

Estimates of the Mass Generated, Disposal Timing and the Spatial Distribution of Disposal Sites Within the Illinois River Watershed (Oklahoma and Arkansas, United States)

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Abstract: Management of the land disposal of fecal wastes from commercial poultry production operations requires managers to have specific knowledge of how much waste is generated, where it is generated and when and where it is disposed. Here we present a methodology developed to (1) identify poultry production locations, (2) estimate the amount of waste generated at each location, (3) identify the timing of poultry waste disposal and (4) identify locations at which waste from poultry production operations was disposed. The work done included: (1) air photo interpretation, (2) on-ground verification of the air photo interpretation, (3) review of animal waste management plans, (4) review of land disposal records and (5) direct observation of the land disposal of poultry waste. A total of 3,226 structures with a possible relationship to poultry production were identified by the initial air photo interpretation. On-ground investigation confirmed 1,917 of these to be active structures. The poultry waste produced was calculated based on a consideration of the amount of waste produced per unit area of poultry structure as a function of bird type. The data used to arrive at these values was obtained from animal waste management plans prepared under the supervision of the U. S. District Court for the Northern District of Oklahoma. This approach produced an estimate of annual poultry waste production in the Illinois River Watershed of 354,000 tons. The proximity of waste disposal locations to waste generation locations was determined from review of records maintained by the Oklahoma Department of Agriculture Food and Forestry. Review of these records showed that poultry waste was typically land disposed near its place of generation; 80% of poultry waste was disposed within 8 km of where it was generated. In addition, although poultry waste is disposed year round within the Illinois River Watershed, approximately 63.4% of poultry waste was disposed between February and June. Although poultry production companies have recently made an effort to export poultry waste from the Illinois River Watershed, review of poultry waste transportation records indicates that at most 19.5% of the poultry waste generated within the Illinois River Watershed in 2006 was disposed outside the Illinois River Watershed.

Keywords: Arkansas; Oklahoma; poultry; waste; disposal; transportation; remote sensing

1 Introduction

Non-point source pollution, especially agricultural runoff, is identified as the leading cause of adverse water quality impacts on surface waters in the United States^[1]. More than 90% of the phosphorus load to about one-third of rivers and streams in the United States is due to non-point source pollution^[2]. Adverse environmental impacts from non-point source phosphorus pollution of surface waters are a major issue along the Oklahoma-Arkansas border. This region is the locus of poultry, particularly broiler chicken, production^[3], and this industry has grown substantially in this region for over 30 years^[4]. The Oklahoma and Arkansas counties along the Oklahoma-Arkansas border (Adair, Delaware, Ottawa, Sequoyah, Le Flore and McCurtain counties in Oklahoma and Benton, Little River, Polk, Sebastian, Sevier, Scott and Washington counties in Arkansas) recorded sales of 589,184,222 broiler chickens in 2002, and Arkansas was the second ranking state in broiler production in 2004 with 1,241,500,00 broilers produced (~14% of US broiler production)^[5,6]. For nearly the entire history of the poultry industry in this region, poultry wastes were surface spread without incorporation as a fertilizer on pastures and hay fields within a short distance from poultry production facilities. Over the past decade, the pollution of eastern Oklahoma surface water by constituents from land applied poultry waste has generated lawsuits by both private parties and governmental entities^[7-9]. A key area of dispute in these lawsuits is the relative contributions of various known phosphorous (P) sources to the phosphorous entering streams, rivers and lakes in the region. The contribution of P from poultry waste to water pollution is substantial. Even though significant amounts of poultry waste are used as fertilizer, a large tonnage remains for which there is no beneficial use, and long-term application of poultry waste to a limited land area that also has a limited capacity to remove P from the soil in the form of harvested crops eventually leads to accumulation of soil P^[10]. In order to estimate the amount of P attributable to poultry waste disposed within a specific watershed, it is necessary to know how much poultry waste is disposed within the watershed. Because, in general, the transportation of poultry waste is limited to 10 to 20 km from where it is generated^[11], a good point of beginning in making a determination of the amount of waste disposed within a watershed is to identify active poultry production facilities within a watershed and estimate the amount of waste generated at these facilities. If data is available, that amount can be corrected upward or downward for the amounts of waste imported to or exported from the watershed.

