

**Report on Perceived Excess of
Infant and Fetal Deaths
in O'Fallon, Missouri in 2000**

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Executive Summary

After receiving an inquiry on 16 January, 2001 concerning infant and fetal deaths in O'Fallon, Missouri during 2000, the Missouri Department of Health and Senior Services (DHSS) undertook an epidemiological evaluation of infant and fetal deaths. DHSS completed the preliminary investigation with preliminary year 2000 data in February 2001. The report identified no excess of either infant or fetal deaths in O'Fallon in 2000, but recommended further investigation due to use of preliminary and incomplete data for year 2000. This updated epidemiological investigation includes additional analytical work not presented in the preliminary report and results of a case series study of index cases referred to DHSS. It presents the methodology utilized in carrying out the updated investigation, the main findings, the conclusions drawn from these findings, and recommendations.

We compiled data from the preceding 10 years for comparison to year 2000 data; this data represents Missouri, St. Charles County and the city of O'Fallon. We collected data on neonatal, post-neonatal and fetal deaths by geographic area. We calculated crude mortality rates per 1,000 live births for neonatal, post-neonatal, fetal and total infant deaths (i.e., neonatal and post-neonatal deaths combined). Where needed we summarized rates for periods of five years (e.g., 1990-1994, 1995-1999, etc.) to allow for valid rate computations using data from areas with either small numbers of live births or small numbers of deaths (e.g., St. Charles County and O'Fallon). We compared observed number of cases in O'Fallon with that in reference populations of St. Charles County and Missouri using different methodologies. We generated computerized maps of births and infant and fetal deaths in St. Charles County, highlighting O'Fallon incorporated area. We implemented a case series study of the six index cases of infant and fetal deaths in O'Fallon that included a comprehensive survey of parents.

Examination of the cause of death for the 40 total reported infant and fetal deaths in St. Charles County for the period from January through December 2000, revealed 22 different causes of death. More specifically, we found six different causes of death for the 13 fetal deaths, and 13 different causes of death for the 21 neonatal deaths. For the six post-neonatal deaths, there were three different causes of death (four of the six deaths due to SIDS). The case series of five deaths revealed no pattern or clustering of risk factors known or suspicious of causing infant and fetal deaths.

Between 1990 and 2000, infant and fetal death rates per 1,000 live births for O'Fallon were generally lower than the corresponding rates in St. Charles County and Missouri. Observed by expected ratios of neonatal, post-neonatal, infant and fetal deaths were similar to or lower than rates in the reference populations. In addition, the observed numbers of fetal, neonatal, post-neonatal and infant deaths in O'Fallon in 2000 were not significantly different from what would be expected based on the number of such deaths that occurred in all of St. Charles County, as well as statewide. Likewise, examination of the potentially related causes of infant and fetal deaths across families of four index cases reveals no specific preponderance for any factor. Specific cause investigated were inequalities in prenatal care, problems with access to health care during pregnancy, specific health conditions in the mother (e.g., infection during pregnancy), and both the mother's and the family's history of premature or congenitally malformed babies.

Since there was no predominant cause(s) of death, it is unlikely that a common source exposure (i.e., a single risk factor) was responsible for these deaths in O'Fallon. Also, past environmental assessments in St. Charles County (Weldon Springs Hazardous Waste/Radiation Site) have failed to identify any clear environmental contaminants or exposures, which might be of concern in this situation.

Despite the current lack of evidence for a clustering or excessive occurrence of infant and fetal deaths in O'Fallon, we recommend continued active surveillance of infant and fetal deaths in O'Fallon and St. Charles County for the next 24 months.

Report on Perceived Excess of Infant and Fetal Deaths in O'Fallon, Missouri in 2000

Background:

On 16 January, 2000, the Missouri Department of Health and Senior Services (DHSS) received an inquiry concerning infant and fetal deaths in O'Fallon, Missouri during 2000. Specifically, a Catholic priest noted six deaths among children less than one year of age in his parish. His main concern is that the infant and fetal deaths could have been caused by proximity to the radiation sites in Weldon Springs. DHSS performed an epidemiological evaluation of infant and fetal death records in O'Fallon and St. Charles County. That investigation concluded that the observed number of deaths in O'Fallon and St. Charles County could have arisen by chance alone. Because the investigation used incomplete data for the year 2000, it was deemed preliminary and DHSS recommended further analysis and active surveillance of O'Fallon. This report includes analysis of updated surveillance data and results of a case series study to identify potential risk factors for infant and fetal deaths. The report presents a description of the methodology utilized in the updated investigation, the main findings and the conclusions drawn from these findings, and recommendations.

