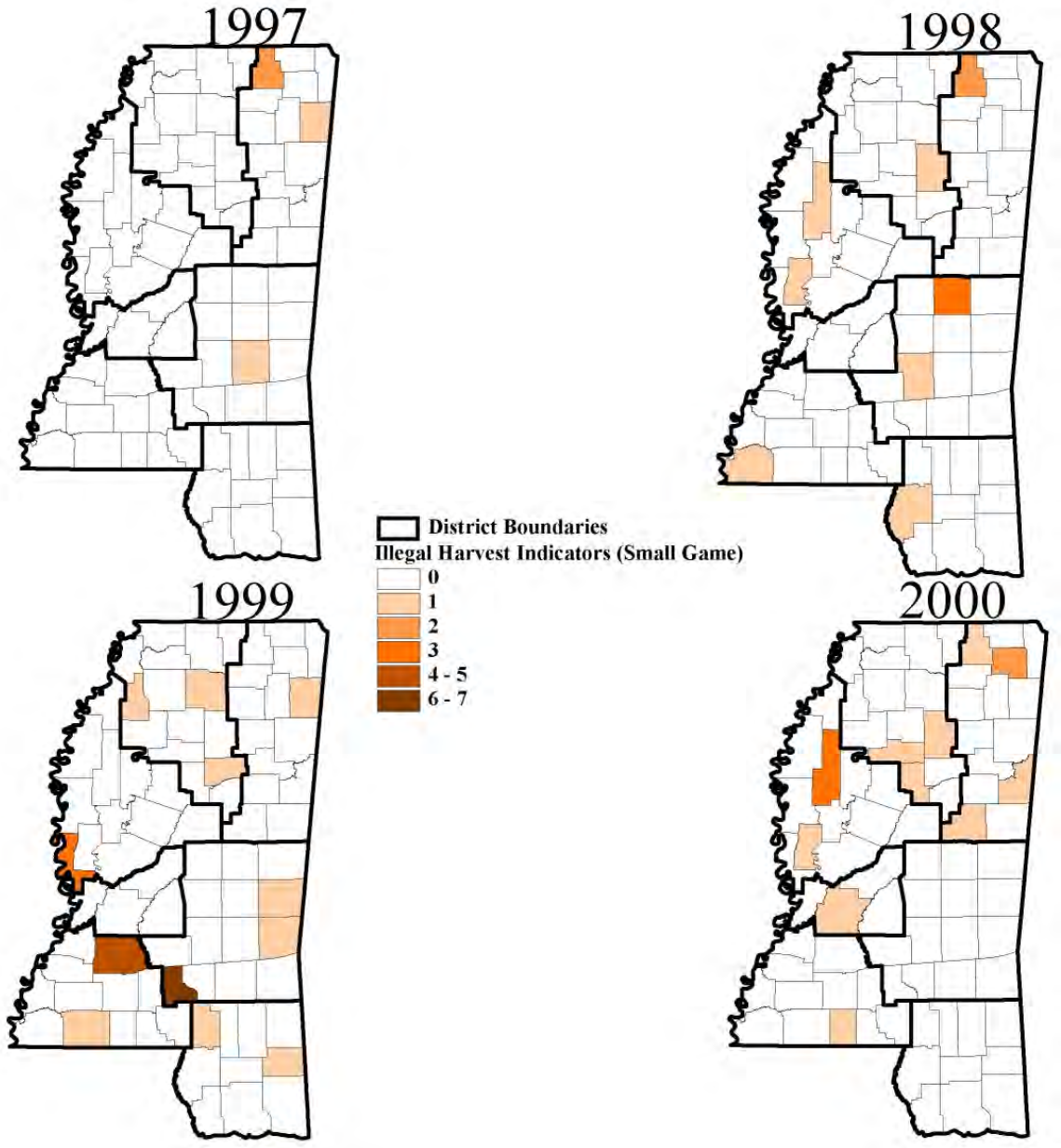

Figure 3.12. Distribution of small game citations in Mississippi during fiscal years 1997 – 2000 that are indicators of illegal harvests. The offense codes used as illegal harvest indicators are baiting, exceeding bag limit, hunting closed season, or hunting over bait.

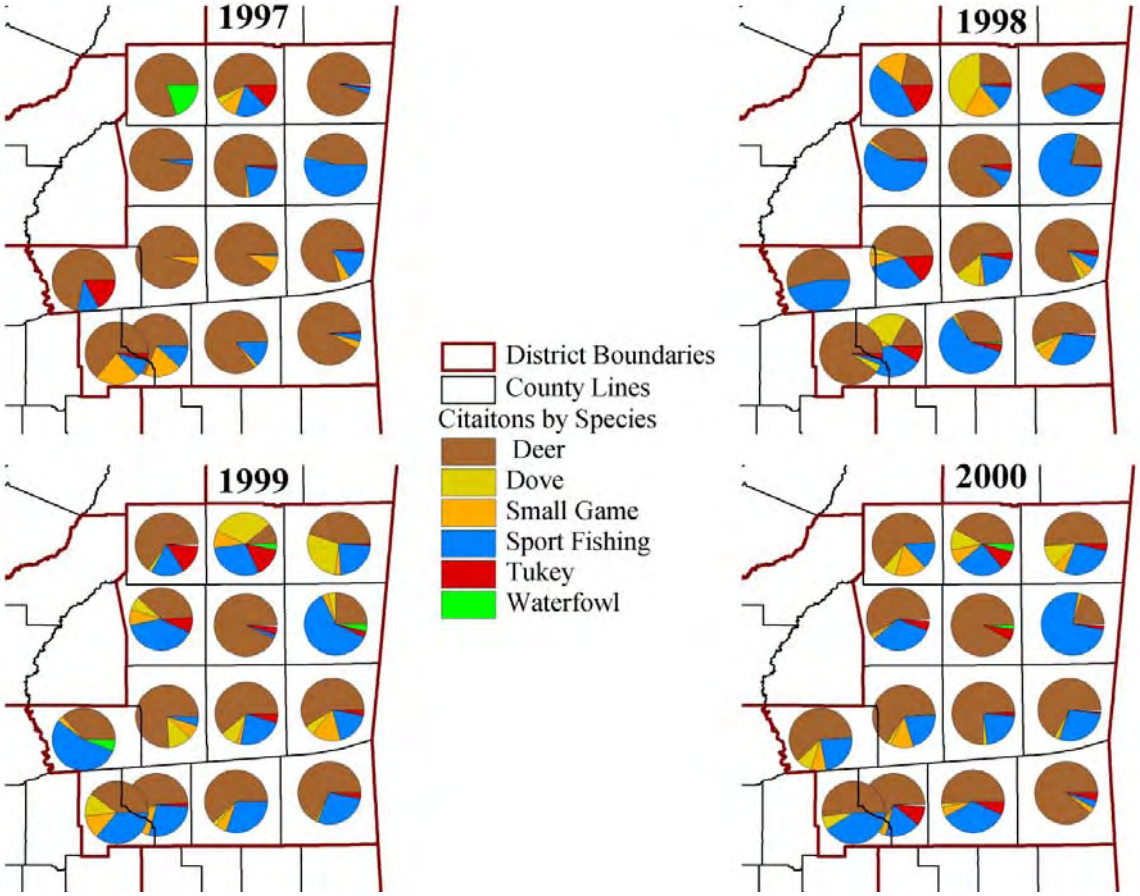

Figure 3.13 Example of a way to symbolize citation data in Mississippi to have an understanding of the citations by species type that are written in each county. The area depicted here is District 4.

Table 3.1. There were 20 different species codes used by Conservation Officers in Mississippi during fiscal years 1997 – 2000. These codes were combined into 8 species groups for analysis.

Species Group	Species Code
Deer	Deer
Dove	Dove
Small Game	Bobcat
	Coyote/Beaver
	Fox
	Frog
	Non-game Bird
	Opossum
	Other Furbearer
	Quail
	Rabbit
	Raccoon
	Squirrel
Sport Fishing	Sport Fishing
Turkey	Turkey
Waterfowl	Waterfowl
Other	Commercial Fish
	Other
	Salt Water Fish
	Shell Fish
No Data	(blank)

Table 3.2 Summary of all citations written by Conservation Officers in Mississippi during fiscal years 1997 – 2000 separated by species group.

Year	Deer	Dove	Small Game [1]	Sport Fishing	Turkey	Waterfowl	Other [2]	No Data [3]	Grand Total
1997	3033	129	291	975	86	124	879	627	6144
1998	4245	677	392	2879	197	114	2887	103	11494
1999	4149	499	466	3213	180	314	4133	34	12988
2000	4128	416	383	3343	153	83	3650	45	12201
1997 - 2000	15555	1721	1532	10410	616	635	11549	809	42827

[1] Small game includes: Bobcat, Coyote/Beaver, Fox, Frog, Non-game bird, Opossum, Other furbearer, Quail, Rabbit, Raccoon, Squirrel

[2] Other includesSalt water fish, Shell fish, Commercial fishing, and all non-wildlife related crimes

[3] No Data: species codes were invalid or not entered

Table 3.3 Summary of citations that are indicators of illegal harvest written by Conservation Officers in Mississippi during fiscal years 1997 – 2000 separated by species group.

	Deer		Dove		Small Game [1]		Turkey		Waterfowl		Grand Total		
Year	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Wildlife Citations	Total Citations
1997	522	3033	34	129	4	291	14	86	4	124	578	3663	6144
1998	775	4245	352	677	11	392	53	197	5	114	1196	5625	11494
1999	770	4149	256	499	23	466	46	180	13	314	1108	5608	12988
2000	953	4128	186	416	14	383	36	153	9	83	1198	5163	12201
1997 - 2000	3020	15555	828	1721	52	1532	149	616	31	635	4080	20059	42827

[1] Small Game includes: Bobcat, Coyote/Beaver, Non-game bird, Opossum, Quail, Raccoon, Squirrel

[2] Offense codes used as Indicators of potential Illegal Harvest: baiting, headlighting deer, exceeding bag limit, killing doe out of season, killing deer or spotted fawn out of season, hunting deer with gun during archery season, hunting closed season, hunting with centerfire rifle during primitive weapon season, illegal buck (less than 4 points), hunting over bait (federal), killing spotted fawn, non-resident killing doe deer, killing jake turkey, killing turkey hen, killing turkey out of season, shooting deer from a boat.

CHAPTER IV

OFFICER SPHERE OF INFLUENCE AND GAP ANALYSIS

Introduction

Evaluation of the area of influence of officers has only been conducted within the realm of officer deployment (Beattie 1976*b*, Cowles 1976, Thomas et al 1999). This past research either dealt with workload-based deployment strategies or officers' perception of needed personnel. Minnis et al (1999) stated that GIS could be a tool that supervisors could use to evaluate and examine effectiveness of officers. A GIS also can be used to determine an individual officer's or a group of officers' "sphere of influence" and tendencies to work in certain areas or to help new officers "learn the county" more rapidly by being able to see where high concentrations of citations have been written in the past (Minnis 1999).

Therefore, an officer sphere of influence (OSI) can be equated to an animal's home range because the citations written by an officer give an indication of their movement patterns over time. Burt (1943) defined a home range as "that area traversed by the individual in its normal activities of food gathering, mating, and caring for young" and Kernohan et al (2001) defined a home range as the extent of area with a defined probability of occurrence of an animal during a specified time period. The

Conservation Officers' sphere of influence is defined as the probable area a Conservation Officer occupies during their normal enforcement activities within a specified time period.

Officer sphere of influence was estimated using 2 home range estimators: minimum convex polygon (MCP) and kernel density estimation. The MCP method of home range estimation (Mohr 1947) is the oldest and most common method of estimating home range (White and Garrott 1990). Kernel density estimation was first described by Worton (1987) as a possible estimator home range size and has become popular for home range estimation since.

Minimum convex polygon estimation has its advantages and disadvantages. The advantages of the MCP are: simplicity, flexibility of shape, and ease of calculation. One disadvantage is home range size increases indefinitely with added locations; because of this it is not appropriate to compare estimates with different sample sizes. MCP home range estimations also are sensitive to outliers and are prone to overestimate area when the polygon is obviously concave due to habitat barriers (White and Garrott 1990).

The kernel density method has advantages over other types of home range estimators. First, it works well with multimodal home ranges (Seaman et al. 1999). Second, there is no underlying assumption of distribution of the data points (Worton 1987). Third, this method is a widely used statistical technique that has been continually updated (Kernohan et al 2001, Jones et al 1996, Park and Marion 1990). Fourth, kernel estimation is a good method for examining large-scale global trends in point data and creates a smooth map of values using spatial data (Anselin et al 2000). Finally, density

estimates can be compared for consecutive time periods and reveal the spatial context of changes over time (Anselin et al 2000).

One major disadvantage is the lack of standardization for in selecting the smoothing parameters (Kernohan et al 2001). Numerous journal articles have been written on this topic (Park and Marron 1990, Wand and Jones 1993, Jones et al 1996, Seaman and Powell 1996). Park and Marion (1990) stated that the choice of a smoothing parameter is very important for the practical application of kernel density estimation but may be impractical to manually select. Jones et al. (1996) reported that it was important to choose the smoothing parameter empirically from the data. Hooge and Eichenlaub (1997) state that the ad hoc calculations in the ArcView Animal Movements extension are close to least squares cross validation (LSCV) for exploratory analysis. The ad hoc calculation in Animal Movements is based on H_{ref} as described by Silverman (1986). Worton (1989) maintained that estimates of practical value can be obtained when the ad hoc choice of smoothing is applied.

Another disadvantage is number of sample locations needed to perform kernel home range estimates. Seaman et al. (1999) recommend a sample size of ≥30 locations, and preferably ≥50 locations. Seaman and Powell (1996) stated that estimates from small samples will over estimate the kernel home range. One problem not addressed in the literature is the impact of too many sample locations on the estimator. This could be a problem with the data in this research because in some cases there are in excess of 1,000 locations in a single analysis.

The spatial concentration of crime data lends itself to representation on crime maps. A crime hot spot is defined as a small area within an identifiable boundary with a concentration of crimes (Anselin et al 2000). Harries (1999) defined a hot spot as a condition indicating some form of clustering in a spatial distribution. However, Harries (1999) also states that there is no widely accepted definition of a crime hot spot and all definitions should be clearly stated. For this research a hot spot is defined as an area of citations that are clustered together and represented through low probability kernel home range estimates.

One problem to deal with in determining OSI is political boundaries that conservation officers do not cross. In Mississippi, the state is divided into 7 enforcement districts (Figure 3.1). These districts are divided into sub-districts that consist of 3 – 5 counties. Officers, which are assigned to a county, may work adjoining counties, but rarely cross sub-district boundaries. Crimes, and criminals, however do not respect political boundaries, so it is important for neighboring jurisdictions to know what is taking place on the other side of the boundary (Canter 1995). Hot spots can cross these political boundaries and care in examining these boundary hotspots should be considered (Brantingham and Brantingham 1995).

Methods

Data entry and corrections to the spatial database are described in Chapter 2. The spatial database was separated by sub-district by year and the ArcView extension Animal Movements (Hooge and Eichenlaub 1997) was used to generate kernel home range estimates for all citations within a sub-district for all citations plotted. The sub-district

boundaries were used to clip the kernel grids and all grids for each year were merged into one grid to give a representation of OSI for all plotted citations for each year.

High concentrations of citations in one area will affect the overall kernel density estimation. To alleviate this problem water related citations, e.g., boating and fishing citations, were removed from the spatial database and the process as stated above was repeated. This gives a representation of where citations were written without the influence of bodies of water and thus removing these artificial hot spots. It is important to realize that there can be hot spots within these bodies of water. However, with this dataset these hot spots cannot be accurately determined because some of the citation locations were approximated on bodies of water (see Chapter 2).

To be able to visualize where "gaps" or "holes" between areas exist over time, a combination density grid of all 4 years was needed. The kernel density grids for each year were combined to form a single grid. Then this single grid for all years was classified by the number of years potential citations were written in an area.

For individual OSI, the officers badge number was used to select the citations from the spatial database. Then MCP and kernel home range estimates were created using the Animal Movements extension (Hooge and Eichenlaub 1997) in ArcView. Due to the limited number of officers which met the sample size requirement of ≥30 locations, individual OSI was not calculated for all officers, but it is shown here as an example of how this analysis can be conducted in the future.

Results

There were 2 counties in Mississippi (Union and Holmes Counties) that did not have any plotted citations. In Union County the paper maps with the plotted citations were misplaced and in Holmes County there was a recent turn over of conservation officers. All other counties had citations that were plotted for all 4 years. These counties are marked with No Data on all OSI maps.

Officer sphere of influence for all citations for each year can be seen in Figure 4.1. It is very easy to see where the large lakes, rivers, and some WMA's are within the state by comparing the OSI maps to a map of lakes and rivers (Figure 4.2). A boundary hot spot can be seen in District 5 between sub-districts B and C in 1999 - 2000. Upon closer inspection, these are near a river which flows across the sub-district boundary.

On the OSI maps for citations that are not fishing/water related (Figure 4.3), there are fewer "gaps" in the coverage across the state; especially note the difference in Districts 1 and 7. It should be noted that there were only 19 citations plotted in District 7 in 1997 that were non-fishing/water related. District 5 had the least amount of change between OSI for all citations and OSI for non-fishing/water related citations.

By examining the OSI for all citations during all years (Figure 4.4), areas where there have been no citations in any of the 4 years are very noticeable. Areas that are highly influenced by water/fishing citations, i.e., Districts 1 and 7, appears to have a much larger area that officers are not writing citations. However, it is important to realize that a high concentration of locations will inversely affect the kernel home range size. This is very evident when comparing the OSI for all citations for all years to the

OSI for citations that are not fishing/water related (Figures 4.4, 4.5). The non-fishing/water related OSI map gives a better interpretation of where officers are writing wildlife/hunting related citations.

In 1997 there were 269 officers that wrote citations, 270 in 1998, 314 in 1999, and 273 in 2000. The number of citations written by an individual officer ranged from 1 – 137 in 1997, 1 – 283 in 1998, 1 – 335 in 1999, and 1 – 566 in 2000. The mean number of citations written for officers that wrote citations was 22.84 in 1997, 41.20 in 1998, 41.36 in 1999, and 44.69 in 2000 (Table 4.1).

There were only 46 of the officers that plotted ≥30 citations for all years and 162 officers that plotted at least 1 citation in all 4 years. If the minimum number of locations was decreased to 20, there were still only 73 officers with ≥20 plotted citations. Because of this, individual officer OSI could not be conducted for individual officers. The numbers of citations per officer for all officers per year are in Appendix E. For demonstration, OSI was calculated for 2 officers to show how difficult it would be to compare between officers. Figures 4.6 (county officer) and 4.7 (WMA officer) show the OSI for these 2 officers as well as a map of citations written in that specific area for all citations over 4 years. All of these maps were created at the same scale for ease in visual comparison. The county officer wrote 187 citations over the 4 year period. The MCP for the county officer was 1,608.55 mi^2 (4,166.13 km^2) and the 95% kernel was 699.88 mi^2 (1,812.68 km^2). The WMA officer wrote 1,314 citations during the same time period. However, the MCP for the WMA officer was 437.82 mi^2 (1,133.95 km^2) and the 95% kernel was 276.64 mi^2 (716.49 km^2).

Discussion

Evaluation of OSI is very subjective and is open to interpretation. There may be underlying factors which cannot be seen on the maps that can cause OSI shifts from year to year. Some of these factors are cities, agriculture lands, presence/absence of conservation officers, and the lack or abundance of wildlife species in an area. Cities and agriculture lands can be observed on maps, but the lack/abundance of wildlife species cannot be represented as easily. One thing OSI does not take into consideration in this case is officer effort. There is no reliable variable in this data that represents officer effort, and this method should not be used as a tool to evaluate officer effort.

Using citations as location points are biased. The locations are not evenly distributed temporally and are often clustered in space and time. They are only indications of where an officer actually writes a citation and not necessarily the officers' movements. The assumptions of independence of point locations and independence of time are being violated in these analyses; however this remains the best estimate of OSI.