2 Study Area

The Illinois River Watershed contains approximately 4,330 km², and lies within the southwestern portion (Springfield Plateau) of the Ozark Uplift physiographic province within portions of Washington and Benton Counties in Arkansas and Adair, Cherokee and Sequoyah Counties in Oklahoma. Approximately 53% of the Illinois River Watershed is in Oklahoma and the remaining 47% is in Arkansas^[12]. The Springfield plateau is generally deeply dissected with rolling upland areas separated by V-shaped stream valleys that range from 6 to 9 m in depth. The Illinois River arises in the Boston Mountains of northwestern Arkansas in Washington

County. From its headwaters, it flows in a northerly and westerly direction to its crossing of the Oklahoma/Arkansas border south of Siloam Springs in Benton Country, Arkansas. From there, the Illinois continues westerly to its confluence with Flint Creek in Delaware County, Oklahoma where it changes course to a southerly direction. The Illinois is impounded by Tenkiller dam just north of its confluence with the Arkansas River at Gore, Oklahoma. From its headwaters to its confluence with the Arkansas, the Illinois flows approximately 261 km. A map showing the Illinois River Watershed is provided in Fig. 1.

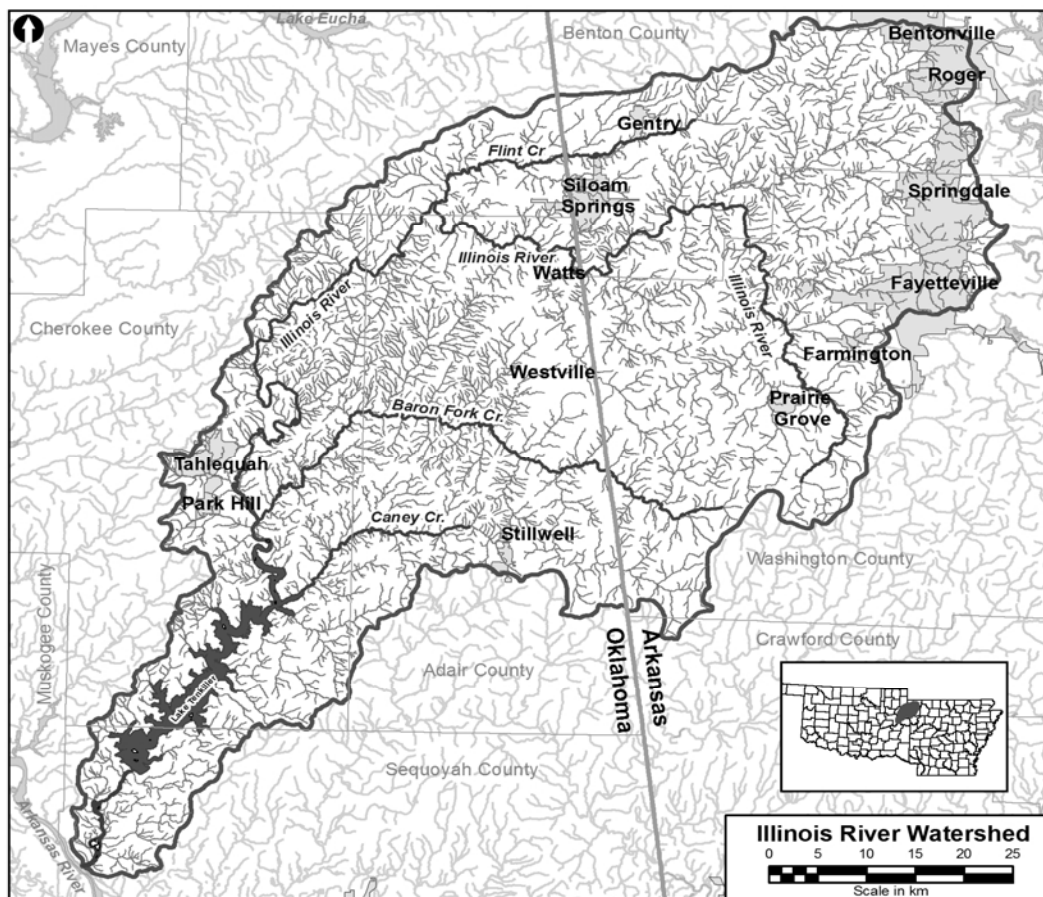


Fig.1 Illinois River Watershed

Two of the primary tributaries to the Illinois River also arise in the Ozark region of Arkansas. Flint Creek originates in Benton County, Arkansas and flows generally westerly toward its confluence with the Illinois just south of Kansas, Oklahoma. Baron Fork Creek arises in Washington County, Arkansas and flows southwesterly to its confluence with the Illinois south of Tahlequah, Oklahoma. The third major tributary to the Illinois River, Caney Creek, originates at Stillwell, Oklahoma and flows generally southwesterly to its confluence with the Illinois in the northern portion of Lake Tenkiller.