Methods:

Data and Study Population

We collected data on neonatal deaths (deaths in infants <28 days of age), post-neonatal deaths (deaths in infants 28 days through one year of age) and fetal deaths (deaths *in utero* at 20 or more weeks of pregnancy) by geographic area. The combined neonatal and post-neonatal deaths composed the total infant deaths. We compiled 11 years of Missouri, St. Charles County and O'Fallon data (1990-2000). We used this data to make comparison of St. Charles County and O'Fallon infant and fetal deaths with Missouri for the period of 1990-2000 and the year 2000. We implemented cluster analysis to evaluate whether infant and fetal deaths were clustered in any area of O'Fallon.

Depending on the cluster analyses, we defined geographic areas in St. Charles County and O'Fallon in two ways. First, for both rate-based calculations of probabilities and adjacencies statistics, we

used Zip codes to define geographic areas. Using this approach, we defined O'Fallon as Zip code 63366, Zip code 63376, Zip code 63304, or combined Zip codes (i.e., 63366, 63376, and 63304). We also included in the analysis all other Zip codes in St. Charles County. Second, for the adjacency statistics only, we used Census enumeration districts (i.e., census tract) to arbitrarily create geographic areas with population sizes close to 10,000 inhabitants (geo-areas). Based on infant and fetal death data available, this approach guarantees a minimal live birth density and number of deaths to make rate-based and adjacency statistics reliable.

Analysis

For each geographic area defined above, we calculated crude death rates per 1,000 live births for neonatal, post-neonatal, fetal and total infant deaths (i.e., neonatal and post-neonatal deaths combined). We summarized rates for a period of years to allow for computation of reliable rates since some of the areas being analyzed (i.e., St. Charles County and O'Fallon) had small numbers of live births and/or small numbers of deaths.

We compared the number of observed with expected fetal, neonatal, post-neonatal and total infant deaths for O'Fallon Zip codes and geo-areas with Missouri and St. Charles County data. We estimated expected deaths based on the Missouri and St. Charles County mortality experience for the period 1990-2000. We used Missouri and St. Charles County natal mortality rates to indirectly calculate expected deaths for O'Fallon Zip codes and geo-areas, along with the ratio of observed by expected deaths. We calculated the probability of observing a specific number of deaths by type of death for each geographic area.

We counted the number of adjacencies among geographic areas of St. Charles County (e.g., both Zip codes and geo-area) and Missouri (e.g., counties). We measured the infant and fetal death rate in each geographic area. We calculated the number of adjacencies associated with different levels of infant and fetal death rates in all Missouri counties and St. Charles County Zip codes and geo-areas. We used Ohno and Grimson methods for testing spatial clustering of adjacent areas among counties of Missouri and geographic areas of St. Charles County (i.e. both areas defined by Zip code and population size). These methods calculate the probability of finding a difference between observed and expected adjacent areas with similar high rate of deaths .

We calculated both count and adjacency type of statistics using multiple definitions of the O'Fallon geographic area. In addition, for calculation of adjacency-based statistics, we used two different ways for defining cut off in the distribution of the observed and expected pairs of adjacency. These approaches increase the sensitivity of finding a greater than expected number of occurrences for the event of interest. However, they falsify the assumptions required for testing statistical differences while minimizing type-I error (i.e., p-value) by imposing multiple testing of the same data. For this reason, p-values should be looked at cautiously in this report and one should only accept conservative probability values that are at least twice smaller than five in one hundred.

Maps

The maps for this project were produced with ArcView 8.1, a microcomputer-based geographic information systems (GIS) program. The thematic maps used illustrate the relative magnitudes of phenomena by geographic location. The dot map uses points to communicate spatial density of discrete geographic phenomena. This map illustrates well the residence location of each death investigated. Choropleth mapping employs distinctive shading to illustrate variation from place to place in accordance with values they represent. This technique was chosen because it best displays differences of rates in the study.