Officer sphere of influence is not a one step evaluation tool. Individual OSI maps by year give a good representation of where officers have written most citations. These maps should be evaluated, along with the non-fishing/water related OSI maps to have a better understanding of the total area influenced by all officers. Individual officer OSI should be examined in areas where there are large holes in coverage from the statewide OSI maps and where there appears to be a good coverage to get a better understanding of which officers are writing the majority of citations. However, with this data the

individual OSI cannot be conducted for all officers because some officers do not write enough citation per year to perform kernel home range estimates.

Comparison of one officer to another also can be problematic. There may be underlying differences that need to be examined, in addition to OSI. Many independent situations can affect where and how many citations a particular officer could write. These could include, but are not limited to, age of the officer, years of service, assignment (e.g., county officer vs. WMA officer), the abundance/lack of wildlife in the area, and/or proximity to water. All of these should be evaluated and understood before comparisons between officers are performed.

Because the data are not abundant enough to generate individual OSI, another approach could be to look at each officer's citations as points on a map, i.e., "point-pattern analysis" (Canter 1995). This should be done for each officer and for each species. This will give a visual representation of the areas the in which the officers are writing citations.

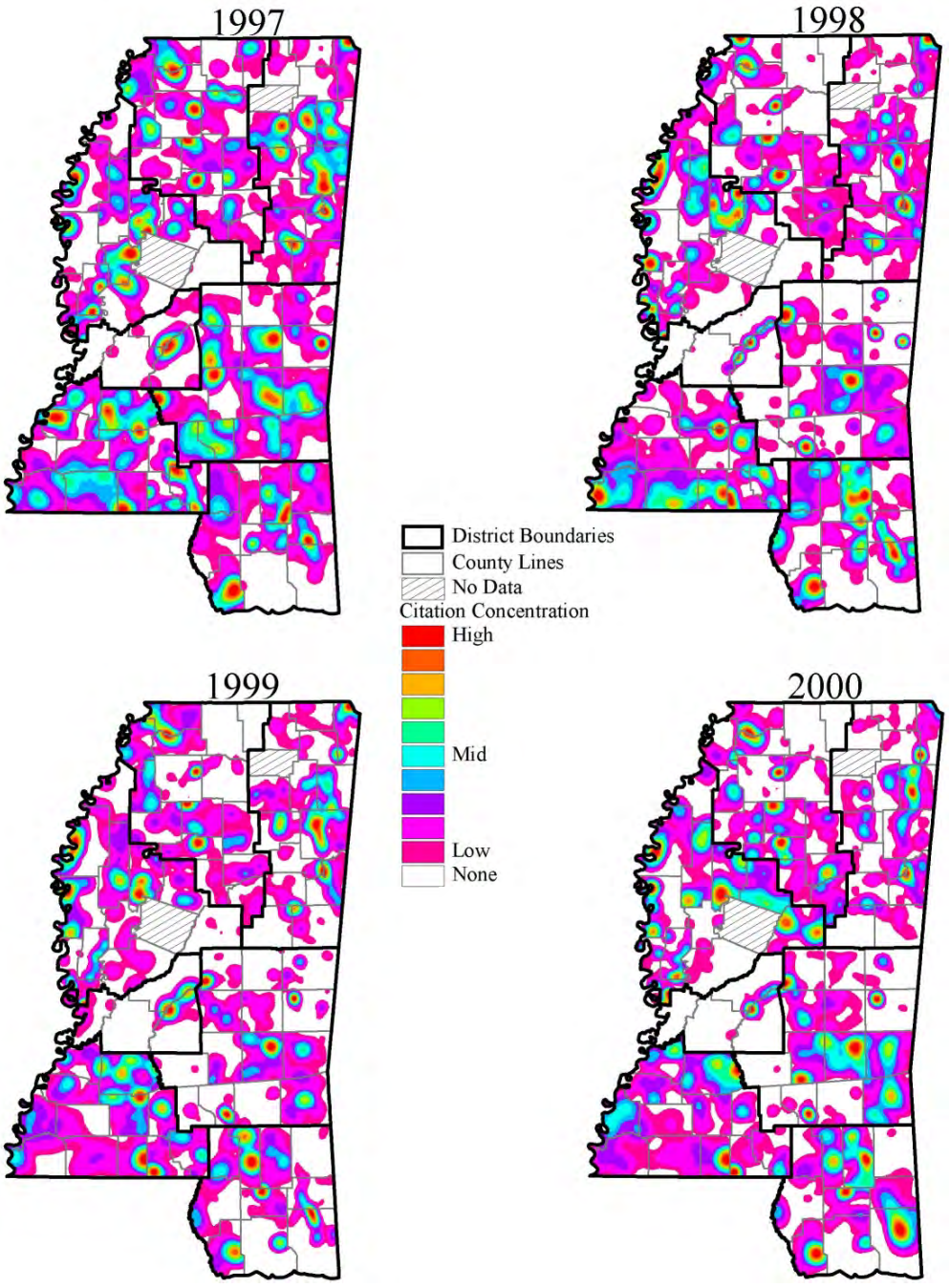

Figure 4.1 Officer sphere of influence for all plotted citations written by Conservation Officers in Mississippi during fiscal years 1997 – 2000. For individual maps of each year see Appendix D.

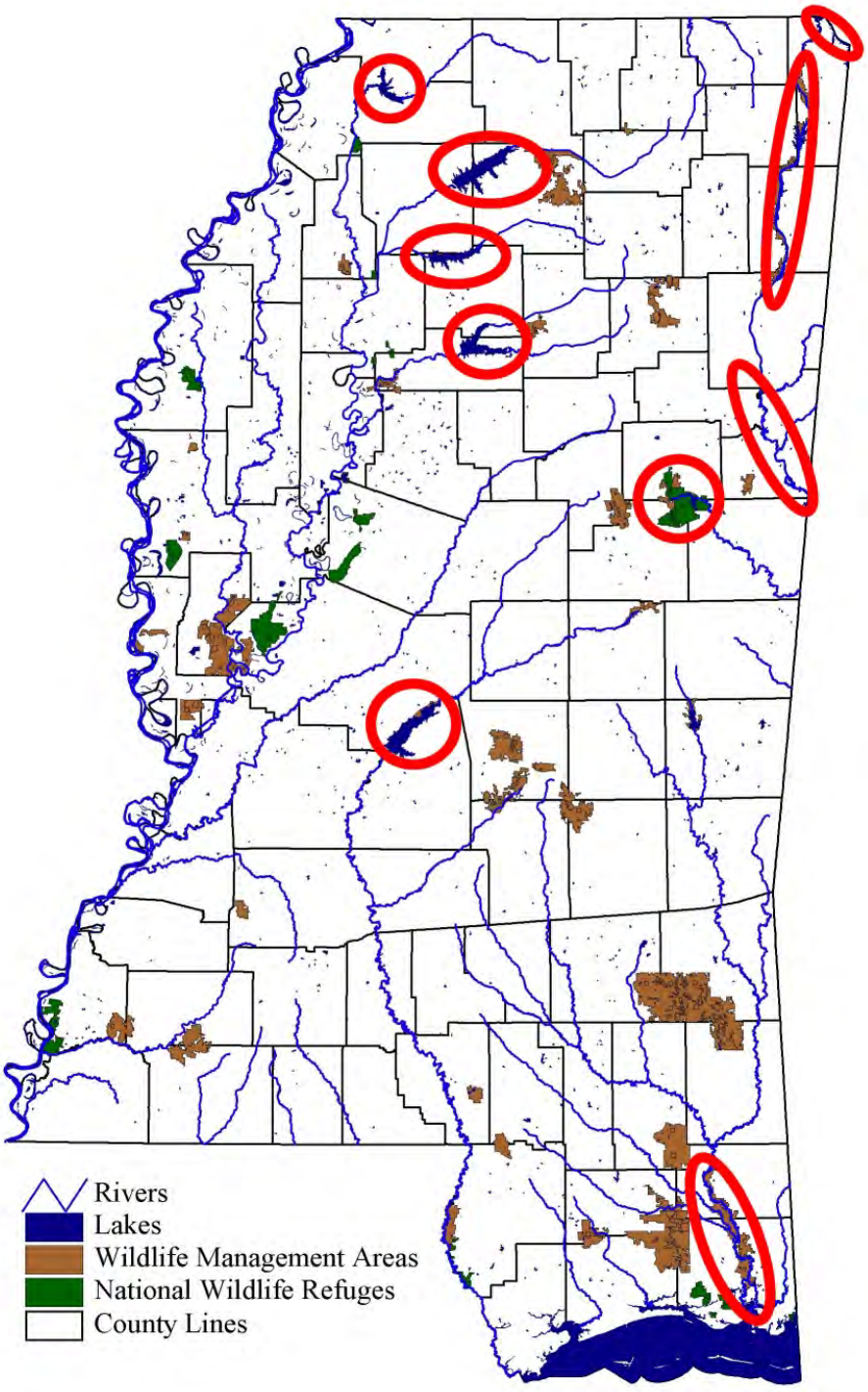

Figure 4.2 Rivers, lakes, and wildlife management areas in Mississippi. Areas highlighted are some areas that show up on the OSI maps.

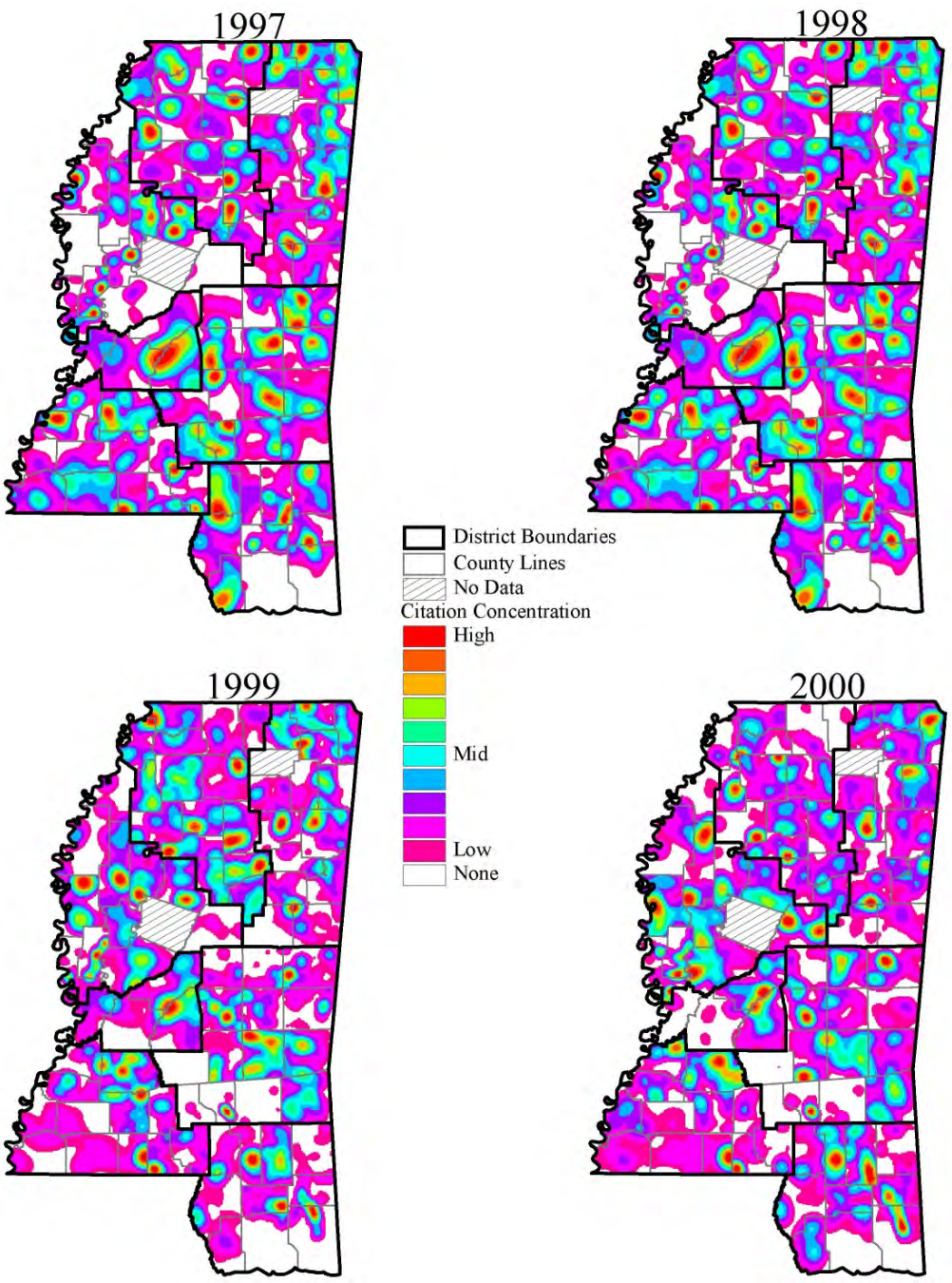

Figure 4.3 Officer sphere of influence for all plotted citations that are not fishing / water related citations written by Conservation Officers in Mississippi during fiscal years 1997 – 2000. For individual maps of each year see Appendix D.

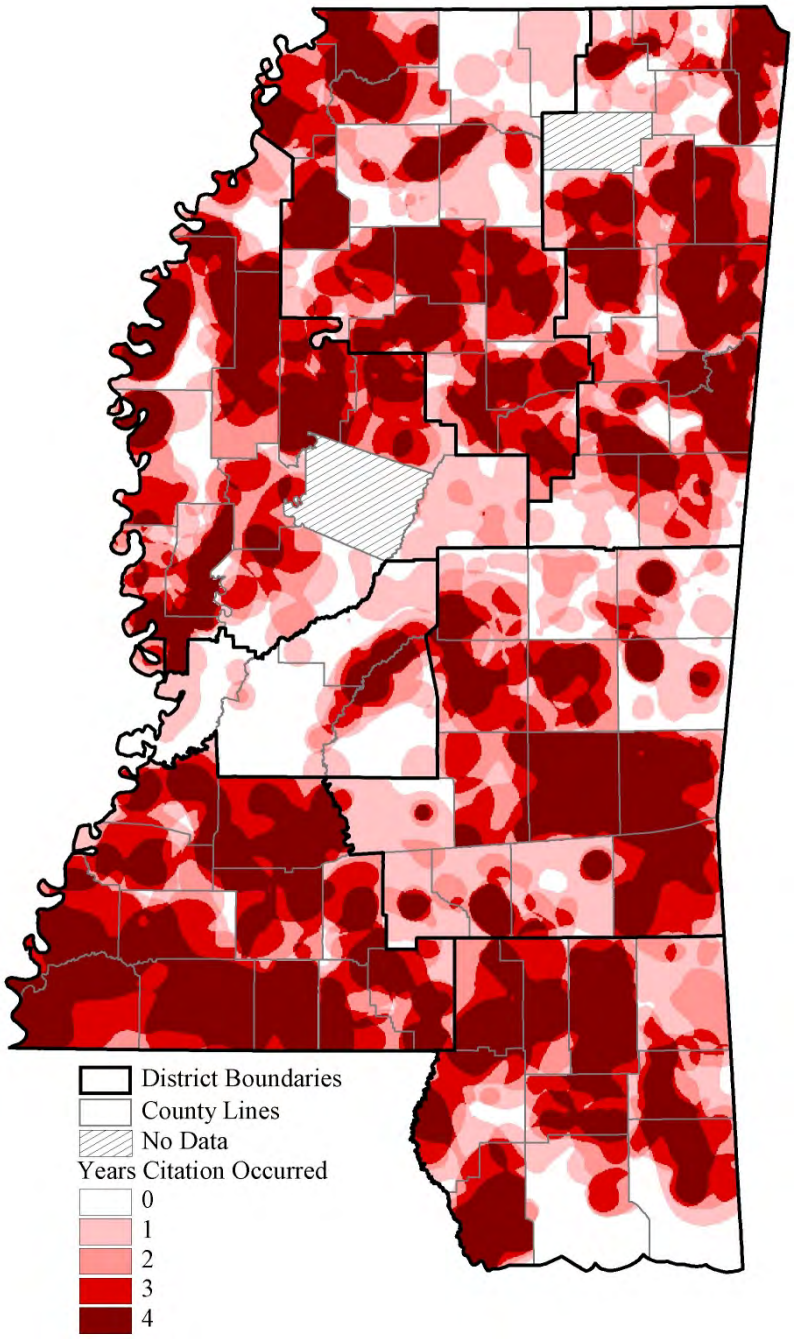

Figure 4.4 Officer sphere of influence for all plotted citations written by Conservation Officers in Mississippi during fiscal years 1997 – 2000.

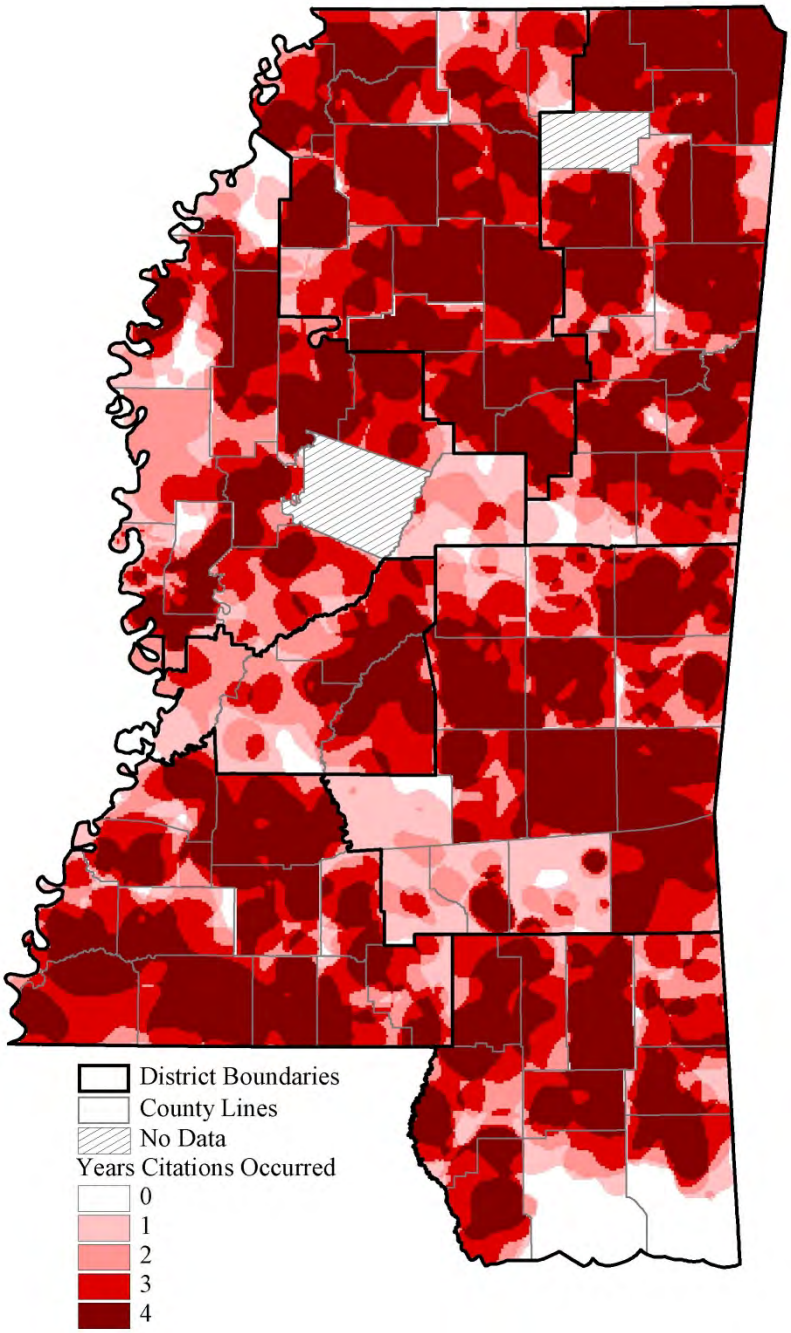

Figure 4.5 Officer sphere of influence for plotted citations that are not fishing / water related citations written by Conservation Officers in Mississippi during fiscal years 1997 – 2000.