Surface water movement within the Illinois River Watershed is controlled by its underlying geology. The major streams in the Illinois River Watershed (Illinois River, Flint Creek, Baron Fork and Caney Creek) have developed within geological faults and fractures^[13]. These streams flow westerly and southwesterly, and become, in general, progressively more deeply incised as they pass from the Arkansas portion of the Illinois River Watershed to the Oklahoma portion of the Illinois River Watershed. Broad open grassed areas of low topographic relief that are dissected by numerous tributary drainages dominate the Arkansas portion of the Illinois River Watershed. In contrast, in the Oklahoma portion of the Illinois River Watershed, topographic relief is greater, and the major streams there form broader more steeply-sided forested valleys that separate more isolated grassed areas.

Agricultural activity within the Illinois River Watershed is, and historically has been, dominated by poultry and beef cattle production, with minor dairy and swine production^[14]. Urban areas within the Illinois River Watershed are located largely along the watershed's boundary, dominantly along the far northeastern boundary of the watershed, and adjacent to the primary east-west transportation corridor (U.S. Highway 412). Simply stated, the Arkansas portion of the Illinois River Watershed is more open, contains a greater proportion of pastureland and those pasturelands are more contiguous in Arkansas than in Oklahoma. This condition facilitates the disposal of poultry wastes in Arkansas through land application. In contrast, the Oklahoma portion of the Illinois River Watershed is generally hillier, traveling westward and southwestward and thus becomes less topographically suitable for the disposal of poultry wastes through land application traveling from east to west.

3 Materials and Methods

A 0.7-meter resolution orthorectified air photo was obtained for both the Oklahoma and Arkansas portions of the Illinois River Watershed in the spring of 2005. All imaged structures were reviewed and structures with characteristics of poultry houses (long, relatively narrow buildings often with feed silos, incinerators and other features potentially characteristic of poultry houses) were identified. In addition, the length and width of all potential poultry houses was measured using ArcView spatial analysis tools. This preliminary air photo interpretation was ground-truthed by field teams. These field teams recorded relevant characteristics of each structure (including any signage) that could be seen from a public right-of-way. Field teams also observed and documented poultry waste disposal within the Illinois River watershed, and whenever possible, documented the source of the waste as well as its disposal location. In addition, Oklahoma Department of Agriculture Food and Forestry (ODAFF) records^[15] and county tax assessor records (which recorded location, bird type and bird inventory data for poultry farms by school district)^[16] were reviewed and compared to the air photo and investigator information. The product of this analysis was a spatial database containing the location of each structure abstracted from the air photo, the length and width of each structure, the poultry integrator responsible for the structure, the farm name, the grower's name, the type of bird grown, and bird capacity of each house.

The amount of waste generated by active poultry houses was calculated based on a consideration of the amount of waste produced per unit area of house by bird type. The amount of waste produced per unit area of house by bird type was calculated from data presented in animal waste management plans prepared under the supervision of the U. S District Court (N.D. OK) by the Eucha/Spavinaw Watershed Management Team^[17]. Each of these waste management plans provided the lengths and widths of each poultry house as well as an assessment of the amount of waste produced by each poultry operation. Because these plans were prepared under Court supervision and were prepared by a small number of professionals working within a single administrative unit, the data in these plans was considered to be reliable and consistent. Moreover, the Eucha/Spavinaw Watershed is contiguous with the Illinois River Watershed and has similar poultry operations that are supplied by the same feed mills, deliver their birds to the same processing plants, are dominated by broiler production and, on average, produce 5.5flocks/year.

Information regarding land disposal of poultry waste in Oklahoma and the location of poultry operations in Oklahoma maintained by the Oklahoma Department of Agriculture, Food and Forestry (ODAFF) was reviewed for the purpose of determining the relationship between the locations of poultry waste sources (poultry houses) and locations of poultry waste land disposal. Data for this purpose was abstracted directly from primary records^[18]. Records were independently entered in duplicate, and conflicts between records were resolved by reference to the primary documents. The relational database structure developed by ODAFF for data pertaining to land disposal of poultry waste, and the registration of poultry operations was used as the backbone for the analysis. The data analyzed comprised both records related to the disposal of poultry waste by poultry waste applicators (waste applicator records) and records related to the disposal of poultry waste by individual growers (grower application records). The records maintained by ODAFF do not, of course, record any instances of poultry waste disposal that were not reported to ODAFF, and do not reflect any waste disposed in Arkansas. Although some waste application records from as early as 1998 are present in the ODAFF database, filing of waste application reports was not mandatory until 2001.

All records considered in the analysis had the following attributes: (1) a legal description (Section – Township – Range) of the waste source location was available, (2) a legal description (Section – Township – Range) of the waste disposal location was available, (3) a date of application was available, and; (4) the amount of waste applied was available and given in units of tons. Prior to the application of the foregoing selection criteria there were a total of 1,280 grower application records, and 3,484 waste applicator records. Application of the selection criteria reduced the number of records considered to 910 grower application records and 2,297 waste applicator records (a total of 3,207 records). The selected records were from the time period 1998-2006, with the bulk (~85%) of the records from the period 2001-2004. The distances between waste sources and the waste disposal sites were estimated by calculating the distances between the centroids (as calculated by ArcView and expressed in UTM coordinates) of the legal descriptions for paired source and disposal locations. This analysis does not include any instances of poultry waste disposal that were not reported to ODAFF and is limited to those waste disposal reports that fulfilled the selection criteria for this analysis.

The same data used for computation of the distance between points of waste generation and points of waste disposal was used to determine the timing of waste disposal within the Illinois River Watershed.

4 Results and Discussion

4.1 Poultry Production Operations in the Illinois River Watershed

As shown in Table 1, at the time the air photo was taken (Spring 2005) there were a total of 3,226 active, inactive, abandoned or removed (foundations still visible) poultry houses within the Illinois River Watershed. In addition there were 294 houses whose status could not be determined (no visibility from a public right-of-way and/or no relevant documents). Shown in Fig 2 is a map of active poultry house locations within the Illinois River Watershed.

4.2 Waste Generation within the Illinois River Watershed

Summary statistics for the poultry house measurements obtained from the high resolution air photo are tabulated by type of bird in Table 2. In the Illinois River Watershed, the typical poultry house is between 300 ft (91.44 m) and 400 ft (121.92 m) long and between 35 ft (10.67 m) and 45 ft (13.72 m) wide. Broiler, layer and turkey houses are typically larger (400 ft x 45 ft; 121.92 m x 13.72 m) than breeder, cornish or pullet houses (300 ft x 35-45 ft; 91.44 m x 10.67-13.72 m). Poultry house sizes are similar in the Spavinaw Creek Watershed which is contiguous to and immediately to the north and west of the Illinois River Watershed, and poultry production operations there are also dominated by broiler production. Because poultry waste disposal in the Spavinaw Creek Watershed is managed by the United States District Court for the Northern District of Oklahoma a settlement agreement^[19], detailed information has been developed in nutrient management plans that can be used to calculate the waste yield per unit area of poultry

houses^[20]. The waste yield per unit area data obtained from the analysis of the Eucha/Spavinaw animal waste management plans is provided in Table 3.

Table 1 Poultry Houses and Probable Poultry Houses in the Illinois River Watershed by Status (c. 2005-2006)

Status	Active	Inactive	Abandoned	Removed	Unknown (probably poultry)	TOTAL Active, Inactive, Abandoned and Removed
Houses	1,917	838	361	110	294	3,226

Table 2 Statistics for length, width and calculated area for poultry houses of known type within the Illinois River Watershed, number in parenthesis beneath house type is the number of houses measured

		Length/ft	Width/ft	Area/ft ²		Length/ft	Width/ft	Area/ft ²
Breeders (197)	Max	850	80	59,600	Layers (39)	805	50	36,225
	Q3	520	45	22,950		527.5	45	23,850
	Median	415	45	18,675		430	45	19,350
	Mean	436.6	45.3	20,017		473.8	45	21,345
	Mode	300	45	13,500		400	45	18,000
	Q1	360	45	15,200		407.5	45	18,000
	Min	175	35	7,875		400	40	17,000
Broilers (1185)	Max	625	60	30,000	Pullets (172)	630	50	28,350
	Q3	500	45	22,500		400	45	16,100
	Median	400	45	18,000		315	40	13,500
	Mean	414.6	44.4	18,569		349.5	40.1	14,061
	Mode	400	45	18,000		300	45	18,000
	Q1	400	45	17,550		300	35	12,000
	Min	200	30	7,000		150	30	6,000
Cornish (57)	Max	600	45	21,000	Turkeys (121)	680	55	37,400
	Q3	400	45	15,750		450	45	20,250
	Median	375	40	14,000		400	45	17,550
	Mean	364.4	39.4	14,366		389.6	44.2	17,388
	Mode	400	35	14,000		400	45	18,000
	Q1	350	35	13,200		307.5	45	14,000
	Min	130	35	4,550		165	25	7,125
Broiler-Cornish (64)	Max	850	80	59,600				
	Q3	520	45	22,950				
	Median	415	45	18,675				
	Mean	436.6	45.3	20,017				
	Mode	300	45	13,500				
	Q1	360	45	15,200				
	Min	175	35	7,875				