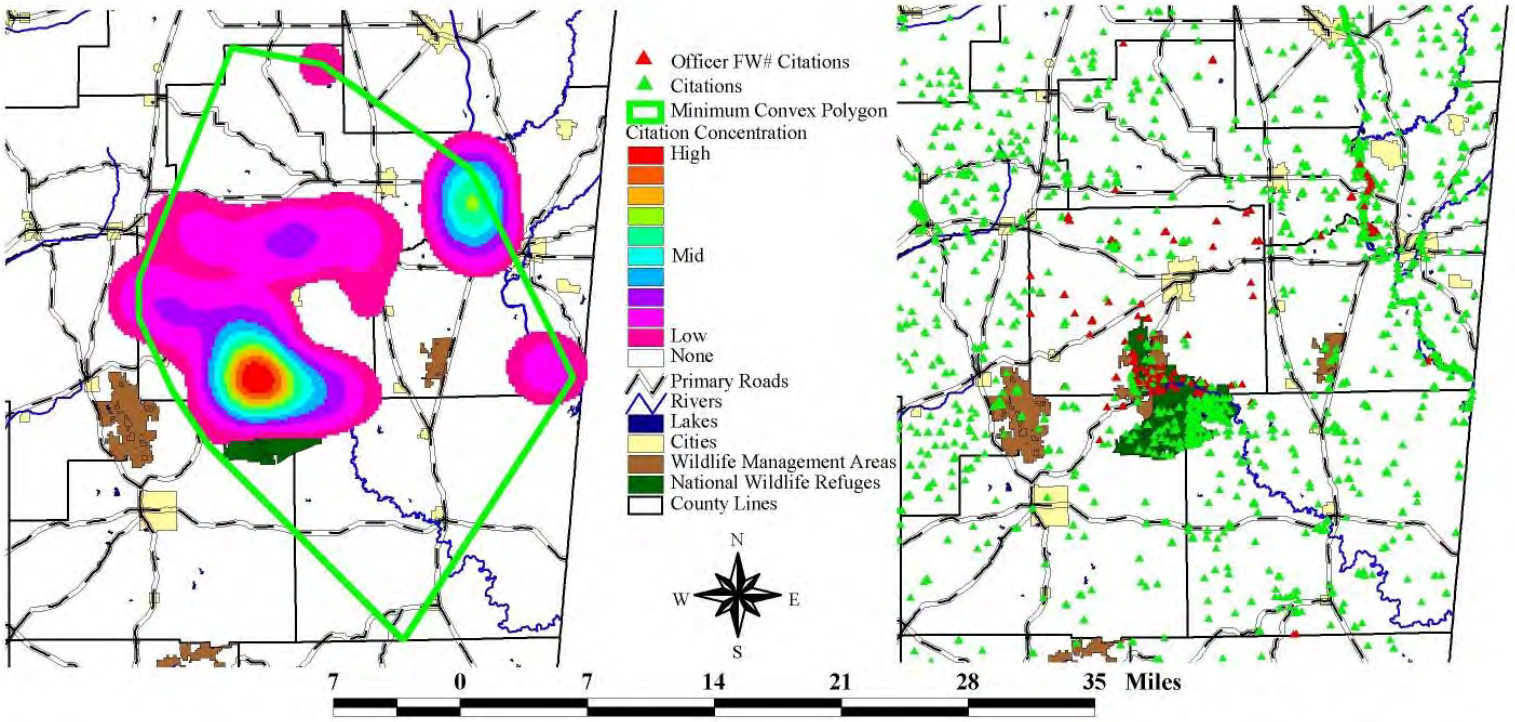

Figure 4.6 Officer sphere of influence (left) for a county Conservation Officer in east-central Mississippi and this officer's citations plotted in red (right) for citations written during fiscal years 1997 – 2000.

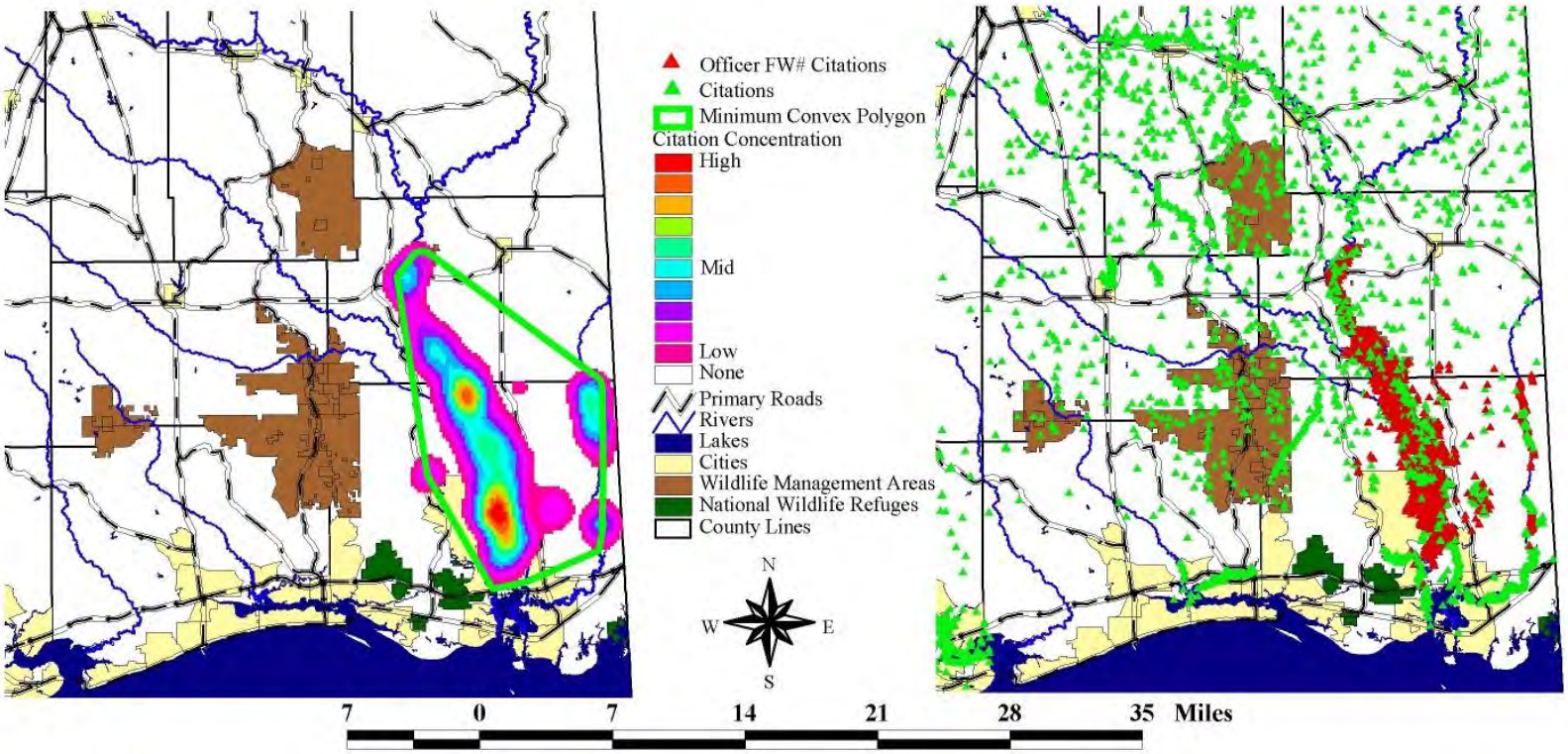

Figure 4.7 Officer sphere of influence (left) for a Conservation Officer assigned to a WMA in south Mississippi and this officer's citations plotted in red (right) for citations written during fiscal years 1997 – 2000 .

Table 4.1 Summary of the number of Conservation Officers in Mississippi who wrote citations and the number citations written during fiscal years 1997 – 2000.

Year	Number of Officers[a]	Minimum citations	Maximum citations	Mean	Total Ciations
1997	269	1	137	22.84	6144
1998	279	1	283	41.20	11494
1999	314	1	335	41.36	12988
2000	273	1	566	44.69	12201
1997 - 2000	198				42827

a. Number of officers that wrote citations in the respective year.

CHAPTER V

CONCLUSION, RECOMMENDATIONS, AND FUTURE RESEARCH NEEDS

The first thing in developing a GIS for CLE is to determine if the GIS is going to use historic data or start from scratch and develop a GIS using only current data. If the historic data is to be used, meetings will need to be held with all conservation officers and they must plot the citation locations on paper maps. Then these points must be digitized into the GIS. The most cost effective way of accomplishing these tasks is to fund a research project at a university or college. A research project can collect and enter the data, and provide valuable analysis that can benefit the entire conservation law enforcement field. After the initial spatial database is established, the only thing the agency will need to do is to update and maintain the GIS on a regular basis (Dacus et al. 2001). To decrease the time needed to conduct the updates, GPS units should be issued to all conservation officers and the coordinates of the violation location should be recorded on the citation. This location information should then be entered into the Citation database along will all other pertinent information.

The most important consideration when developing a GIS for use in conservation law enforcement is the standardization of the data to be collected by the officers. This

can be as simple as making sure all officers use the same citation format and codes, i.e., species and violation codes; and can be as specific as making sure all officers collect citation locations in the same coordinate system and datum. Dacus et al. (2001) recommend data be collected in decimal degrees (latitude/longitude) World Geodetic Systems 1984 (WGS 84) in Mississippi. All GPS units come preset to latitude/longitude WGS 84 as a default. The only change that needs to be made on the GPS unit is to change the coordinates from degrees, minutes, and seconds to decimal degrees. These data can be converted at a later time to a different projection, if so desired, with little effort.

Success of any program, especially a GIS program requires first and foremost support from the agency and administration. Any program that does not receive support from the administration is doomed to fail. Miller (1995) suggested 3 rules to consider when developing a GIS for use in law enforcement: 1) determine your needs as an agency; 2) find software that will satisfy your needs; and 3) find hardware that will run the selected software. However, there are additional steps needed in conjunction with Miller's rules when developing a GIS for use in conservation law enforcement. Some suggestions are to: 1) develop a vision of how the GIS will fit into the agency's goals; 2) determine the needs of the agency; 3) set a budget; 4) acquire adequate space and security for the GIS lab; 5) hire a qualified GIS specialist to oversee and maintain the GIS; 6) find software to satisfy the agency's needs; 7) find hardware to run the selected software; 8) educate agency personnel about the GIS; 9) acquire data and; 10) update the software and hardware. Developing a vision and determining the needs of a conservation law

enforcement agency can be the most difficult of these steps. This is primarily due to the lack of information available on how GIS can and is being used in CLE.

The best way to continue the progression of conservation law enforcement agencies from the days of folded paper maps into the digital age is through quality research. Research will not only benefit the agency, but it can aid in the progression of the entire conservation law enforcement profession by presenting research findings at regional, national, and international conferences. Such research will ensure that conservation law enforcement continues to advance in a world of ever changing technologies and ideas (Dacus et al. 2001).

The most valuable aspect of a GIS in conservation law enforcement is that it can reduce the learning curve for an officer in a new area and keep all of the knowledge that is accumulated by these officers over the years within the agency (Dacus et al. 2001). Today officers depend on their partners to help them learn about the areas that they will be working in. A GIS will not replace the need for this interaction between partners, but it will help the officers to be more efficient and more effective in a briefer time period. In Mississippi the scenario of an officer retiring unexpectedly and not being able to train the replacement officer is the norm. Without a GIS, this new officer has to learn the county on his/her own, start a mental database of information, and obtains no input from the retiring officer's knowledge of the area. With a GIS, this same officer can "go back in time" and look at the citations that were written to learn where problem areas have been, who the problem people were, and what they did in the past within his/her work area (Minnis et al. 1999, Dacus et al. 2001).

There is additional data that is collected at the time the citation is written that is not currently included in the Citation database. For example, number of animals over the limit or how many illegally harvested animals are taken is written in the comments section of illegal harvest citations. This data would give researchers a valid way of estimating illegal harvest of these species. Giles et al. (1971) remarked about how important the knowledge relating illegal harvest to existing populations or to legal harvest could be to game management. In the future, this data along with TEL-CHEK data could give the MDWFP biologist an idea of actual harvest (legal and illegal) of deer and turkey in Mississippi by region or county.

I have only demonstrated the basic uses GIS for conservation law enforcement. There are numerous other ways GIS can be used in conservation law enforcement. Below are descriptions of a few of the ways GIS can be used in conservation law enforcement with citation data:

1. Relate citations to harvest information and wildlife density estimations and hunter density estimations;

2. Develop models based on locations, times, and dates of citations, human population demographics, habitat types, and violator attitudes to get a better understanding of where and when violators should be most active;

3. Relate the location of citations to land ownership (i.e. public lands, hunting clubs, timber company lands) to provide officers with a greater knowledge of violations within their area;

4. Study wildlife/water related accidents by plotting, or having GPS locations, these accident locations may provide insight into ways to prevent these accidents or show the need for an increase in hunter education and/or boating safety classes;

5. Study officer effort. The research in this thesis does not account for officer effort. Officers could keep track of time and location of duties during a week or month and these data could be input into a GIS as an

effort variable. Citations written could be related to officer effort for a more complete representation of activity within a territory. This could be very important if an officer has established a strong presence in an area and is not writing a large number of citations;

6. Evaluate the need for officers in an area, i.e., officer deployment. A GIS of wildlife citations, complaints of violations, officer sphere of influence, and demographic information could be combined to develop a GIS layer depicting where and how many officers need to be working in an area;

7. Evaluate the number of citations by county/district per year or in a specified time frame (i.e., number of duck citations during duck season, number of deer citations during deer season, etc.). By looking at these relationships, along with officer effort (see #5), the agency could get a better understanding of what types of seasons the conservation officers are working and if officers are working all types of game or only certain species.

8. Relate officer sphere of influence to the officer's home locations. This can be done by recording which officers are reassigned to a new area within a specified time frame to determine if citations are only being written within the officer's core area, i.e. around his/her home location, in one direction from his/her home, or if he/she are writing citations across the entire county;

9. Develop a system where complaints are issued to the officer who lives closest to a complainant. Currently, complaints within a county are issued to the officers within that county. In actuality officers in adjacent counties may live closer to complainant or may have a quicker route because of natural obstacles, e.g., rivers, WMA's, or National Wildlife Refuges.

Minnis et al. (1999) stated the ultimate goal should be to provide the means for enforcement to become more pro-active and efficient at helping to manage and protect our wildlife resources. Dacus et al. (2001) stated that a GIS can provide officers this means. This may be achieved by keeping the knowledge of all officers that have worked for an agency, or in a specific area, with that agency and in that area. With this knowledge base in place, wildlife resources can be protected effectively for years to come.

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APPENDIX A

SURVEY OF STATE WILDLIFE AND FISHERIES AGENCIES REGARDING THE USE OF SPATIAL TECHNOLOGIES IN CONSERVATION LAW ENFORCEMENT

Survey of State Wildlife and Fisheries Agencies Regarding the use of Spatial Technologies in Conservation Law Enforcement

Research Objective: To determine the current use of spatial technologies in conservation law enforcement.

This research is being conducted by Chad M. Dacus, Graduate Research Assistant in the Department of Wildlife and Fisheries at Mississippi State University. If you have any questions or need additional information about the research, please contact Chad at ___-___-____ or _____.

1. What is the name of the agency and the division/section within the agency that you represent? In what state?

2. What is your position within this agency?
   □ Chief of Law Enforcement □ Assistant Chief of Law Enforcement
   □ District Supervisor □ Conservation Officer
   □ Other: please describe _____

3. How many field level conservation officers (game wardens, patrol officers, etc.) are there within the division of the agency that you represent?

4. Are any of these officers issued global positioning system (GPS) units by your state agency?
   □ YES □ NO

   If NO, Are there any officers in your agency that obtain GPS units from other sources (personal units, from the county, etc.)?
   □ YES □ NO

   If NO, skip to Question #7.
   If YES, who provides the GPS units to the officers?

5. How many officers in your agency have GPS units in their possession for official use?

6. How are these GPS units used? (Check all that apply.)
   □ To locate wildlife and fisheries projects/activities
   □ To locate citations
   □ To monitor officer movement
   □ To locate officers
   □ To locate hunting/boating accident sites
   □ Other (please list)

7. Does your agency plan to provide GPS units to officers in the future?
□ YES □ NO
If NO, skip to Question #9.
If YES, when? □ Currently provided; □ 1–3 years; □ 3-5 years; □ 5-10 years

8. What will be the use of the GPS units? (Check all that apply.)
□ To locate wildlife and fisheries projects/locations
□ To locate citations
□ To monitor officer movement
□ To locate officers
□ To locate hunting/boating accident sites
□ Other (please list)

9. Is citation data input into a database to manage your officers' citations?
□ YES □ NO
If NO, skip to Question #11.

10. At what level of resolution is the citation data maintained?
(Check all that apply.)
□ State level
□ District level
□ County level
□ Other: _____

11. Does the agency use a geographic information system (GIS) to map specific citation locations?
□ YES □ NO
If NO, skip to Question #15.

12. What analyses are done on your law enforcement data?

13. What computer software is used to perform these tasks?

14. How is the information geo-referenced? (i.e., by county, latitude/longitude, UTM, etc.)

15. Please rate the following potential uses of GIS in order of usefulness to your agency: 1=most useful, 5=least useful

a. To evaluate officer placement/deployment
□ 1 □ 2 □ 3 □ 4 □ 5

b. To determine officer work habits (officer's sphere of influence)
□ 1 □ 2 □ 3 □ 4 □ 5

c. To evaluate citation distribution by county/district
□ 1 □ 2 □ 3 □ 4 □ 5

d. To evaluate the distribution of citations by citation type
□ 1 □ 2 □ 3 □ 4 □ 5

e. To evaluate the effectiveness of newly implemented programs (i.e., officer education programs)
□ 1 □ 2 □ 3 □ 4 □ 5

f. To determine the location of citations in relation to land ownership (i.e., public lands, hunting clubs, timber company lands, etc.)
□ 1 □ 2 □ 3 □ 4 □ 5

g. To determine and evaluate the location of wildlife/water related accidents
□ 1 □ 2 □ 3 □ 4 □ 5

h. To evaluate the relationship between citation locations and harvest information
□ 1 □ 2 □ 3 □ 4 □ 5

i. Other(s): please describe and rate
□ 1 □ 2 □ 3 □ 4 □ 5

16. What other uses of this technology can you see that would be beneficial to your officers and/or agency?

APPENDIX B

DISTRIBUTION OF CITATIONS BY SPECIES

Table B.1 Distribution of citations written by Conservation Officers in Mississippi grouped by species type, county, and district during fiscal year 1997 in districts 1 – 3.

District	County	Deer	Dove	Small Game [1]	Sport Fishing	Turkey	Waterfowl	Other [2]	No Data [3]	Grand Total
1	Alcorn	16	3	0	0	4	1	0	13	37
	Chickasaw	49	14	2	15	5	12	0	0	97
	Clay	35	8	3	0	0	6	1	0	53
	Itawamba	64	7	3	10	4	7	2	1	98
	Lee	17	5	2	6	0	18	0	2	50
	Lowndes	30	4	1	20	4	38	3	1	101
	Monroe	94	32	1	19	10	10	0	4	170
	Noxubee	54	4	2	33	1	16	0	0	110
	Oktibbeha	42	6	2	12	0	7	2	0	71
	Pontotoc	44	0	1	8	2	9	0	0	64
	Prentiss	40	6	0	8	5	4	0	0	63
	Tippah	48	2	2	19	2	15	0	0	88
	Tishomingo	38	0	7	164	4	27	0	1	241
	Union	20	14	1	0	0	0	4	0	39
	Winston	24	5	3	3	0	0	0	1	36
	1 Total	615	110	30	317	41	170	12	23	1318
2	Benton	76	0	0	0	1	0	1	0	78
	Calhoun	79	0	0	10	0	3	4	4	100
	Choctaw	31	2	1	2	1	0	1	0	38
	Desoto	23	0	0	8	0	11	0	3	45
	Grenada	38	0	4	31	3	54	9	0	139
	Lafayette	54	0	10	6	2	27	15	0	114
	Marshall	32	0	2	3	8	0	2	1	48
	Montgomery	47	0	0	1	0	0	3	0	51
	Panola	58	0	8	12	6	60	0	0	144
	Quitman	14	0	0	0	13	0	0	4	31
	Tallahatchie	5	0	0	5	16	0	0	0	26
	Tate	7	0	4	5	1	9	0	1	27
	Tunica	20	0	1	0	2	13	0	6	42
	Webster	71	0	1	0	2	0	0	21	95
	Yalobusha	42	0	2	16	2	53	1	0	116
	2 Total	597	2	33	99	57	230	36	40	1094
3	Attala	10	0	1	0	0	2	1	0	14
	Bolivar	13	0	2	7	0	8	0	26	56
	Carroll	106	0	1	0	1	15	0	0	123
	Coahoma	1	0	2	1	0	5	0	1	10
	Holmes	41	0	9	5	0	62	2	2	121
	Humphreys	2	0	6	4	17	2	0	0	31
	Issaquena	22	0	18	15	2	20	0	1	78
	Leflore	18	0	2	0	7	47	0	19	93
	Sharkey	64	0	19	15	22	1	4	2	127
	Sunflower	13	0	4	12	15	2	0	3	49
	Washington	4	0	1	17	0	41	0	0	63
	Yazoo	16	0	4	10	0	4	1	2	37
	3 Total	310	0	69	86	64	209	8	56	802

[1] Small game includes: Squirrel, Raccoon, Quail, Opossum, Non-game bird, Frog, Coyote/Beaver, Bobcat

[2] Other includesSalt water fish, Shell fish, Commercial fishing, and all not wildlife related crimes

[3] No Data: species codes were invalid or not entered

Table B.2 Distribution of citations written by Conservation Officers in Mississippi grouped by species type, county, and district during fiscal year 1997 in districts 4 – 7.

District	County	Deer	Dove	Small Game [1]	Sport Fishing	Turkey	Waterfowl	Other [2]	No Data [3]	Grand Total
4	Clarke	48	0	0	34	3	9	1	0	95
	Covington	40	0	0	10	11	7	0	0	68
	Jasper	103	0	1	6	10	1	0	0	121
	Jefferson Davis	30	0	1	5	11	4	2	0	53
	Jones	41	0	0	9	1	6	0	0	57
	Kemper	82	0	1	15	0	3	1	0	102
	Lauderdale	49	0	0	16	1	59	0	0	125
	Leake	12	0	1	0	0	0	0	3	16
	Neshoba	13	1	1	6	2	4	3	0	30
	Newton	40	0	2	6	1	11	1	0	61
	Scott	34	0	1	7	0	1	0	0	43
	Simpson	13	0	0	9	0	2	3	0	27
	Smith	51	0	1	2	2	0	0	0	56
	Wayne	76	0	8	2	3	3	1	0	93
	4 Total	632	1	17	127	45	110	12	3	947
5	Adams	26	1	0	0	3	2	0	0	32
	Amite	75	1	1	0	4	1	5	0	87
	Claiborne	44	0	0	0	0	0	0	0	44
	Copiah	80	2	6	1	0	26	0	0	115
	Franklin	54	0	1	1	0	0	0	0	56
	Jefferson	30	0	15	10	0	0	0	0	55
	Lawrence	19	1	0	0	0	0	0	0	20
	Lincoln	40	0	2	16	8	9	0	0	75
	Marion	36	6	4	9	11	30	2	0	98
	Pike	38	1	4	7	0	2	1	0	53
	Walthall	27	0	0	1	2	2	0	0	32
	Wilkinson	59	0	1	18	3	3	0	0	84
	5 Total	528	12	34	63	31	75	8	0	751
6	Forrest	10	0	8	2	0	1	0	0	21
	George	19	0	30	29	3	39	0	0	120
	Greene	2	0	148	4	0	2	2	0	158
	Hancock	15	2	27	34	8	18	0	0	104
	Harrison	16	0	26	27	0	0	0	0	69
	Jackson	36	0	50	18	8	13	2	0	127
	Lamar	31	0	22	7	11	1	2	0	74
	Pearl River	60	0	28	11	14	12	0	0	125
	Perry	79	1	46	7	3	20	4	0	160
	Stone	30	0	34	4	2	0	0	0	70
	6 Total	298	3	419	143	49	106	10	0	1028
7	Hinds	5	0	0	0	4	8	0	0	17
	Madison	29	1	3	14	0	24	0	1	72
	Rankin	8	0	5	28	0	41	0	0	82
	Warren	11	0	17	2	0	2	0	1	33
	7 Total	53	1	25	44	4	75	0	2	204

[1] Small game includes: Squirrel, Raccoon, Quail, Opossum, Non-game bird, Frog, Coyote/Beaver, Bobcat

[2] Other includesSalt water fish, Shell fish, Commercial fishing, and all not wildlife related crimes

[3] No Data: species codes were invalid or not entered

Table B.3 Distribution of citations written by Conservation Officers in Mississippi grouped by species type, county, and district during fiscal year 1998 in districts 1 – 3.

District	County	Deer	Dove	Small Game [1]	Sport Fishing	Turkey	Waterfowl	Other [2]	No Data [3]	Grand Total
1	Alcorn	67	1	0	10	3	2	1	0	84
	Chickasaw	61	29	1	26	6	6	0	7	136
	Clay	31	11	0	14	2	5	0	6	69
	Itawamba	76	17	0	6	4	13	0	1	117
	Lee	48	94	1	17	8	20	0	4	192
	Lowndes	23	17	1	44	12	30	7	6	140
	Monroe	86	3	1	44	2	60	2	6	204
	Noxubee	32	15	0	31	7	12	1	0	98
	Oktibbeha	28	4	0	4	0	8	4	0	48
	Pontotoc	22	22	0	5	0	14	0	0	63
	Prentiss	48	2	1	53	1	11	0	0	116
	Tippah	63	3	0	30	10	21	10	0	137
	Tishomingo	82	0	4	408	1	29	0	5	529
	Union	28	0	0	2	1	6	0	0	37
	Winston	40	3	0	3	0	0	0	0	46
	1 Total	735	221	9	697	57	237	25	35	2016
2	Benton	33	0	0	0	0	0	0	0	33
	Calhoun	68	6	0	0	1	11	0	3	89
	Choctaw	68	5	1	1	0	2	2	0	79
	Desoto	19	4	0	27	1	55	1	7	114
	Grenada	73	11	0	60	0	47	1	1	193
	Lafayette	56	6	6	14	3	102	7	5	199
	Marshall	42	11	0	0	3	4	0	5	65
	Montgomery	36	0	0	0	0	0	0	0	36
	Panola	135	5	11	106	0	220	1	0	478
	Quitman	15	2	0	22	16	0	0	25	80
	Tallahatchie	33	2	0	0	7	4	3	2	51
	Tate	12	1	0	3	3	19	0	4	42
	Tunica	22	1	0	5	24	14	0	9	75
	Webster	63	0	0	13	3	3	0	0	82
	Yalobusha	34	4	1	36	1	71	6	1	154
	2 Total	709	58	19	287	62	552	21	62	1770
3	Attala	42	0	0	2	0	0	0	0	44
	Bolivar	16	9	1	31	1	45	1	1	105
	Carroll	167	2	2	0	2	4	0	0	177
	Coahoma	5	1	1	7	1	10	0	1	26
	Holmes	91	1	1	13	0	79	2	0	187
	Humphreys	9	9	0	11	37	12	0	0	78
	Issaquena	59	30	1	21	3	84	0	3	201
	Leflore	53	53	2	17	17	33	0	0	175
	Sharkey	80	3	1	30	22	7	2	2	147
	Sunflower	12	19	0	12	35	15	0	2	95
	Washington	23	11	1	67	13	135	0	0	250
	Yazoo	34	3	0	9	5	5	1	3	60
	3 Total	591	141	10	220	136	429	6	12	1545

[1] Small game includes: Squirrel, Raccoon, Quail, Opossum, Non-game bird, Frog, Coyote/Beaver, Bobcat

[2] Other includesSalt water fish, Shell fish, Commercial fishing, and all not wildlife related crimes

[3] No Data: species codes were invalid or not entered

Table B.4 Distribution of citations written by Conservation Officers in Mississippi grouped by species type, county, and district during fiscal year 1998 in districts 4 – 7.

District	County	Deer	Dove	Small Game [1]	Sport Fishing	Turkey	Waterfowl	Other [2]	No Data [3]	Grand Total
4	Clarke	122	5	1	26	7	11	4	0	176
	Covington	12	18	2	209	6	27	6	0	280
	Jasper	115	25	1	20	5	37	7	0	210
	Jefferson Davis	64	3	0	10	0	2	2	0	81
	Jones	52	1	0	96	2	96	7	1	255
	Kemper	76	0	1	64	0	51	8	0	200
	Lauderdale	44	2	6	141	0	170	2	0	365
	Leake	4	0	0	8	3	8	3	0	26
	Neshoba	12	20	0	1	9	6	1	0	49
	Newton	49	0	4	2	0	5	2	0	62
	Scott	23	0	0	49	1	34	1	0	108
	Simpson	37	0	0	10	0	32	0	0	79
	Smith	33	2	0	8	5	23	11	0	82
	Wayne	83	5	0	44	12	45	2	0	191
	4 Total	726	81	15	688	50	547	56	1	2164
5	Adams	53	0	0	14	6	41	2	0	116
	Amite	145	14	2	7	3	6	2	0	179
	Claiborne	49	0	0	0	0	19	1	0	69
	Copiah	52	0	4	13	2	36	2	0	109
	Franklin	46	13	0	9	0	3	3	0	74
	Jefferson	58	0	0	0	0	0	3	0	61
	Lawrence	50	0	3	16	2	14	2	0	87
	Lincoln	42	10	1	66	13	15	11	0	158
	Marion	33	10	1	9	4	47	0	0	104
	Pike	13	23	0	63	1	20	0	0	120
	Walthall	43	2	0	36	0	5	0	0	86
	Wilkinson	126	0	0	29	1	58	4	0	218
	5 Total	710	72	11	262	32	264	30	0	1381
6	Forrest	10	0	0	46	0	31	0	0	87
	George	69	0	2	134	3	64	12	0	284
	Greene	108	2	4	6	5	14	21	0	160
	Hancock	17	1	5	108	1	23	0	0	155
	Harrison	22	0	2	15	5	0	0	0	44
	Jackson	125	2	3	184	9	267	4	2	596
	Lamar	49	2	11	19	7	12	12	0	112
	Pearl River	52	63	2	17	5	29	6	2	176
	Perry	145	19	1	17	4	34	1	0	221
	Stone	54	0	3	4	0	10	0	0	71
	6 Total	651	89	33	550	39	484	56	4	1906
7	Hinds	14	0	0	4	2	59	1	0	80
	Madison	42	0	1	51	1	55	1	0	151
	Rankin	20	15	5	100	6	170	1	0	317
	Warren	47	0	0	28	7	82	0	0	164
	7 Total	123	15	6	183	16	366	3	0	712

[1] Small game includes: Squirrel, Raccoon, Quail, Opossum, Non-game bird, Frog, Coyote/Beaver, Bobcat

[2] Other includesSalt water fish, Shell fish, Commercial fishing, and all not wildlife related crimes

[3] No Data: species codes were invalid or not entered

Table B.5 Distribution of citations written by Conservation Officers in Mississippi grouped by species type, county, and district during fiscal year 1999 in districts 1 – 3.

District	County	Deer	Dove	Small Game [1]	Sport Fishing	Turkey	Waterfowl	Other [2]	No Data [3]	Grand Total
1	Alcorn	34	0	0	14	0	1	4	22	75
	Chickasaw	35	0	0	47	5	2	0	0	89
	Clay	19	2	0	18	5	20	2	6	72
	Itawamba	52	5	0	33	1	43	0	29	163
	Lee	40	9	0	16	1	8	3	0	77
	Lowndes	32	6	1	49	4	52	1	20	165
	Monroe	73	35	1	78	3	86	6	5	287
	Noxubee	38	4	0	32	6	18	2	0	100
	Oktibbeha	33	5	0	8	0	1	0	4	51
	Pontotoc	25	10	0	16	4	11	3	0	69
	Prentiss	54	4	0	73	2	10	0	3	146
	Tippah	42	3	0	23	12	14	0	2	96
	Tishomingo	38	0	1	266	4	16	2	3	330
	Union	67	21	3	11	7	46	6	0	161
	Winston	12	2	0	2	1	3	6	0	26
	1 Total	594	106	6	686	55	331	35	94	1907
2	Benton	43	1	0	0	0	0	0	0	44
	Calhoun	24	10	1	5	12	0	0	22	74
	Choctaw	43	3	1	15	4	14	0	0	80
	Desoto	21	8	0	13	0	16	0	4	62
	Grenada	57	8	1	46	11	103	1	7	234
	Lafayette	65	6	0	58	4	121	3	5	262
	Marshall	49	6	0	3	1	10	2	1	72
	Montgomery	56	0	0	2	0	0	7	0	65
	Panola	119	15	0	232	19	177	2	8	572
	Quitman	14	0	0	5	30	11	0	14	74
	Tallahatchie	33	0	0	5	16	11	0	1	66
	Tate	22	0	0	6	2	17	0	10	57
	Tunica	46	7	0	4	5	18	1	2	83
	Webster	68	0	0	6	3	24	4	4	109
	Yalobusha	51	0	0	45	4	51	2	3	156
	2 Total	711	64	3	445	111	573	22	81	2010
3	Attala	25	1	1	2	1	0	0	5	35
	Bolivar	17	4	0	8	2	79	18	2	130
	Carroll	146	14	1	2	0	5	1	0	169
	Coahoma	6	2	0	2	0	10	0	6	26
	Holmes	92	30	0	17	2	39	0	2	182
	Humphreys	30	2	0	4	3	6	0	1	46
	Issaquena	45	5	0	26	7	103	1	10	197
	Leflore	39	2	0	5	4	66	2	9	127
	Sharkey	76	14	0	1	23	8	0	22	144
	Sunflower	28	31	0	2	21	6	0	12	100
	Washington	37	11	1	152	18	172	3	3	397
	Yazoo	54	1	0	24	7	8	0	1	95
	3 Total	595	117	3	245	88	502	25	73	1648

[1] Small game includes: Squirrel, Raccoon, Quail, Opossum, Non-game bird, Frog, Coyote/Beaver, Bobcat

[2] Other includesSalt water fish, Shell fish, Commercial fishing, and all not wildlife related crimes

[3] No Data: species codes were invalid or not entered

Table B.6 Distribution of citations written by Conservation Officers in Mississippi grouped by species type, county, and district during fiscal year 1999 in districts 4 – 7.

District	County	Deer	Dove	Small Game [1]	Sport Fishing	Turkey	Waterfowl	Other [2]	No Data [3]	Grand Total
4	Clarke	88	7	0	11	22	26	5	0	159
	Covington	61	5	2	390	12	31	2	0	503
	Jasper	117	18	0	17	4	44	9	0	209
	Jefferson Davis	31	9	1	25	9	28	0	0	103
	Jones	83	3	1	119	8	40	0	0	254
	Kemper	64	39	0	34	4	32	2	0	175
	Lauderdale	38	6	0	108	5	94	4	6	261
	Leake	34	1	0	7	0	9	8	0	59
	Neshoba	7	21	0	11	6	20	10	2	77
	Newton	42	0	1	11	0	1	2	0	57
	Scott	38	7	0	81	8	40	8	0	182
	Simpson	13	0	0	8	1	19	0	2	43
	Smith	45	7	0	7	4	3	0	0	66
	Wayne	105	2	0	58	0	43	4	0	212
	4 Total	766	125	5	887	83	430	54	10	2360
5	Adams	72	0	1	74	10	53	2	0	212
	Amite	77	4	0	4	3	2	2	0	92
	Claiborne	35	0	0	7	0	14	0	1	57
	Copiah	80	0	1	17	14	57	4	0	173
	Franklin	49	0	1	0	0	0	2	0	52
	Jefferson	39	0	0	1	1	0	0	1	42
	Lawrence	25	0	0	6	0	21	2	3	57
	Lincoln	87	29	1	27	3	7	0	0	154
	Marion	55	2	0	18	1	28	1	0	105
	Pike	31	3	2	118	4	4	0	0	162
	Walthall	51	0	0	21	4	5	0	0	81
	Wilkinson	72	0	0	25	0	30	1	2	130
	5 Total	673	38	6	318	40	221	14	7	1317
6	Forrest	63	1	3	142	3	279	4	0	495
	George	86	25	2	135	11	90	1	4	354
	Greene	104	5	0	7	0	30	7	0	153
	Hancock	30	1	3	140	3	33	0	1	211
	Harrison	27	1	1	292	1	54	0	0	376
	Jackson	103	1	2	393	34	231	7	15	786
	Lamar	40	1	0	12	3	30	3	0	89
	Pearl River	37	0	0	40	6	21	1	26	131
	Perry	115	3	0	18	3	89	1	0	229
	Stone	62	0	0	103	2	28	2	1	198
	6 Total	667	38	11	1282	66	885	26	47	3022
7	Hinds	11	2	0	9	4	11	1	0	38
	Madison	15	2	0	67	3	39	0	0	126
	Rankin	28	7	0	123	8	135	1	2	304
	Warren	89	0	0	71	8	86	2	0	256
	7 Total	143	11	0	270	23	271	4	2	724

[1] Small game includes: Squirrel, Raccoon, Quail, Opossum, Non-game bird, Frog, Coyote/Beaver, Bobcat

[2] Other includesSalt water fish, Shell fish, Commercial fishing, and all not wildlife related crimes

[3] No Data: species codes were invalid or not entered

Table B.7 Distribution of citations written by Conservation Officers in Mississippi grouped by species type, county, and district during fiscal year 2000 in districts 1 - 3.

District	County	Deer	Dove	Small Game [1]	Sport Fishing	Turkey	Waterfowl	Other [2]	No Data [3]	Grand Total
1	Alcorn	27	5	4	1	0	0	17	0	54
	Chickasaw	60	0	1	4	1	0	68	0	134
	Clay	11	13	4	8	0	0	27	3	66
	Itawamba	118	15	5	119	2	3	76	0	338
	Lee	42	2	1	45	0	0	23	0	113
	Lowndes	44	20	8	57	0	4	56	0	189
	Monroe	71	6	13	60	1	0	47	0	198
	Noxubee	35	10	5	19	0	0	16	0	85
	Oktibbeha	43	3	4	3	0	13	5	0	71
	Pontotoc	33	11	5	14	0	0	15	2	80
	Prentiss	35	0	6	35	2	0	95	0	173
	Tippah	31	0	2	28	6	5	13	0	85
	Tishomingo	61	1	4	25	0	0	237	0	328
	Union	49	8	4	2	0	0	2	0	65
	Winston	40	8	6	0	6	0	0	0	60
	1 Total	700	102	72	420	18	25	697	5	2039
2	Benton	9	0	0	0	0	0	0	0	9
	Calhoun	46	15	1	1	0	0	1	0	64
	Choctaw	96	16	2	9	1	0	9	0	133
	Desoto	16	5	0	19	0	8	7	0	55
	Grenada	100	31	9	56	3	0	44	0	243
	Lafayette	66	3	13	76	4	6	73	0	241
	Marshall	27	4	0	0	1	0	4	0	36
	Montgomery	45	0	1	4	1	0	0	0	51
	Panola	162	3	8	57	0	0	169	0	399
	Quitman	2	16	15	11	1	1	12	0	58
	Tallahatchie	39	0	7	41	0	0	1	0	88
	Tate	14	0	2	34	0	1	6	0	57
	Tunica	0	2	5	10	0	2	6	0	25
	Webster	98	1	1	40	0	0	17	0	157
	Yalobusha	50	0	1	49	0	1	36	0	137
	2 Total	770	96	65	407	11	19	385	0	1753
3	Attala	81	0	0	1	8	0	3	0	93
	Bolivar	18	0	5	62	0	0	13	0	98
	Carroll	120	1	6	0	0	0	0	0	127
	Coahoma	3	1	1	24	0	0	3	0	32
	Holmes	51	4	0	46	0	0	24	0	125
	Humphreys	7	4	8	18	0	0	7	3	47
	Issaquena	60	0	10	90	0	0	32	1	193
	Leflore	36	9	4	19	0	2	28	0	98
	Sharkey	53	6	40	5	3	0	17	0	124
	Sunflower	33	17	8	15	0	3	39	0	115
	Washington	25	7	1	163	0	0	162	0	358
	Yazoo	17	3	10	5	0	0	23	0	58
	3 Total	504	52	93	448	11	5	351	4	1468

[1] Small game includes: Squirrel, Raccoon, Quail, Opossum, Non-game bird, Frog, Coyote/Beaver, Bobcat

[2] Other includesSalt water fish, Shell fish, Commercial fishing, and all not wildlife related crimes

[3] No Data: species codes were invalid or not entered

Table B.8 Distribution of citations written by Conservation Officers in Mississippi grouped by species type, county, and district during fiscal year 2000 in districts 4 – 7.