Table 3 Annual Unit Area Waste Yield by Poultry Type

Bird Type	Average Waste Yield/ (lbs-ft ⁻² -yr ⁻¹)
Broiler	24.164
Breeder/hen	17.317
Turkey	15.111
Cornish	12.082
Pullet	10.267

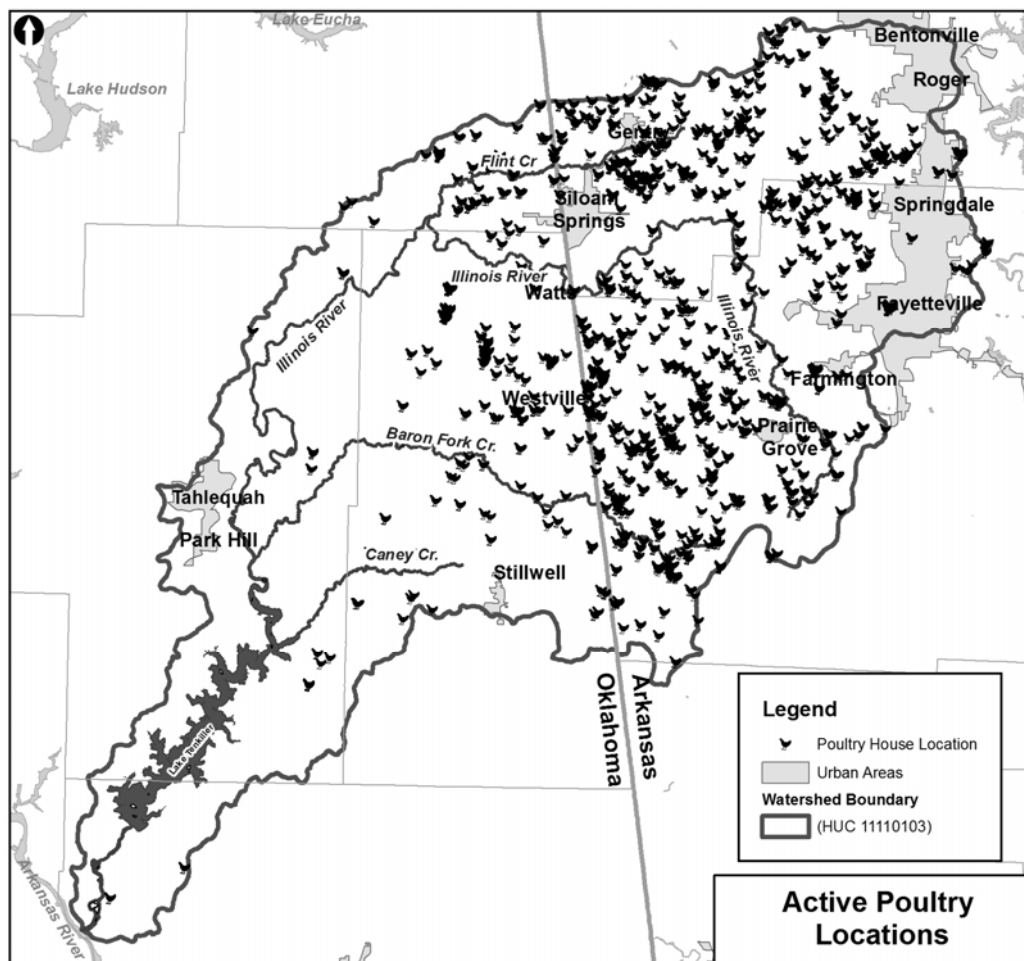


Fig. 2 Locations of active poultry houses in the Illinois River Watershed

These waste yields were multiplied times the area of each of the active houses identified in the Illinois River Watershed. To be included in this computation, it was required that a poultry house be classed as active, and that its responsible integrator had been identified. In all, 1,835 poultry houses met these criteria. Inactive houses and houses for which an integrator had not been determined were not included in this computation. The results of this computation are given in Table 4. Based on this approach, a total of 354,000 tons of poultry waste was generated in 2005 in the Illinois River Watershed. This estimate is conservative. If the amount of waste was estimated based on the number of birds produced in the Illinois River Watershed and standard USDA waste production coefficients^[21], total poultry waste production in the watershed would be nearly 500,000 tons/year.