District	County	Deer	Dove	Small Game [1]	Sport Fishing	Turkey	Waterfowl	Other [2]	No Data [3]	Grand Total
4	Clarke	56	2	1	23	1	0	10	0	93
	Covington	83	3	4	22	13	0	210	1	336
	Jasper	88	2	0	26	2	0	11	0	129
	Jefferson Davis	24	3	0	19	0	0	12	0	58
	Jones	48	2	5	33	7	0	84	0	179
	Kemper	25	6	3	13	2	0	54	0	103
	Lauderdale	17	0	2	63	2	0	102	0	186
	Leake	28	3	7	6	0	0	8	0	52
	Neshoba	39	10	7	23	9	5	8	0	101
	Newton	45	0	0	0	3	1	7	0	56
	Scott	49	1	2	28	4	0	59	0	143
	Simpson	24	3	3	9	0	0	12	0	51
	Smith	38	1	7	12	0	0	30	0	88
	Wayne	89	0	3	4	4	0	26	0	126
	4 Total	653	36	44	281	47	6	633	1	1701
5	Adams	70	0	11	35	10	0	21	16	163
	Amite	54	2	0	1	4	11	2	1	75
	Claiborne	89	1	1	11	1	0	3	0	106
	Copiah	76	22	2	29	0	0	38	0	167
	Franklin	32	0	2	2	1	0	2	0	39
	Jefferson	31	0	2	2	2	0	0	0	37
	Lawrence	40	0	1	18	0	0	10	0	69
	Lincoln	36	0	4	2	2	0	10	1	55
	Marion	68	0	7	26	1	0	31	0	133
	Pike	21	6	4	12	1	0	99	2	145
	Walthall	22	0	3	1	1	0	88	1	116
	Wilkinson	56	0	7	7	0	8	27	0	105
	5 Total	595	31	44	146	23	19	331	21	1210
6	Forrest	91	19	3	221	7	0	191	2	534
	George	106	14	9	61	4	0	83	0	277
	Greene	66	1	4	4	3	0	6	0	84
	Hancock	37	18	4	69	0	0	90	1	219
	Harrison	36	0	3	15	2	0	62	2	120
	Jackson	91	6	17	562	3	0	352	3	1034
	Lamar	51	5	3	23	4	4	10	0	100
	Pearl River	54	1	0	35	0	0	31	1	122
	Perry	124	2	3	78	9	4	40	0	260
	Stone	114	9	9	101	3	0	82	0	318
	6 Total	770	75	55	1169	35	8	947	9	3068
7	Hinds	9	0	2	91	0	0	8	1	111
	Madison	66	12	3	121	2	1	167	1	373
	Rankin	38	12	5	191	5	0	105	2	358
	Warren	23	0	0	69	1	0	26	1	120
	7 Total	136	24	10	472	8	1	306	5	962

[1] Small game includes: Squirrel, Raccoon, Quail, Opossum, Non-game bird, Frog, Coyote/Beaver, Bobcat

[2] Other includesSalt water fish, Shell fish, Commercial fishing, and all not wildlife related crimes

[3] No Data: species codes were invalid or not entered

APPENDIX C

ILLEGAL HARVEST CITATION DISTRIBUTION

Table C.1. Distribution of illegal harvest citations written by Conservation Officers in Mississippi grouped by species type, county, and district during fiscal year 1997 in districts 1 – 3.

		Deer		Dove		Small Game [1]		Turkey		Waterfowl		Grand Total	
District	County	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations
1	Alcorn	3	16	0	3	0	4	0	0	0	13	3	37
	Chickasaw	4	49	7	14	0	5	0	0	0	0	11	97
	Clay	7	35	0	8	0	0	0	1	0	0	7	53
	Itawamba	13	64	4	7	1	4	2	2	1	1	21	98
	Lee	3	17	0	5	0	0	0	0	0	2	3	50
	Lowndes	6	30	0	4	0	4	0	3	0	1	6	101
	Monroe	14	94	16	32	0	10	0	0	0	4	30	170
	Noxubee	10	54	0	4	0	1	0	0	0	0	10	110
	Oktibbeha	10	42	0	6	0	0	0	2	0	0	10	71
	Pontotoc	1	44	0	0	0	2	0	0	0	0	1	64
	Prentiss	4	40	0	6	0	5	0	0	0	0	4	63
	Tippah	9	48	0	2	2	2	0	0	0	0	11	88
	Tishomingo	4	38	0	0	0	4	0	0	0	1	4	241
	Union	3	20	6	14	0	0	2	4	0	0	11	39
	Winston	10	24	0	5	0	0	0	0	1	1	11	36
	1 Total	101	615	33	110	3	41	4	12	2	23	143	1318
2	Benton	8	76	0	0	0	1	0	1	0	0	8	78
	Calhoun	6	79	0	0	0	0	0	4	0	4	6	100
	Choctaw	4	31	0	2	0	1	0	1	0	0	4	38
	Desoto	1	23	0	0	0	0	0	0	0	3	1	45
	Grenada	13	38	0	0	0	3	3	9	0	0	16	139
	Lafayette	7	54	0	0	0	2	0	15	0	0	7	114
	Marshall	8	32	0	0	0	8	2	2	0	1	10	48
	Montgomery	15	47	0	0	0	0	0	3	0	0	15	51
	Panola	10	58	0	0	0	6	0	0	0	0	10	144
	Quitman	2	14	0	0	0	13	0	0	0	4	2	31
	Tallahatchie	0	5	0	0	0	16	0	0	0	0	0	26
	Tate	1	7	0	0	0	1	0	0	0	1	1	27
	Tunica	2	20	0	0	0	2	0	0	1	6	3	42
	Webster	12	71	0	0	0	2	0	0	0	21	12	95
	Yalobusha	2	42	0	0	0	2	0	1	0	0	2	116
	2 Total	91	597	0	2	0	57	5	36	1	40	97	1094
3	Attala	1	10	0	0	0	0	0	1	0	0	1	14
	Bolivar	2	13	0	0	0	0	0	0	0	26	2	56
	Carroll	25	106	0	0	0	1	0	0	0	0	25	123
	Coahoma	0	1	0	0	0	0	0	0	0	1	0	10
	Holmes	4	41	0	0	0	0	0	2	0	2	4	121
	Humphreys	0	2	0	0	0	17	0	0	0	0	0	31
	Issaquena	6	22	0	0	0	2	0	0	0	1	6	78
	Leflore	0	18	0	0	0	7	0	0	0	19	0	93
	Sharkey	3	64	0	0	0	22	0	4	0	2	3	127
	Sunflower	0	13	0	0	0	15	0	0	0	3	0	49
	Washington	0	4	0	0	0	0	0	0	0	0	0	63
	Yazoo	3	16	0	0	0	0	0	1	0	2	3	37
	3 Total	44	310	0	0	0	64	0	8	0	56	44	802

[1] Small Game includes: Bobcat, Coyote/Beaver, Non-game bird, Opossum, Quail, Raccoon, Squirrel

[2] Offense codes used as indicators of potnetial Illegal Harvest: baiting, headlighting deer, exceeding bag limit, killing doe out of season, killing deer or spotted fawn out of season, hunting deer with gun during archery season, hunting closed season, hunting with centerfire rifle during primative weapon season, illegal buck (less than 4 points), hunting over bait (federal), killing spotted fawn, non-resident killing doe deer, killing jake turkey, killing turkey hen, killing turkey out of season, shooting deer from a boat.

Table C.2. Distribution of illegal harvest citations written by Conservation Officers in Mississippi grouped by species type, county, and district during fiscal year 1997 in districts 4 – 7.

		Deer		Dove		Small Game [1]		Turkey		Waterfowl		Grand Total	
District	County	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations
4	Clarke	16	48	0	0	0	3	1	1	0	0	17	95
	Covington	12	40	0	0	0	11	0	0	0	0	12	68
	Jasper	35	103	0	0	1	10	0	0	0	0	36	121
	Jefferson Da	1	30	0	0	0	11	1	2	0	0	2	53
	Jones	7	41	0	0	0	1	0	0	0	0	7	57
	Kemper	20	82	0	0	0	0	0	1	0	0	20	102
	Lauderdale	13	49	0	0	0	1	0	0	0	0	13	125
	Leake	1	12	0	0	0	0	0	0	0	3	1	16
	Neshoba	3	13	1	1	0	2	1	3	0	0	5	30
	Newton	6	40	0	0	0	1	0	1	0	0	6	61
	Scott	2	34	0	0	0	0	0	0	0	0	2	43
	Simpson	3	13	0	0	0	0	0	3	0	0	3	27
	Smith	4	51	0	0	0	2	0	0	0	0	4	56
	Wayne	21	76	0	0	0	3	0	1	0	0	21	93
	4 Total	144	632	1	1	1	45	3	12	0	3	149	947
5	Adams	3	26	0	1	0	3	0	0	0	0	3	32
	Amite	14	75	0	1	0	4	0	5	0	0	14	87
	Claiborne	5	44	0	0	0	0	0	0	0	0	5	44
	Copiah	13	80	0	2	0	0	0	0	0	0	13	115
	Franklin	3	54	0	0	0	0	0	0	0	0	3	56
	Jefferson	8	30	0	0	0	0	0	0	0	0	8	55
	Lawrence	2	19	0	1	0	0	0	0	0	0	2	20
	Lincoln	2	40	0	0	0	8	0	0	0	0	2	75
	Marion	9	36	0	6	0	11	0	2	0	0	9	98
	Pike	13	38	0	1	0	0	0	1	0	0	13	53
	Walthall	9	27	0	0	0	2	0	0	0	0	9	32
	Wilkinson	8	59	0	0	0	3	0	0	0	0	8	84
	5 Total	89	528	0	12	0	31	0	8	0	0	89	751
6	Forrest	2	10	0	0	0	0	0	0	0	0	2	21
	George	2	19	0	0	0	3	0	0	0	0	2	120
	Greene	2	2	0	0	0	0	0	2	0	0	2	158
	Hancock	4	15	0	2	0	8	0	0	0	0	4	104
	Harrison	2	16	0	0	0	0	0	0	0	0	2	69
	Jackson	4	36	0	0	0	8	0	2	0	0	4	127
	Lamar	3	31	0	0	0	11	1	2	0	0	4	74
	Pearl River	14	60	0	0	0	14	0	0	0	0	14	125
	Perry	7	79	0	1	0	3	1	4	0	0	8	160
	Stone	2	30	0	0	0	2	0	0	0	0	2	70
	6 Total	42	298	0	3	0	49	2	10	0	0	44	1028
7	Hinds	0	5	0	0	0	4	0	0	0	0	0	17
	Madison	3	29	0	1	0	0	0	0	0	1	3	72
	Rankin	4	8	0	0	0	0	0	0	0	0	4	82
	Warren	4	11	0	0	0	0	0	0	1	1	5	33
	7 Total	11	53	0	1	0	4	0	0	1	2	12	204

[1] Small Game includes: Bobcat, Coyote/Beaver, Non-game bird, Opossum, Quail, Raccoon, Squirrel

[2] Offense codes used as indicators of potnetial Illegal Harvest: baiting, headlighting deer, exceeding bag limit, killing doe out of season, killing deer or spotted fawn out of season, hunting deer with gun during archery season, hunting closed season, hunting with centerfire rifle during primative weapon season, illegal buck (less than 4 points), hunting over bait (federal), killing spotted fawn, non-resident killing doe deer, killing jake turkey, killing turkey hen, killing turkey out of season, shooting deer from a boat.

Table C.3. Distribution of illegal harvest citations written by Conservation Officers in Mississippi grouped by species type, county, and district during fiscal year 1998 in districts 1 – 3.

		Deer		Dove		Small Game [1]		Turkey		Waterfowl		Grand Total	
District	County	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations
1	Alcorn	10	67	0	1	0	3	0	1	0	0	10	84
	Chickasaw	7	61	17	29	0	6	0	0	0	7	24	136
	Clay	4	31	6	11	0	2	0	0	1	6	11	69
	Itawamba	7	76	6	17	0	4	0	0	0	1	13	117
	Lee	9	48	59	94	0	8	0	0	0	4	68	192
	Lowndes	7	23	3	17	0	12	4	7	0	6	14	140
	Monroe	7	86	1	3	0	2	0	2	0	6	8	204
	Noxubee	10	32	0	15	0	7	1	1	0	0	11	98
	Oktibbeha	3	28	0	4	0	0	2	4	0	0	5	48
	Pontotoc	1	22	11	22	0	0	0	0	0	0	12	63
	Prentiss	10	48	0	2	0	1	0	0	0	0	10	116
	Tippah	12	63	0	3	2	10	3	10	0	0	17	137
	Tishomingo	8	82	0	0	0	1	0	0	0	5	8	529
	Union	4	28	0	0	0	1	0	0	0	0	4	37
	Winston	4	40	0	3	0	0	0	0	0	0	4	46
	1 Total	103	735	103	221	2	57	10	25	1	35	219	2016
2	Benton	5	33	0	0	0	0	0	0	0	0	5	33
	Calhoun	3	68	4	6	1	1	0	0	0	3	8	89
	Choctaw	11	68	0	5	0	0	0	2	0	0	11	79
	Desoto	3	19	0	4	0	1	0	1	0	7	3	114
	Grenada	18	73	8	11	0	0	1	1	0	1	27	193
	Lafayette	8	56	4	6	0	3	0	7	0	5	12	199
	Marshall	4	42	0	11	0	3	0	0	0	5	4	65
	Montgomery	5	36	0	0	0	0	0	0	0	0	5	36
	Panola	14	135	0	5	0	0	0	1	0	0	14	478
	Quitman	1	15	0	2	0	16	0	0	0	25	1	80
	Tallahatchie	6	33	0	2	0	7	1	3	0	2	7	51
	Tate	2	12	0	1	0	3	0	0	0	4	2	42
	Tunica	3	22	0	1	0	24	0	0	2	9	5	75
	Webster	11	63	0	0	0	3	0	0	0	0	11	82
	Yalobusha	9	34	3	4	0	1	2	6	0	1	14	154
	2 Total	103	709	19	58	1	62	4	21	2	62	129	1770
3	Attala	11	42	0	0	0	0	0	0	0	0	11	44
	Bolivar	4	16	3	9	0	1	0	1	0	1	7	105
	Carroll	37	167	0	2	0	2	0	0	0	0	37	177
	Coahoma	0	5	0	1	0	1	0	0	0	1	0	26
	Holmes	11	91	1	1	0	0	2	2	0	0	14	187
	Humphreys	0	9	3	9	0	37	0	0	0	0	3	78
	Issaquena	4	59	26	30	0	3	0	0	0	3	30	201
	Leflore	1	53	25	53	0	17	0	0	0	0	26	175
	Sharkey	5	80	0	3	1	22	0	2	0	2	6	147
	Sunflower	1	12	16	19	1	35	0	0	2	2	20	95
	Washington	1	23	2	11	0	13	0	0	0	0	3	250
	Yazoo	4	34	0	3	0	5	0	1	0	3	4	60
	3 Total	79	591	76	141	2	136	2	6	2	12	161	1545

[1] Small Game includes: Bobcat, Coyote/Beaver, Non-game bird, Opossum, Quail, Raccoon, Squirrel

[2] Offense codes used as indicators of potnetial Illegal Harvest: baiting, headlighting deer, exceeding bag limit, killing doe out of season, killing deer or spotted fawn out of season, hunting deer with gun during archery season, hunting closed season, hunting with centerfire rifle during primative weapon season, illegal buck (less than 4 points), hunting over bait (federal), killing spotted fawn, non-resident killing doe deer, killing jake turkey, killing turkey hen, killing turkey out of season, shooting deer from a boat.

Table C.4. Distribution of illegal harvest citations written by Conservation Officers in Mississippi grouped by species type, county, and district during fiscal year 1998 in districts 4 – 7.

		Deer		Dove		Small Game [1]		Turkey		Waterfowl		Grand Total	
District	County	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations
4	Clarke	39	122	3	5	0	7	4	4	0	0	46	176
	Covington	1	12	10	18	0	6	0	6	0	0	11	280
	Jasper	43	115	14	25	0	5	0	7	0	0	57	210
	Jefferson Da	15	64	0	3	0	0	0	2	0	0	15	81
	Jones	9	52	1	1	0	2	2	7	0	1	12	255
	Kemper	23	76	0	0	0	0	0	8	0	0	23	200
	Lauderdale	19	44	0	2	0	0	0	2	0	0	19	365
	Leake	1	4	0	0	0	3	1	3	0	0	2	26
	Neshoba	3	12	19	20	3	9	0	1	0	0	25	49
	Newton	3	49	0	0	0	0	2	2	0	0	5	62
	Scott	5	23	0	0	0	1	1	1	0	0	6	108
	Simpson	5	37	0	0	0	0	0	0	0	0	5	79
	Smith	2	33	0	2	1	5	3	11	0	0	6	82
	Wayne	18	83	2	5	0	12	0	2	0	0	20	191
	4 Total	186	726	49	81	4	50	13	56	0	1	252	2164
5	Adams	4	53	0	0	0	6	1	2	0	0	5	116
	Amite	28	145	9	14	0	3	1	2	0	0	38	179
	Claiborne	10	49	0	0	0	0	0	1	0	0	10	69
	Copiah	8	52	0	0	0	2	1	2	0	0	9	109
	Franklin	4	46	13	13	0	0	3	3	0	0	20	74
	Jefferson	8	58	0	0	0	0	1	3	0	0	9	61
	Lawrence	10	50	0	0	0	2	0	2	0	0	10	87
	Lincoln	4	42	5	10	0	13	2	11	0	0	11	158
	Marion	14	33	0	10	0	4	0	0	0	0	14	104
	Pike	4	13	21	23	0	1	0	0	0	0	25	120
	Walthall	15	43	0	2	0	0	0	0	0	0	15	86
	Wilkinson	33	126	0	0	1	1	0	4	0	0	34	218
	5 Total	142	710	48	72	1	32	9	30	0	0	200	1381
6	Forrest	4	10	0	0	0	0	0	0	0	0	4	87
	George	22	69	0	0	0	3	3	12	0	0	25	284
	Greene	48	108	0	2	0	5	9	21	0	0	57	160
	Hancock	1	17	0	1	0	1	0	0	0	0	1	155
	Harrison	2	22	0	0	0	5	0	0	0	0	2	44
	Jackson	30	125	0	2	0	9	0	4	0	2	30	596
	Lamar	9	49	0	2	0	7	1	12	0	0	10	112
	Pearl River	3	52	37	63	1	5	1	6	0	2	42	176
	Perry	20	145	11	19	0	4	1	1	0	0	32	221
	Stone	9	54	0	0	0	0	0	0	0	0	9	71
	6 Total	148	651	48	89	1	39	15	56	0	4	212	1906
7	Hinds	0	14	0	0	0	2	0	1	0	0	0	80
	Madison	6	42	0	0	0	1	0	1	0	0	6	151
	Rankin	8	20	9	15	0	6	0	1	0	0	17	317
	Warren	0	47	0	0	0	7	0	0	0	0	0	164
	7 Total	14	123	9	15	0	16	0	3	0	0	23	712

[1] Small Game includes: Bobcat, Coyote/Beaver, Non-game bird, Opossum, Quail, Raccoon, Squirrel

[2] Offense codes used as indicators of potnetial Illegal Harvest: baiting, headlighting deer, exceeding bag limit, killing doe out of season, killing deer or spotted fawn out of season, hunting deer with gun during archery season, hunting closed season, hunting with centerfire rifle during primative weapon season, illegal buck (less than 4 points), hunting over bait (federal), killing spotted fawn, non-resident killing doe deer, killing jake turkey, killing turkey hen, killing turkey out of season, shooting deer from a boat.