Table 4 Poultry Waste Production Within the Illinois River Watershed Estimated from a Consideration of the Total Area of Active Poultry Houses Operated by a Known Poultry Integrator

Integrator	Broiler	Breeder	Turkey	Pullet	Cornish	Hen	TOTAL	%
A	129,421	18,593		7,735	9,874	1,521	167,144	47.22%
B	58,724	5,757		1,818			66,299	18.73%
C	49,813	5,911		2,489		1,888	60,101	16.98%
D	35,063	491		277		1,311	37,143	10.49%
E		2,860	15,108				17,968	5.08%
F		358		112		2,280	2,750	0.78%
G			2,597				2,597	0.73%
TOTAL	273,022	33,970	17,704	12,430	9,874	6,999	354,000	100%
%	77.12%	9.60%	5.00%	3.51%	2.79%	1.98%	100%	

Broiler chickens dominated poultry waste production within the Illinois River Watershed with ~77% of total poultry waste produced. Other chicken production (breeders, pullets, cornish and hens were collectively responsible for ~18% of total poultry waste produced and turkeys produced ~ 5% of the waste.

4.3 Waste Disposal in the Illinois River Watershed

Poultry waste is disposed very near where it is generated. As shown in Fig. 3, analysis of the ODAFF records demonstrated that the overwhelming majority of poultry waste generated in the Illinois River Watershed was disposed near where it was generated. Approximately 30% of the waste generated was land disposed within the same square mile (2.59 km²) within which it was generated, approximately 67.5% of the waste was land disposed within two miles (3.2 km) of where it was generated and approximately 80% was land disposed within 3.6 miles (5.8 km) of where it was generated. These data are consistent with the observations made by the field teams who tracked poultry waste disposal trucks from farms where poultry waste had been generated to poultry waste disposal sites. Their observations showed that in 80% of the operations observed in Arkansas and Oklahoma, poultry waste was hauled no more than 3 miles (4.8 km), and was never hauled more than 15 miles (24.1 km) from its source.

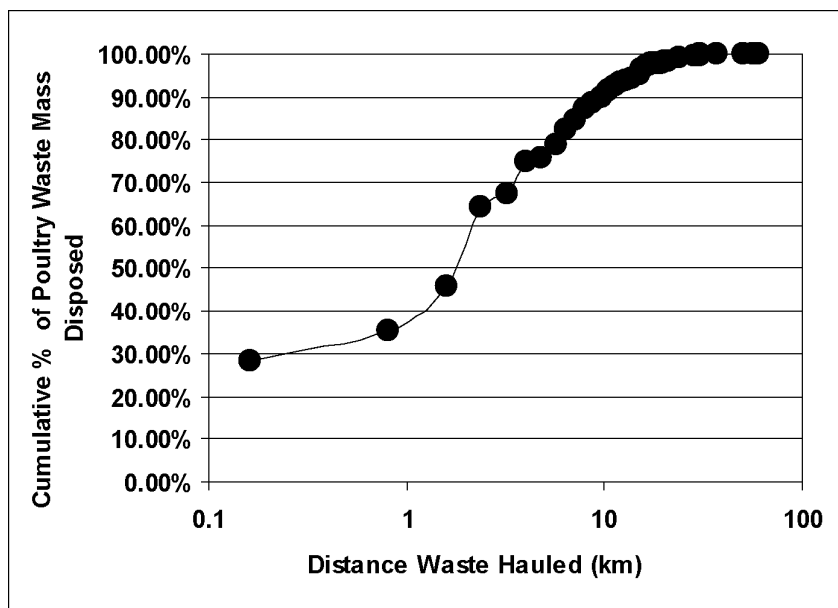


Fig.3 Cumulative frequency plot of the distances between the location of poultry waste production and the location of poultry waste disposal for wastes originating within the Illinois River Watershed in Oklahoma.

There are no official records regarding poultry waste disposal for Arkansas that are equivalent to those available for Oklahoma, and those official Arkansas records that do exist lack the geographic specificity and temporal scope to replicate the Oklahoma waste disposal contiguity calculation. Nonetheless, all of the information that pertains to industry practices in general, and specifically to practices within the Arkansas portion of the Illinois River Watershed demonstrates that disposal practices in the Arkansas portion of the watershed are (and would be expected to be) similar to those practiced in the Oklahoma portion of the Illinois River Watershed. As a general premise it is commonly known that, “in many areas, manure is rarely transported more than 10 miles from where it is produced. As a result manure is often applied to soils that already have sufficient nutrients to support crop growth^[22].