Table C.5 Distribution of illegal harvest citations written by Conservation Officers in Mississippi grouped by species type, county, and district during fiscal year 1999 in districts 1 – 3.

		Deer		Dove		Small Game [1]		Turkey		Waterfowl		Grand Total	
District	County	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations
1	Alcorn	4	34	0	0	0	0	0	4	0	22	4	75
	Chickasaw	2	35	0	0	0	5	0	0	0	0	2	89
	Clay	0	19	0	2	0	5	1	2	0	6	1	72
	Itawamba	8	52	4	5	1	1	0	0	2	29	15	163
	Lee	9	40	4	9	0	1	2	3	0	0	15	77
	Lowndes	7	32	1	6	0	4	0	1	0	20	8	165
	Monroe	16	73	21	35	0	3	0	6	0	5	37	287
	Noxubee	11	38	0	4	0	6	0	2	0	0	11	100
	Oktibbeha	7	33	1	5	0	0	0	0	0	4	8	51
	Pontotoc	8	25	7	10	0	4	3	3	0	0	18	69
	Prentiss	15	54	0	4	0	2	0	0	0	3	15	146
	Tippah	8	42	1	3	0	12	0	0	1	2	10	96
	Tishomingo	4	38	0	0	0	4	0	2	0	3	4	330
	Union	9	67	11	21	0	7	1	6	0	0	21	161
	Winston	2	12	0	2	0	1	0	6	0	0	2	26
	1 Total	110	594	50	106	1	55	7	35	3	94	171	1907
2	Benton	3	43	0	1	0	0	0	0	0	0	3	44
	Calhoun	2	24	4	10	0	12	0	0	2	22	8	74
	Choctaw	6	43	0	3	0	4	0	0	0	0	6	80
	Desoto	4	21	5	8	0	0	0	0	0	4	9	62
	Grenada	7	57	5	8	0	11	0	1	0	7	12	234
	Lafayette	13	65	0	6	1	4	0	3	0	5	14	262
	Marshall	9	49	0	6	0	1	0	2	1	1	10	72
	Montgomery	12	56	0	0	0	0	0	7	0	0	12	65
	Panola	13	119	9	15	0	19	0	2	0	8	22	572
	Quitman	0	14	0	0	1	30	0	0	0	14	1	74
	Tallahatchie	4	33	0	0	0	16	0	0	0	1	4	66
	Tate	5	22	0	0	0	2	0	0	1	10	6	57
	Tunica	1	46	1	7	0	5	0	1	0	2	2	83
	Webster	15	68	0	0	1	3	0	4	0	4	16	109
	Yalobusha	10	51	0	0	0	4	1	2	0	3	11	156
	2 Total	104	711	24	64	3	111	1	22	4	81	136	2010
3	Attala	7	25	0	1	0	1	0	0	0	5	7	35
	Bolivar	4	17	4	4	0	2	8	18	0	2	16	130
	Carroll	34	146	5	14	0	0	0	1	0	0	39	169
	Coahoma	0	6	2	2	0	0	0	0	0	6	2	26
	Holmes	18	92	23	30	0	2	0	0	0	2	41	182
	Humphreys	1	30	0	2	0	3	0	0	0	1	1	46
	Issaquena	7	45	0	5	3	7	0	1	0	10	10	197
	Leflore	12	39	1	2	0	4	0	2	0	9	13	127
	Sharkey	7	76	12	14	0	23	0	0	2	22	21	144
	Sunflower	2	28	16	31	0	21	0	0	4	12	22	100
	Washington	1	37	3	11	0	18	0	3	0	3	4	397
	Yazoo	13	54	0	1	0	7	0	0	0	1	13	95
	3 Total	106	595	66	117	3	88	8	25	6	73	189	1648

[1] Small Game includes: Bobcat, Coyote/Beaver, Non-game bird, Opossum, Quail, Raccoon, Squirrel

[2] Offense codes used as indicators of potnetial Illegal Harvest: baiting, headlighting deer, exceeding bag limit, killing doe out of season, killing deer or spotted fawn out of season, hunting deer with gun during archery season, hunting closed season, hunting with centerfire rifle during primative weapon season, illegal buck (less than 4 points), hunting over bait (federal), killing spotted fawn, non-resident killing doe deer, killing jake turkey, killing turkey hen, killing turkey out of season, shooting deer from a boat.

Table C.6. Distribution of illegal harvest citations written by Conservation Officers in Mississippi grouped by species type, county, and district during fiscal year 1999 in districts 4 – 7.

		Deer		Dove		Small Game [1]		Turkey		Waterfowl		Grand Total	
District	County	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations
4	Clarke	31	88	3	7	1	22	4	5	0	0	39	159
	Covington	14	61	1	5	0	12	1	2	0	0	16	503
	Jasper	35	117	16	18	0	4	1	9	0	0	52	209
	Jefferson Da	5	31	9	9	7	9	0	0	0	0	21	103
	Jones	19	83	1	3	0	8	0	0	0	0	20	254
	Kemper	20	64	32	39	0	4	2	2	0	0	54	175
	Lauderdale	11	38	0	6	1	5	2	4	0	6	14	261
	Leake	6	34	0	1	0	0	4	8	0	0	10	59
	Neshoba	1	7	14	21	0	6	2	10	0	2	17	77
	Newton	5	42	0	0	0	0	1	2	0	0	6	57
	Scott	5	38	0	7	0	8	1	8	0	0	6	182
	Simpson	4	13	0	0	0	1	0	0	0	2	4	43
	Smith	9	45	7	7	0	4	0	0	0	0	16	66
	Wayne	20	105	0	2	0	0	1	4	0	0	21	212
	4 Total	185	766	83	125	9	83	19	54	0	10	296	2360
5	Adams	4	72	0	0	0	10	0	2	0	0	4	212
	Amite	25	77	0	4	1	3	1	2	0	0	27	92
	Claiborne	7	35	0	0	0	0	0	0	0	1	7	57
	Copiah	19	80	0	0	4	14	0	4	0	0	23	173
	Franklin	8	49	0	0	0	0	1	2	0	0	9	52
	Jefferson	6	39	0	0	0	1	0	0	0	1	6	42
	Lawrence	8	25	0	0	0	0	0	2	0	3	8	57
	Lincoln	8	87	18	29	0	3	0	0	0	0	26	154
	Marion	9	55	0	2	0	1	0	1	0	0	9	105
	Pike	4	31	0	3	0	4	0	0	0	0	4	162
	Walthall	15	51	0	0	0	4	0	0	0	0	15	81
	Wilkinson	17	72	0	0	0	0	1	1	0	2	18	130
	5 Total	130	673	18	38	5	40	3	14	0	7	156	1317
6	Forrest	3	63	1	1	0	3	0	4	0	0	4	495
	George	22	86	6	25	1	11	1	1	0	4	30	354
	Greene	35	104	1	5	0	0	3	7	0	0	39	153
	Hancock	3	30	1	1	0	3	0	0	0	1	4	211
	Harrison	2	27	0	1	0	1	0	0	0	0	2	376
	Jackson	18	103	0	1	0	34	0	7	0	15	18	786
	Lamar	10	40	0	1	1	3	0	3	0	0	11	89
	Pearl River	7	37	0	0	0	6	0	1	0	26	7	131
	Perry	14	115	0	3	0	3	1	1	0	0	15	229
	Stone	9	62	0	0	0	2	2	2	0	1	11	198
	6 Total	123	667	9	38	2	66	7	26	0	47	141	3022
7	Hinds	0	11	0	2	0	4	1	1	0	0	1	38
	Madison	2	15	0	2	0	3	0	0	0	0	2	126
	Rankin	7	28	6	7	0	8	0	1	0	2	13	304
	Warren	3	89	0	0	0	8	0	2	0	0	3	256
	7 Total	12	143	6	11	0	23	1	4	0	2	19	724

[1] Small Game includes: Bobcat, Coyote/Beaver, Non-game bird, Opossum, Quail, Raccoon, Squirrel

[2] Offense codes used as indicators of potnetial Illegal Harvest: baiting, headlighting deer, exceeding bag limit, killing doe out of season, killing deer or spotted fawn out of season, hunting deer with gun during archery season, hunting closed season, hunting with centerfire rifle during primative weapon season, illegal buck (less than 4 points), hunting over bait (federal), killing spotted fawn, non-resident killing doe deer, killing jake turkey, killing turkey hen, killing turkey out of season, shooting deer from a boat.

Table C.7. Distribution of illegal harvest citations written by Conservation Officers in Mississippi grouped by species type, county, and district during fiscal year 2000 in districts 1 – 3.

		Deer		Dove		Small Game [1]		Turkey		Waterfowl		Grand Total	
District	County	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations
1	Alcorn	4	27	4	5	0	4	0	0	0	0	8	54
	Chickasaw	13	60	0	0	0	1	1	1	0	0	14	134
	Clay	3	11	8	13	0	4	0	0	0	0	11	66
	Itawamba	22	118	9	15	0	5	1	2	0	3	32	338
	Lee	13	42	0	2	0	1	0	0	0	0	13	113
	Lowndes	10	44	11	20	1	8	0	0	0	4	22	189
	Monroe	16	71	1	6	0	13	0	1	0	0	17	198
	Noxubee	11	35	0	10	0	5	0	0	0	0	11	85
	Oktibbeha	13	43	0	3	0	4	0	0	0	13	13	71
	Pontotoc	11	33	10	11	0	5	0	0	0	0	21	80
	Prentiss	10	35	0	0	2	6	1	2	0	0	13	173
	Tippah	10	31	0	0	1	2	1	6	0	5	12	85
	Tishomingo	7	61	0	1	0	4	0	0	0	0	7	328
	Union	16	49	4	8	0	4	0	0	0	0	20	65
	Winston	11	40	0	8	1	6	0	6	0	0	12	60
	1 Total	170	700	47	102	5	72	4	18	0	25	226	2039
2	Benton	1	9	0	0	0	0	0	0	0	0	1	9
	Calhoun	6	46	14	15	1	1	0	0	0	0	21	64
	Choctaw	21	96	7	16	0	2	0	1	0	0	28	133
	Desoto	6	16	2	5	0	0	0	0	3	8	11	55
	Grenada	10	100	24	31	1	9	2	3	0	0	37	243
	Lafayette	11	66	2	3	0	13	0	4	0	6	13	241
	Marshall	4	27	0	4	0	0	0	1	0	0	4	36
	Montgomery	13	45	0	0	1	1	0	1	0	0	14	51
	Panola	22	162	0	3	0	8	0	0	0	0	22	399
	Quitman	0	2	11	16	0	15	0	1	0	1	11	58
	Tallahatchie	6	39	0	0	0	7	0	0	0	0	6	88
	Tate	2	14	0	0	0	2	0	0	0	1	2	57
	Tunica	0	0	0	2	0	5	0	0	0	2	0	25
	Webster	20	98	0	1	0	1	0	0	0	0	20	157
	Yalobusha	12	50	0	0	0	1	0	0	1	1	13	137
	2 Total	134	770	60	96	3	65	2	11	4	19	203	1753
3	Attala	27	81	0	0	0	0	4	8	0	0	31	93
	Bolivar	1	18	0	0	0	5	0	0	0	0	1	98
	Carroll	47	120	1	1	0	6	0	0	0	0	48	127
	Coahoma	0	3	0	1	0	1	0	0	0	0	0	32
	Holmes	12	51	0	4	0	0	0	0	0	0	12	125
	Humphreys	0	7	1	4	0	8	0	0	0	0	1	47
	Issaquena	9	60	0	0	0	10	0	0	0	0	9	193
	Leflore	7	36	7	9	0	4	0	0	1	2	15	98
	Sharkey	8	53	3	6	1	40	0	3	0	0	12	124
	Sunflower	3	33	11	17	3	8	0	0	0	3	17	115
	Washington	3	25	1	7	0	1	0	0	0	0	4	358
	Yazoo	7	17	1	3	0	10	0	0	0	0	8	58
	3 Total	124	504	25	52	4	93	4	11	1	5	158	1468

[1] Small Game includes: Bobcat, Coyote/Beaver, Non-game bird, Opossum, Quail, Raccoon, Squirrel

[2] Offense codes used as indicators of potnetial Illegal Harvest: baiting, headlighting deer, exceeding bag limit, killing doe out of season, killing deer or spotted fawn out of season, hunting deer with gun during archery season, hunting closed season, hunting with centerfire rifle during primative weapon season, illegal buck (less than 4 points), hunting over bait (federal), killing spotted fawn, non-resident killing doe deer, killing jake turkey, killing turkey hen, killing turkey out of season, shooting deer from a boat.

Table C.8. Distribution of illegal harvest citations written by Conservation Officers in Mississippi grouped by species type, county, and district during fiscal year 2000 in districts 4 – 7.

		Deer		Dove		Small Game [1]		Turkey		Waterfowl		Grand Total	
District	County	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations	Illegal Harvest[2]	Total Citations
4	Clarke	31	56	0	2	0	1	0	1	0	0	31	93
	Covington	20	83	0	3	0	4	7	13	0	0	27	336
	Jasper	48	88	2	2	0	0	0	2	0	0	50	129
	Jefferson Da	11	24	0	3	0	0	0	0	0	0	11	58
	Jones	17	48	0	2	0	5	3	7	0	0	20	179
	Kemper	17	25	4	6	0	3	0	2	0	0	21	103
	Lauderdale	4	17	0	0	0	2	0	2	0	0	4	186
	Leake	7	28	0	3	0	7	0	0	0	0	7	52
	Neshoba	19	39	0	10	0	7	4	9	0	5	23	101
	Newton	4	45	0	0	0	0	3	3	0	1	7	56
	Scott	13	49	0	1	0	2	1	4	0	0	14	143
	Simpson	3	24	0	3	0	3	0	0	0	0	3	51
	Smith	6	38	0	1	0	7	0	0	0	0	6	88
	Wayne	10	89	0	0	0	3	0	4	0	0	10	126
	4 Total	210	653	6	36	0	44	18	47	0	6	234	1701
5	Adams	8	70	0	0	0	11	0	10	0	0	8	163
	Amite	18	54	0	2	0	0	0	4	1	11	19	75
	Claiborne	17	89	0	1	0	1	0	1	0	0	17	106
	Copiah	18	76	12	22	0	2	0	0	0	0	30	167
	Franklin	6	32	0	0	0	2	0	1	0	0	6	39
	Jefferson	14	31	0	0	0	2	1	2	0	0	15	37
	Lawrence	12	40	0	0	0	1	0	0	0	0	12	69
	Lincoln	10	36	0	0	0	4	0	2	0	0	10	55
	Marion	22	68	0	0	0	7	0	1	0	0	22	133
	Pike	4	21	5	6	1	4	0	1	0	0	10	145
	Walthall	4	22	0	0	0	3	0	1	0	0	4	116
	Wilkinson	15	56	0	0	0	7	0	0	2	8	17	105
	5 Total	148	595	17	31	1	44	1	23	3	19	170	1210
6	Forrest	19	91	10	19	0	3	1	7	0	0	30	534
	George	23	106	0	14	0	9	0	4	0	0	23	277
	Greene	17	66	0	1	0	4	1	3	0	0	18	84
	Hancock	7	37	12	18	0	4	0	0	0	0	19	219
	Harrison	4	36	0	0	0	3	1	2	0	0	5	120
	Jackson	12	91	0	6	0	17	0	3	0	0	12	1034
	Lamar	15	51	1	5	0	3	1	4	0	4	17	100
	Pearl River	12	54	0	1	0	0	0	0	0	0	12	122
	Perry	31	124	0	2	0	3	3	9	0	4	34	260
	Stone	10	114	0	9	0	9	0	3	0	0	10	318
	6 Total	150	770	23	75	0	55	7	35	0	8	180	3068
7	Hinds	0	9	0	0	1	2	0	0	0	0	1	111
	Madison	12	66	4	12	0	3	0	2	1	1	17	373
	Rankin	5	38	4	12	0	5	0	5	0	0	9	358
	Warren	0	23	0	0	0	0	0	1	0	0	0	120
	7 Total	17	136	8	24	1	10	0	8	1	1	27	962

[1] Small Game includes: Bobcat, Coyote/Beaver, Non-game bird, Opossum, Quail, Raccoon, Squirrel

[2] Offense codes used as indicators of potnetial Illegal Harvest: baiting, headlighting deer, exceeding bag limit, killing doe out of season, killing deer or spotted fawn out of season, hunting deer with gun during archery season, hunting closed season, hunting with centerfire rifle during primative weapon season, illegal buck (less than 4 points), hunting over bait (federal), killing spotted fawn, non-resident killing doe deer, killing jake turkey, killing turkey hen, killing turkey out of season, shooting deer from a boat.

APPENDIX D

OFFICER SPHERE OF INFLUENCE MAPS

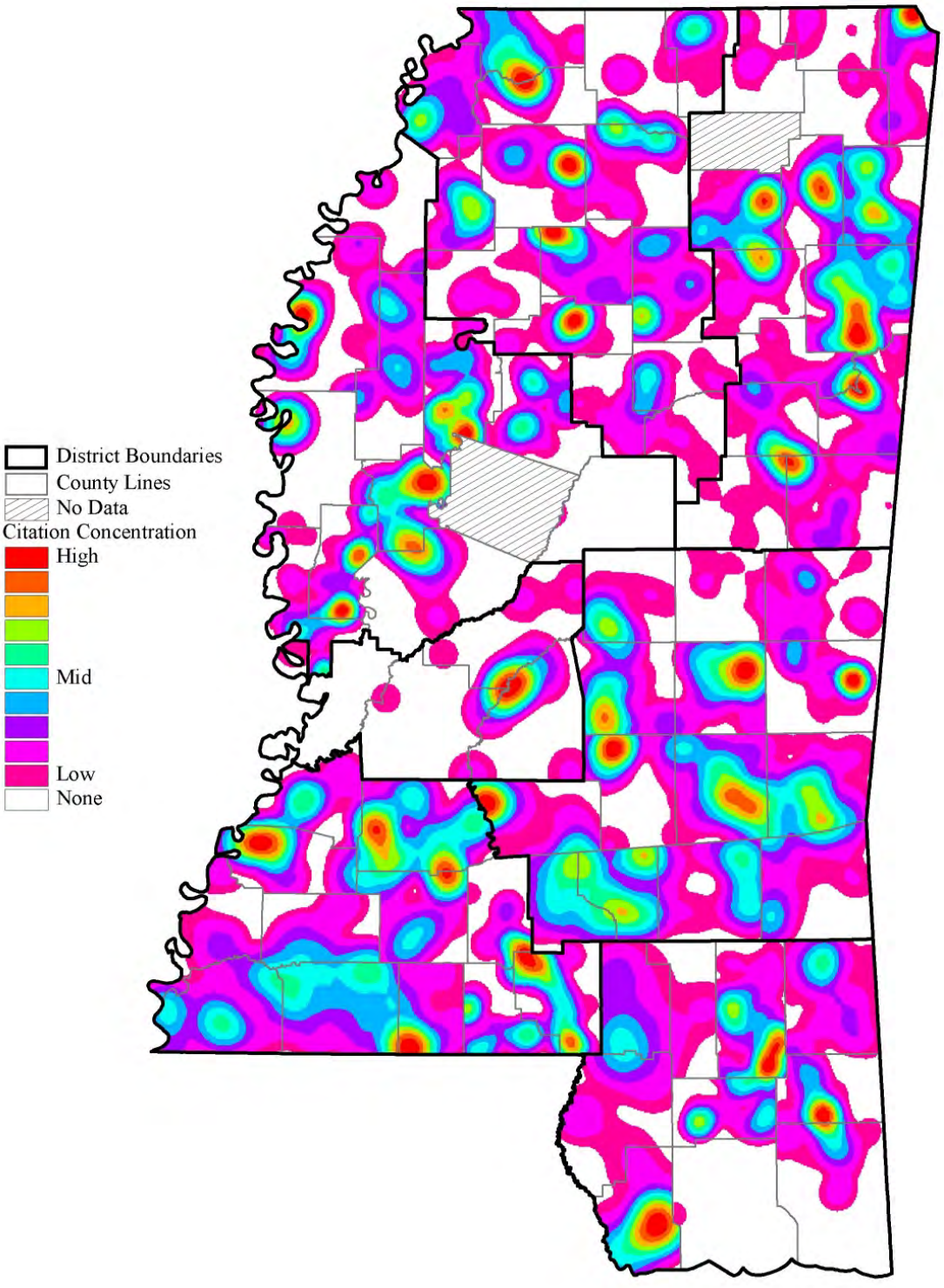

Figure D.1. Officer sphere of influence for all plotted citations written by Conservation Officers in Mississippi during fiscal year 1997.