Deposition testimony provided by witnesses in an ongoing lawsuit^[23, 24] and academic research^[25-28] indicate that there is no structural or technical reason that waste disposal practices in the Arkansas portion of the Illinois River Watershed should materially differ from those practiced in the Oklahoma portion of the Illinois River Watershed (i.e. poultry waste will be disposed close to where it is generated). with respect to the Illinois River Watershed in particular, BMPs, Inc in their final report to EPA in 2007^[29] indicated that poultry waste within the Illinois River Watershed has been land applied in large quantities leading to potential to impact water quality. Moreover, BMPs Inc. proposal to transport a small portion of the poultry waste out of the Illinois River Watershed was built on this premise. The USDA published that a significant part of the water quality problems in the Illinois River Watershed were the result of the large amount of poultry waste generated and disposed within the watershed^[30]. Non-point source modeling work conducted in the Illinois River Watershed found that a maximum poultry waste transport distance of 8 km (5 miles) from poultry houses in the Illinois River Watershed provided the best observed fit between estimated and observed soil test phosphorus^[31]. Data obtained from the Arkansas Soil and Water Conservation Commission show that substantial amounts of poultry waste were applied in the Illinois River Watershed during the period 2004-2007 (see Table 4)^[32].

The long-term consequence of poultry waste disposal very close to where it is generated is the presence of excessive levels of poultry waste constituents such as phosphorus, copper and zinc in soils near the production facilities^[33]. This has been recognized as the case in the Illinois River Watershed. In a study of input and removal trends for agricultural soils in Arkansas, Slaton et al^[34] concluded that, “Transport of excess nutrients, primarily in poultry litter, outside of the districts in western Arkansas is needed to

achieve a balance between soil inputs and removals of P and N.” Currently, Arkansas recognizes the Illinois River Watershed as a “Nutrient Surplus Area” and more stringently controls disposal of poultry waste in this area^[35].

Poultry waste generated within the Illinois River Watershed is disposed year-round, but is dominantly disposed from late winter through spring. The same data used for computation of the distance between points of waste generation and points of waste disposal were used to determine the timing of waste disposal within the Illinois River Watershed. Analysis of these data demonstrated that the principal period during which poultry waste is land disposed within the Illinois River Watershed extends over five months from February through June. Based on disposal records from 1999 through 2004, approximately 63.4% of the poultry waste land disposed within the Illinois River Watershed is disposed during this period (see Fig. 4). This period of intensive poultry waste disposal coincides with the period during which most rain falls and most runoff events occur within the Illinois River Watershed. As a consequence, this practice of poultry waste disposal produces a circumstance in which disposed poultry waste is more likely to runoff fields shortly after it is disposed, and before it has an opportunity to become incorporated in surface soil.

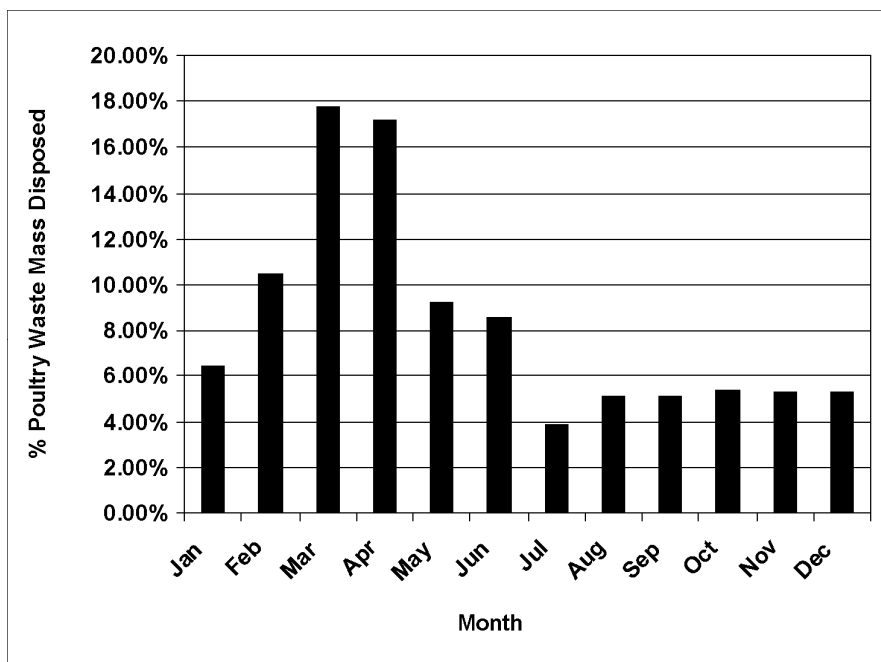


Fig. 4 Timing of poultry waste disposal within the Oklahoma portion of the Illinois River Watershed determined from records maintained by the Oklahoma Department of Agriculture Food and Forestry (1999-2004 data)