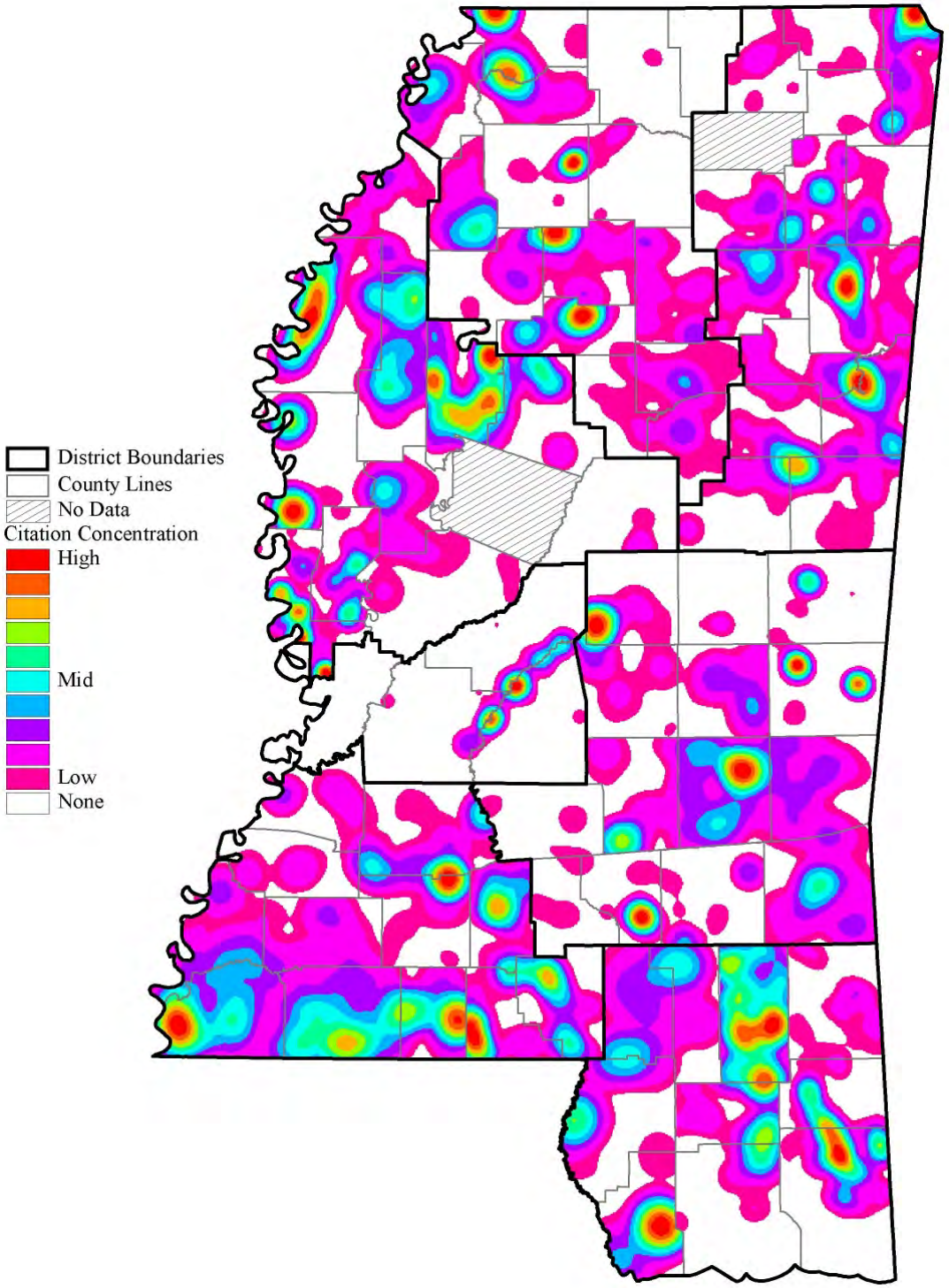

Figure D.2. Officer sphere of influence for all plotted citations written by Conservation Officers in Mississippi during fiscal year 1998.

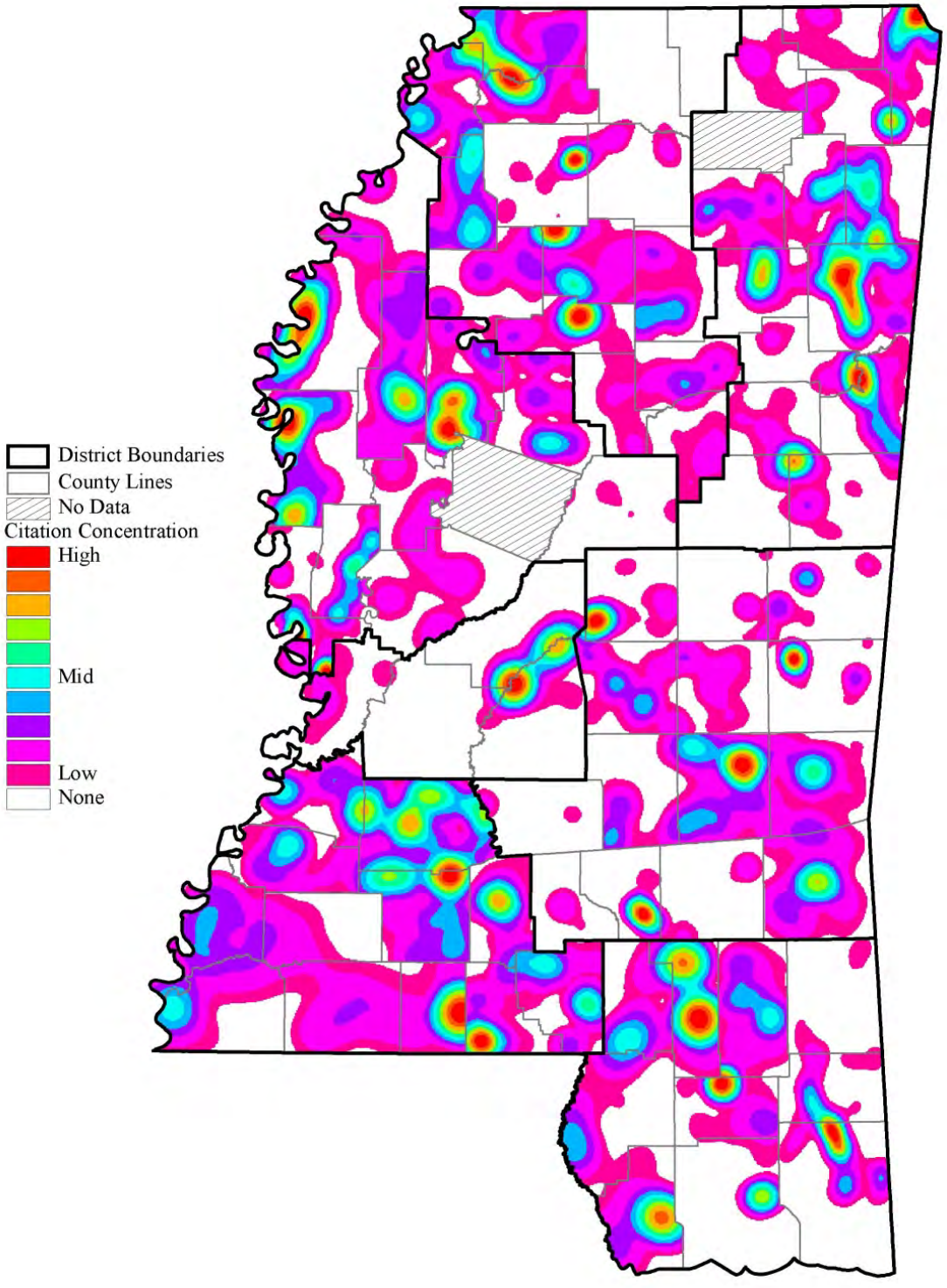

Figure D.3. Officer sphere of influence for all plotted citations written by Conservation Officers in Mississippi during fiscal year 1999.

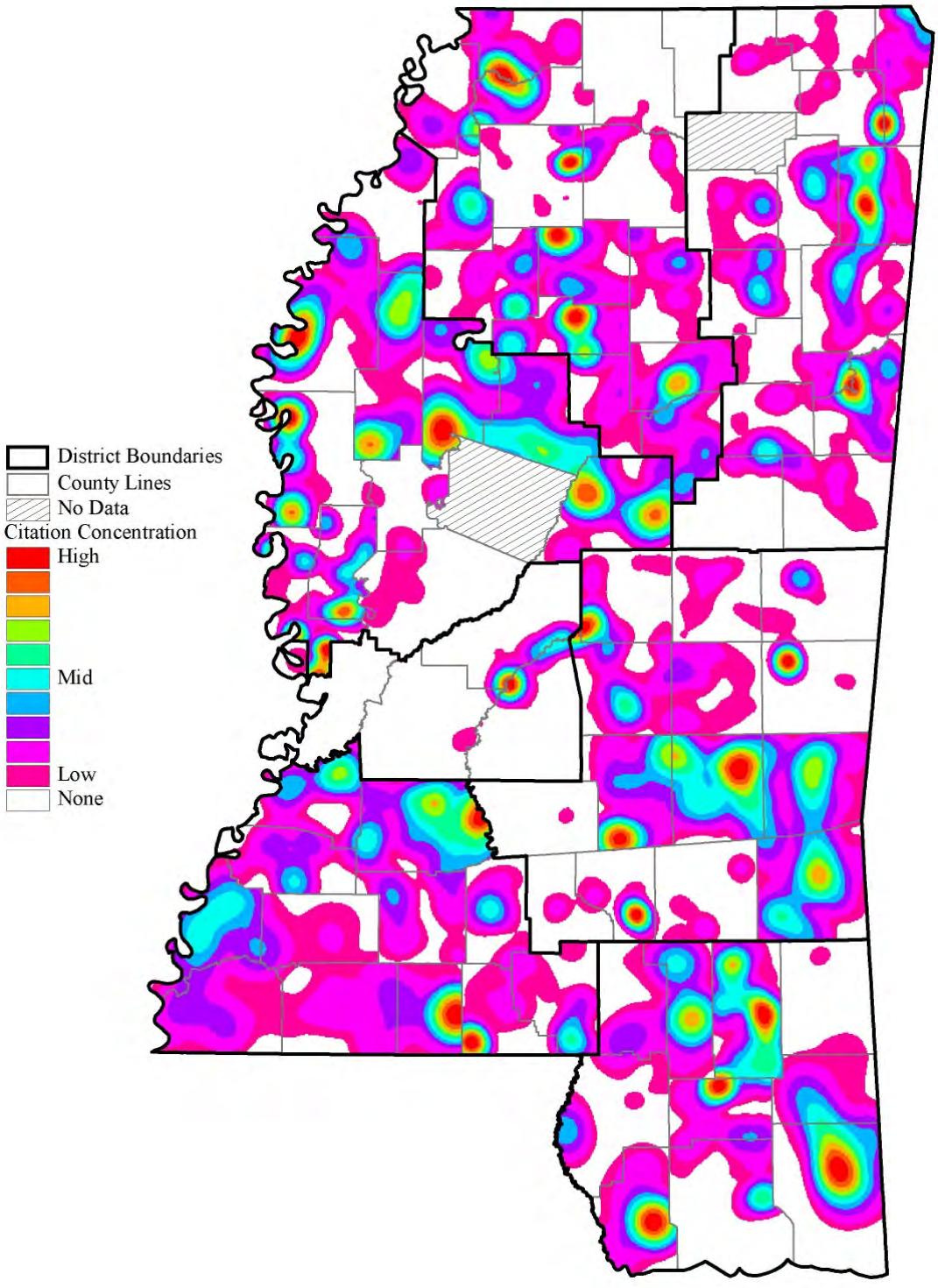

Figure D.4. Officer sphere of influence for all plotted citations written by Conservation Officers in Mississippi during fiscal year 2000.

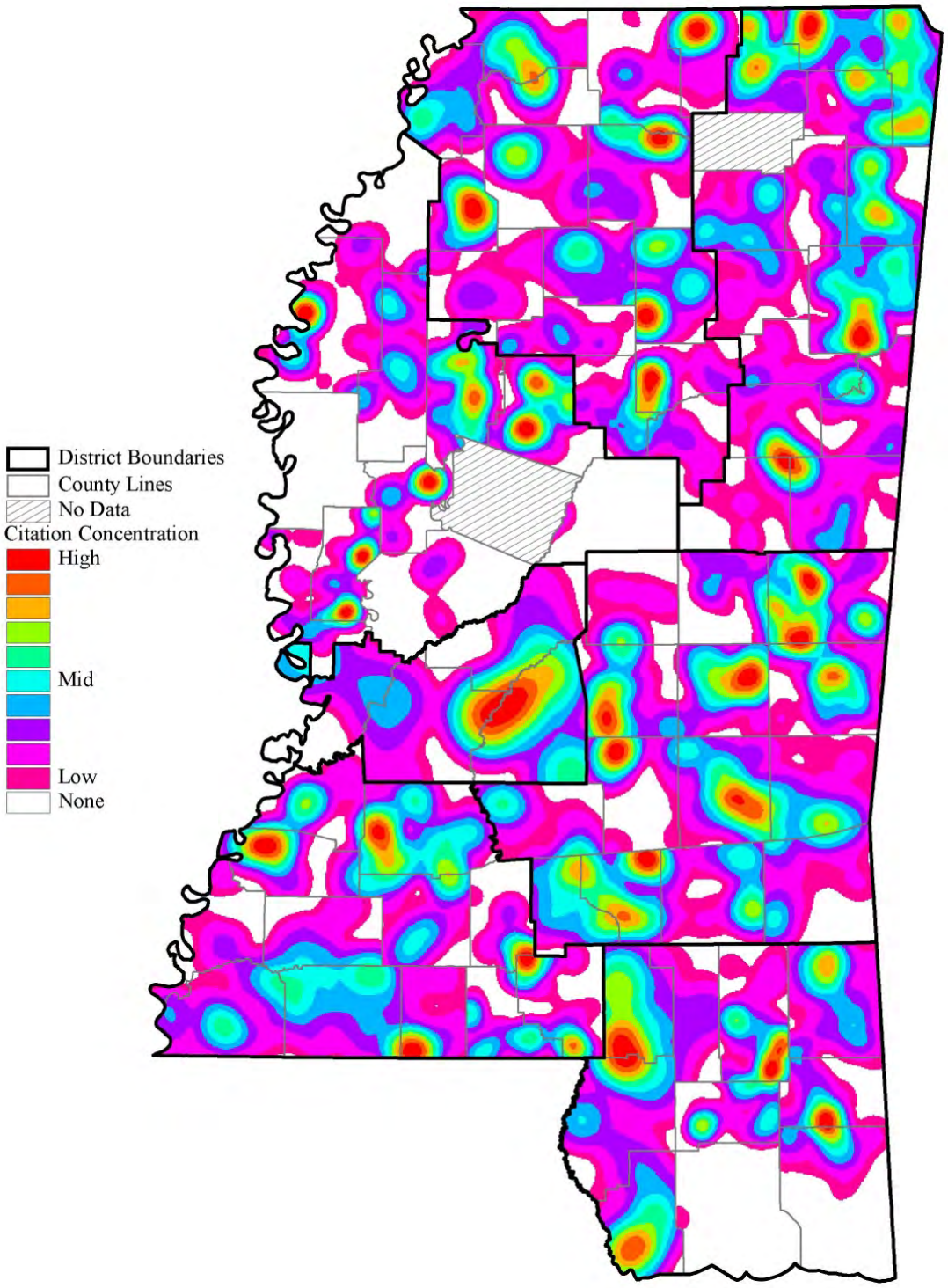

Figure D.5. Officer sphere of influence for plotted citations that are not fishing or water related written by Conservation Officers in Mississippi during fiscal year 1997.

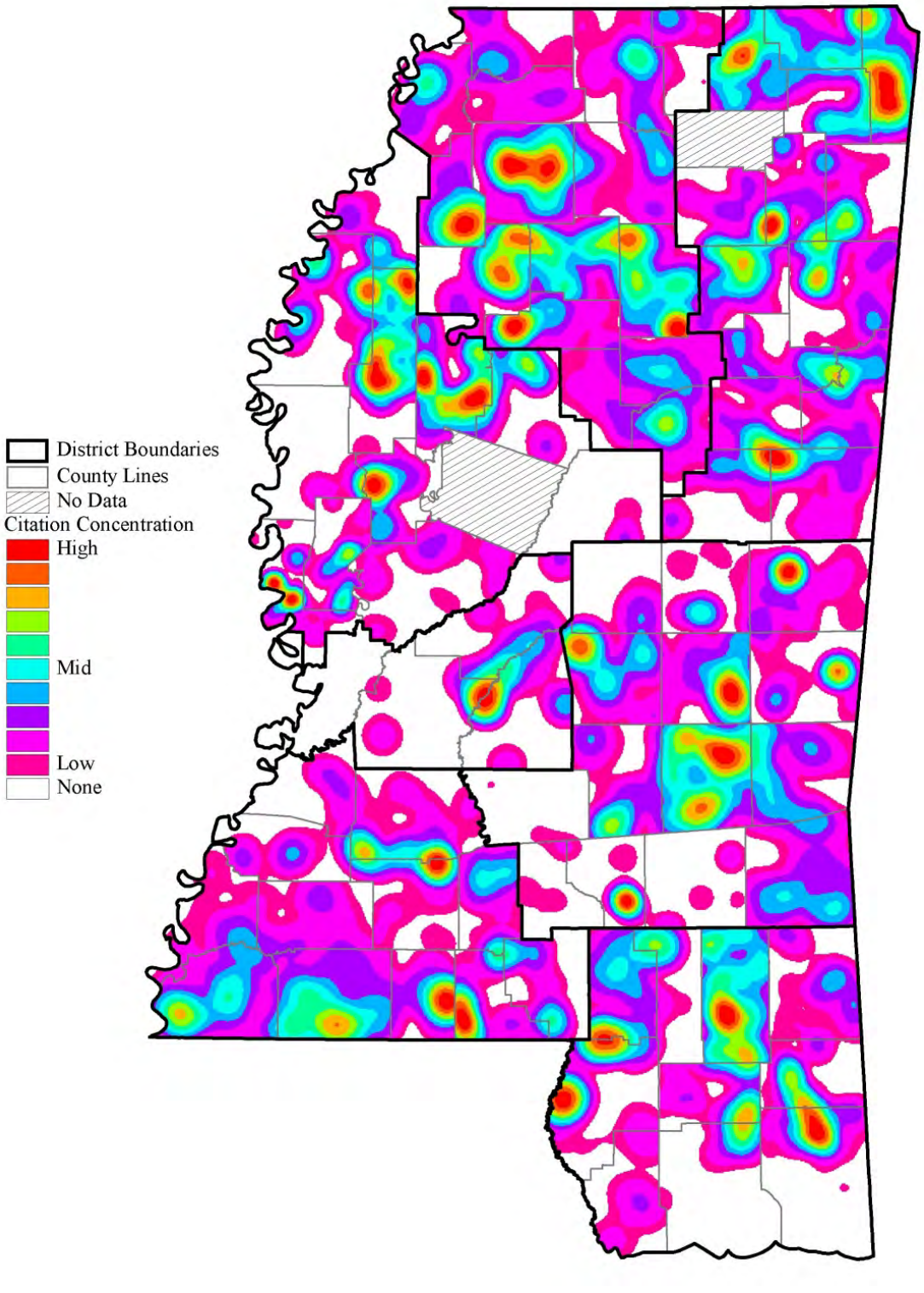

Figure D.6. Officer sphere of influence for plotted citations, that are not fishing or water related, written by Conservation Officers in Mississippi during fiscal year 1998.