The mass of poultry waste generated within the Illinois River Watershed but disposed outside the watershed is a minority of the waste generated within the Illinois River Watershed. The estimate of the amount of poultry waste generated within the Illinois River Watershed given above is 354,000 tons/year. In the recent past, a non-profit entity, BMPs, Inc. has engaged in hauling poultry waste from points within the Illinois River Watershed to locations outside the Illinois River Watershed. BMPs, Inc's records show that BMPs, Inc. began hauling poultry waste from the Illinois River Watershed in 2004. In 2006, BMPs, Inc. reports hauling just less than 60,000 tons of poultry waste from the Illinois River Watershed. One integrator has also actively engaged in hauling poultry waste from the Illinois River Watershed. Records obtained from this integrator indicate the first year in which they hauled poultry waste out of the Illinois River Watershed was 2003, and the peak hauling year was 2005. In that year this integrator removed approximately 11,400 tons of poultry waste from the Illinois River Watershed. The amount of poultry waste hauled by BMPs, Inc. and the actively hauling integrator from the Illinois River Watershed during the period 2003-2006 is given in Table 5. Given the conservative estimate of poultry waste produced within the Illinois River Watershed of about 354,000 tons/year, in the peak year of 2006, no more than 19.5% of the total amount of poultry waste generated within the Illinois River watershed was hauled from the Illinois River Watershed. For the period of record (2003-2006) no more than ~8.8% of the total waste generated was hauled from the Illinois River Watershed.

Table 5 Arkansas Soil and Water Conservation Commission Estimate of Poultry Waste Land Applied in the Illinois River Watershed (all data in short tons)

County	Year			
	2004	2005	2006	2007
Benton	11,440	7,925	5,935.75	36,180

Washington	24,457	19,269	20,009	30,010
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Table 6 Tons of Poultry Waste Hauled from the Illinois River Watershed to Locations Outside the Illinois River Watershed by BMPs, Inc. and an Integrator

	Year	2003	2004	2005	2006	TOTAL
BMPs, Inc. Tons		0.00	905.88	14,783.57	59,736.56	75,426.01
Integrator Tons		8,877.60	11,406.30	19,651.13	9,282.45	49,217.48
TOTAL Short Tons		8,877.60	12,312.18	34,434.7	69,019.01	1,246,43.50
% of Poultry Waste Produced that was Hauled		2.51%	3.48%	9.73%	19.50%	8.80%

5 Conclusions

An estimate of the number of birds produced is not necessary to estimate the amount of poultry waste produced in a specified geographic area. Air photo interpretation combined with on-ground observation can be used to identify active poultry production facilities. If data concerning the amount of waste produced per unit area of poultry house is available, photogrammetric data can be used to estimate the amount of waste generated from active poultry production facilities. For the Illinois River Watershed, the estimate of annual waste production based on knowledge of the amount of waste produced per unit area of poultry house is conservative; estimates of annual waste production based on bird number resulted in an estimate ~35% larger than that based on waste yield per unit area of poultry house and the total area of poultry houses. Because the waste yield per unit area of poultry house varies among bird types, knowledge of the type of bird produced at a poultry production facility is important.

Poultry waste was typically land disposed near its place of generation. In this study 80% of poultry waste was disposed within 8 km of where it was generated. As a consequence, the spatial concentration of poultry production facilities will, over time, result in excessive levels of poultry waste constituents such as phosphorus, copper and zinc in soils. In addition, although poultry waste is disposed year round within the Illinois River Watershed, approximately 63.4% of poultry waste was disposed between February and June. Since this is the time in which most rain falls in this area, this practice enhances the probability that newly applied poultry waste will be transported to surface waters in runoff. Although poultry production companies have recently made an effort to export poultry waste from the Illinois River Watershed, review of poultry waste transportation records indicates that at most 19.5% of the poultry waste generated within the Illinois River Watershed in 2006 was disposed outside the Illinois River Watershed.

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