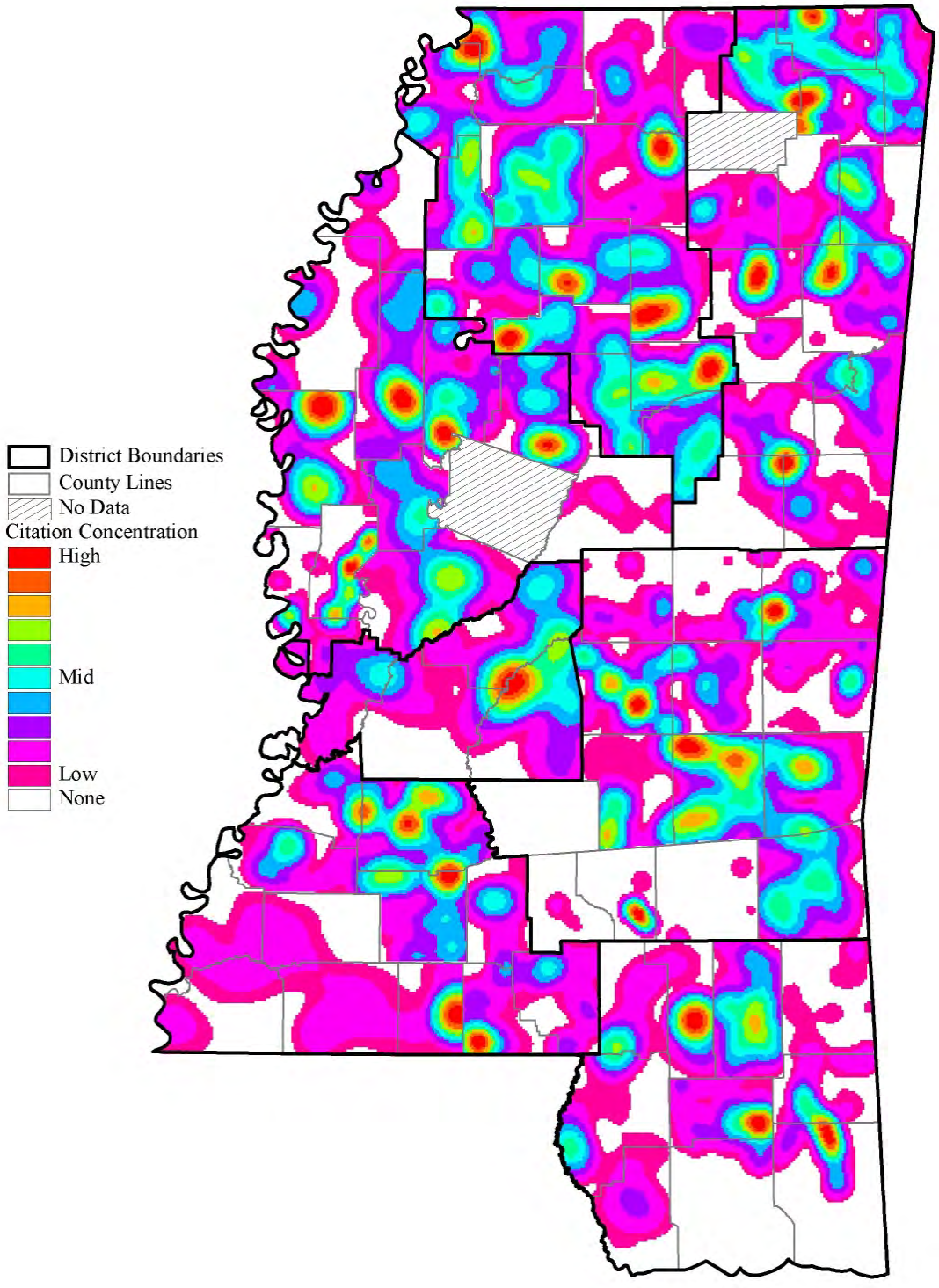

Figure D.7. Officer sphere of influence for plotted citations, that are not fishing or water related, written by Conservation Officers in Mississippi during fiscal year 1998.

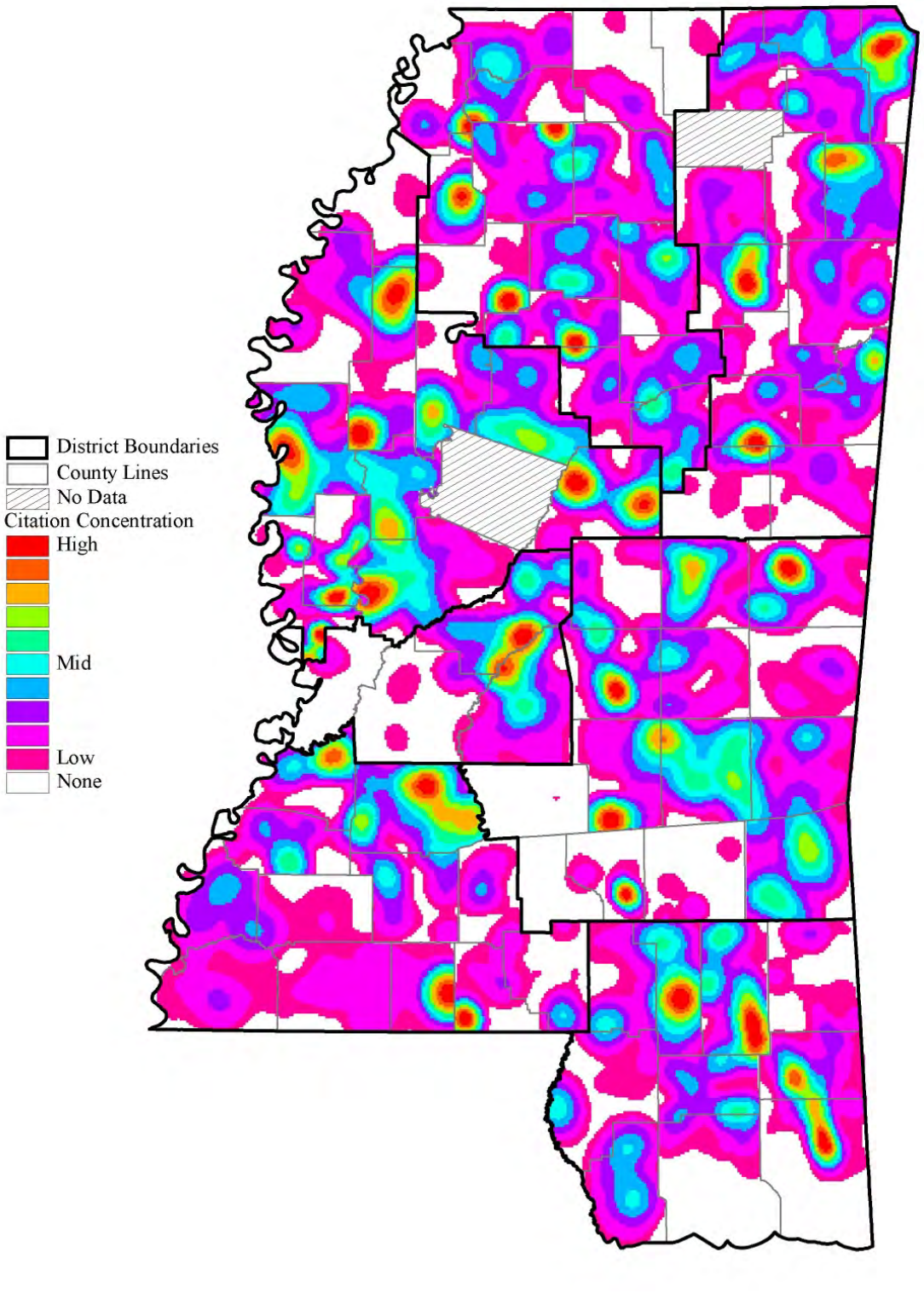

Figure D.8. Officer sphere of influence for plotted citations, that are not fishing or water related, written by Conservation Officers in Mississippi during fiscal year 2000.

APPENDIX E

NUMBER OF CITATIONS PER OFFICER BY YEAR

Table E.1 Number of citations written by all Conservation Officers in Mississippi during fiscal years 1997 – 2000.

Badge Number	1997	1998	1999	2000
16	1	.	.	.
33	.	.	1	.
40	8	16	.	.
41	6	.	.	.
44	2	9	.	.
54	20	97	35	52
100	1	2	.	.
103	.	.	2	3
112	4	11	1	7
121	35	77	47	52
122	48	106	98	84
126	25	69	55	35
127	42	94	71	47
130	75	162	95	80
131	55	76	68	49
132	49	121	53	49
134	28	47	62	63
135	22	43	36	.
136	.	21	47	44
138	12	.	62	63
139	.	.	.	10
140	24	2	2	12
141	33	56	46	62
142	22	39	46	161
144	.	56	76	57
145	34	79	45	42
148	31	25	38	28
149	43	39	50	49
151	.	.	.	3
152	49	102	52	81
153	.	.	49	64
155	.	2	77	85
156	87	82	44	34
157	8	17	4	.
158	11	117	129	103
160	.	.	3	.
161	39	19	20	39
162	37	57	48	48
164	8	3	4	7
166	36	46	34	65
167	.	.	.	26
169	20	15	15	1
170	37	43	50	68
171	38	31	48	46

Table E.1 (Continued)

Badge Number	1997	1998	1999	2000
174	42	57	27	.
175	70	52	76	61
178	.	.	49	39
179	7	15	3	6
180	.	.	1	1
181	3	15	5	16
182	11	9	22	13
183	1	1	12	2
187	24	19	22	32
188	.	.	.	5
220	3	2	1	1
221	15	32	23	21
222	38	53	30	27
223	14	14	33	9
224	30	58	68	27
225	10	32	26	27
226	20	29	34	30
227	20	25	29	18
228	37	49	26	25
229	6	11	8	4
240	25	15	16	11
241	72	104	81	49
242	8	246	301	225
244	.	42	49	47
245	.	48	69	82
246	3	2	2	4
247	22	17	22	11
248	36	40	39	28
249	37	67	60	50
250	.	.	4	.
251	54	26	29	7
252	2	145	182	125
253	27	6	42	23
260	3	1	.	1
261	.	.	35	76
262	28	35	51	38
263	54	61	52	40
264	39	33	49	33
265	33	1	28	12
266	79	94	31	57
267	4	18	25	12
268	5	5	2	5
280	17	9	14	11
281	53	79	73	81
282	65	70	69	72

Table E.1 (Continued)

Badge Number	1997	1998	1999	2000
283	6	38	20	.
284	.	8	21	55
285	28	37	69	37
286	.	.	.	15
287	49	45	64	104
288	45	50	76	94
289	15	24	38	46
290	15	39	65	82
301	1	.	4	2
304	.	.	9	23
320	6	11	6	5
322	15	24	30	56
324	96	145	151	83
325	.	.	10	34
326	.	.	.	47
328	30	51	61	50
329	45	69	78	50
340	2	4	7	4
341	14	33	32	29
342	23	89	37	64
344	.	3	192	202
345	3	27	38	32
346	17	39	63	49
360	21	18	13	6
361	2	2	9	6
362	5	42	48	42
363	.	.	.	57
364	6	15	20	17
365	.	.	.	10
366	63	107	73	95
367	20	30	44	29
380	6	6	9	5
381	32	55	66	37
382	21	54	42	43
383	5	15	23	5
384	38	126	72	75
386	30	60	35	20
387	38	53	65	55
392	.	.	.	8
393	9	10	4	1
394	3	.	.	.
400	36	98	95	5
410	1	.	.	.
421	29	50	34	22
422	.	.	.	29

Table E.1 (Continued)

Badge Number	1997	1998	1999	2000
424	16	56	68	59
425	6	5	16	36
426	17	16	41	19
427	.	1	21	33
428	15	8	2	4
429	2	2	9	9
430	2	8	13	10
431	.	39	81	61
433	11	17	22	23
440	6	7	.	.
441	17	24	52	43
442	.	.	27	60
443	19	13	42	12
444	18	26	12	29
445	.	.	.	4
446	32	40	55	28
447	25	36	28	16
448	46	169	81	71
451	20	40	26	15
452	36	63	92	32
453	63	199	90	108
461	12	48	14	21
462	16	28	7	8
463	34	52	35	18
464	24	127	133	77
465	20	99	96	98
467	18	4	15	10
469	26	120	123	59
470	24	53	114	76
471	14	31	103	33
472	18	88	147	97
473	54	73	106	107
474	3	7	25	21
481	52	112	117	78
482	47	79	75	39
483	12	6	2	.
485	.	28	.	.
486	83	107	113	79
488	8	32	23	18
489	26	12	9	16
490	16	30	33	48
493	27	74	60	66
494	9	55	50	31
500	3	5	4	2
502	1	.	1	2

Table E.1 (Continued)

Badge Number	1997	1998	1999	2000
511	.	.	1	.
527	25	28	13	29
528	16	36	32	53
530	19	5	20	30
531	21	16	16	14
540	.	.	1	.
542	26	59	71	28
543	102	110	140	139
545	30	64	53	18
547	25	45	77	33
561	30	40	57	53
563	.	.	.	22
565	7	.	1	3
566	1	.	.	18
567	38	69	44	27
568	.	65	102	86
569	28	73	48	51
570	21	86	52	48
572	38	137	55	55
573	52	107	105	47
574	20	54	88	71
575	33	35	37	26
580	3	5	8	12
581	.	10	10	.
582	13	5	9	16
583	5	67	61	78
585	5	25	13	27
586	25	43	62	52
588	17	26	9	24
589	.	.	5	.
590	35	37	58	93
591	.	4	12	10
600	.	.	1	.
605	.	.	17	26
621	58	95	71	67
622	70	157	237	221
623	52	63	45	50
624	65	70	33	37
625	.	.	2	50
626	2	10	8	4
628	.	1	276	316
629	.	27	49	106
630	55	60	66	93
641	4	130	133	162
642	70	54	89	75

Table E.1 (Continued)

Badge Number	1997	1998	1999	2000
643	47	31	15	1
644	33	6	6	12
645	.	.	14	262
646	33	18	126	74
647	.	60	56	54
648	7	7	47	16
649	1	.	1	.
651	34	15	77	34
652	.	.	4	13
661	105	47	157	161
662	64	108	54	49
663	.	149	244	221
664	46	181	171	55
665	.	.	33	124
666	137	283	335	566
667	1	209	174	67
668	55	77	89	45
670	.	.	.	76
721	.	2	22	.
723	.	1	11	18
724	.	.	33	74
727	1	.	22	147
728	2	27	95	225
731	6	42	24	15
732	.	.	29	133
733	9	62	96	90
734	.	123	35	30
736	34	87	68	92
737	.	.	1	70
738	.	1	55	31
777	79	73	68	64
827	.	1	.	.
832	19	52	31	1
836	24	112	91	24
1040	.	.	1	.
1064	.	.	.	2
1104	6	.	3	.
1111	5	51	2	9
1120	3	.	.	.
1122	26	.	.	.
1123	5	15	8	23
1124	7	.	.	.
1130	1	.	.	.
1138	.	1	126	43
1139	.	1	17	46

Table E.1 (Continued)

Badge Number	1997	1998	1999	2000
1141	38	33	8	.
1142	.	.	1	.
1143	.	.	1	.
1162	.	.	1	.
1167	.	.	.	3
1186	15	12	9	.
1210	1	.	.	1
1211	2	4	12	12
1343	15	60	120	29
1368	.	.	1	.
1382	.	.	1	.
1392	.	1	.	.
1410	.	.	1	.
1411	.	1	1	.
1441	.	2	.	.
1450	.	1	.	.
1454	.	1	.	.
1461	12	29	12	8
1480	.	.	1	1
1483	.	1	.	.
1485	.	24	.	.
1501	.	.	.	1
1525	1	.	.	.
1528	.	1	1	1
1533	52	.	.	.
1542	.	.	1	.
1546	9	.	1	2
1563	1	.	.	.
1592	43	31	26	13
1602	.	.	.	2
1605	.	.	1	.
1625	1	.	.	.
1627	2	.	1	.
1628	9	4	.	.
1645	.	.	.	1
1648	1	.	.	.
1650	.	.	.	1
1651	9	.	1	.
1708	.	.	3	.
1710	.	.	1	.
1714	2	.	.	.
1718	.	.	10	.
1721	5	1	76	.
1722	.	.	2	1
1729	.	.	9	1

Table E.1 (Continued)

Badge Number	1997	1998	1999	2000
1741	.	.	.	22
1837	.	.	1	.
2001	3	2	.	.
2020	.	.	6	5
2123	.	1	.	.
2243	20	23	24	6
2326	2	.	.	.
2488	1	1	.	.
2501	22	8	9	2
2841	11	1	.	.
2861	18	.	.	.
3001	6	.	.	.
3021	.	1	.	.
3022	.	2	.	.
3233	.	.	1	1
3311	4	13	28	.
3321	100	176	133	99
3325	11	16	7	.
3327	2	37	10	.
3362	7	5	.	.
3365	2	19	5	.
3443	37	12	.	.
4203	1	1	1	.
4214	27	39	.	.
4224	33	22	12	3
4400	.	5	.	.
4425	11	29	45	2
4444	.	1	.	.
4455	3	1	1	.
4485	.	4	.	.
4486	1	.	2	1
4487	4	.	.	.
4604	.	5	.	.
5241	.	28	.	.
5510	.	5	3	.
5541	7	1	3	3
5562	2	18	15	16
5566	15	37	2	10
5601	37	17	35	2
5721	.	.	.	1
6100	2	.	.	.
6231	.	.	1	1
6411	1	.	.	.
6601	1	1	1	1
6603	4	1	.	.

Table E.1 (Continued)

Badge Number	1997	1998	1999	2000
6620	1	.	.	.
6624	1	2	15	.
6627	3	7	27	6
6629	2	10	9	.
6631	.	8	.	.
6633	.	.	1	.
6640	.	1	3	.
6641	13	3	.	.
6645	15	5	1	.
6691	2	5	9	14
7060	.	.	27	.
7093	.	.	3	.
7117	4	1	.	.
7133	.	.	11	.
7211	1	.	.	.
7221	.	.	1	.
7233	.	.	3	.
7247	1	1	5	.
7291	1	.	.	.
7311	.	.	3	.
7337	.	.	28	.
7703	.	2	1	.
7705	1	.	13	.
7707	.	.	4	.
7710	2	8	21	2
7712	.	4	12	.
7715	.	1	4	.
7719	.	.	10	1
7726	.	1	19	.
7728	.	.	6	.
7730	.	.	21	.
7732	.	.	11	.
99999*	3	3	6	.

* Unable to distinguish badge number