Given that birth density is an important variable in examining the distribution of infant and fetal death cases across space, a map was created that combined the strengths of dot and surface mapping. This was done in ArcView 8.1, a leading GIS program operating on the UNIX platform. Population, at the various scales employed in this study, is best represented as a continuous surface. This method compensates for a major limitation of choropleth mapping, which assumes a uniform distribution of a phenomenon across each defined zone. Enumeration districts used by the U.S. Census Bureau, for example, are designed to facilitate the counting of the people. Their purpose is not to illustrate the natural spatial extent of the many variables reported in their zones. To create the birth density surface, the geographic center was first identified for each birth or death case. The area of interest was then divided into numerous equal area cells. A standardized attribute value was attached to each case centroid based on the total number of births in the cell divided by its area. Because considerable variation can occur between and among contiguous cells, values from other center points within a 50-meter radius of

each centroid were used to create a smoothed value. These derived values were then used to create a relief surface based on birth density. Finally, locations of infant and fetal death cases were laid on top of the density model.

Address Matching

Before any mapping or spatial analysis can occur, all cases had to be address matched. This involved finding the residence location and linking it to geographic areas recognized and coded by the U.S. Census.

The address matching process involves two files. One file is the 1998 TIGER digital street map which describes the locational coordinates of the centerline of all streets, the range of street addresses that are found on each street segment, and the different political and administrative areas to which each side of each street line segment belongs. The U.S. Census Bureau has developed TIGER line files to describe the street centerline map of the U.S. and Census Geography. The second file contains the street address descriptions of the death cases.

Of the 42,964 births and 400 deaths in St. Charles County with street addresses, 85 to 91% were address matched depending on the analysis, which is high by GIS industry standards.

Unmatched cases were the result of the case file not being compatible with the digital street map. This can happen because of inaccuracies or inconsistencies in the digital street map or because of inaccuracies or inconsistencies in the file of addresses to be matched.

Case Series Study

We investigated the six index infant deaths through a comprehensive interview questionnaire of the parents. The survey questionnaire included questions on family and personal health history of both parents. We asked mothers about their reproductive history, including the history and development of the pregnancy resulting in an infant or fetal death. We sought detailed information on the parent's exposure to occupational and environmental chemical and known toxins. Other factors of interest were parent's smoking, residency history, health care coverage, and health services availability and use. Upon closer examination, there were only five families living in the area of O'Fallon and one family refused participation in the investigation. This resulted in a final series of four families with infant and/or fetal deaths who responded to the case series questionnaire survey.

Results

Surveillance Based Data:

We identified a total of 40 infant and fetal deaths reported from St. Charles County during the period from January through December of 2000. For these 40 individuals, 22 different causes of death were given. Specifically, we found six different causes of death for the 13 fetal deaths, and 13 different causes of death for the 21 neonatal deaths. For the six post-neonatal deaths, there were three different causes of death (four of the six deaths due to SIDS).

Between 1990 and 2000, the reported five-year infant and fetal death rates per 1,000 live births for O'Fallon were similar to, or lower than, those reported for both St. Charles County and Missouri, as well as the U.S. (Table 1). Five-year fetal death rates in both O'Fallon and St. Charles County were lower than in Missouri during the period (not shown in tables). Five-year neonatal and post-neonatal death rates for O'Fallon, St. Charles County and Missouri slightly decreased during the same period. (not shown in tables)

Ratio of observed number of neonatal deaths were less than expected for St. Charles County and four areas of O'Fallon defined by Zip Codes 63366, 63376, 63304 and a combination of these and other surrounding Zip Codes. (Table 2) The ratios of the observed number of post-neonatal, infant and fetal deaths were all less than expected.

Overall, the observed numbers of adjacencies for Zip codes or geo-areas as related to fetal, neonatal, post-neonatal and infant deaths in O'Fallon for 1990-2000 and 2000 were not significantly different from what would be expected by chance alone (Table 3). Only one out of fourteen calculations for differences between observed and expected adjacencies (i.e.; fetal deaths using quartile of the distribution of adjacent pairs as cut off), shows statistics at level of significance using a standard acceptance level (i.e., $p\text{-value} < 0.05$).

In incorporated O'Fallon, we found geo-areas of 10,000 inhabitants with infant and fetal deaths rates comparable to the surrounding areas (Figures 1-3). Dot-density maps show a higher concentration of infant and fetal deaths in areas with greater number of births (Figures 4-6). There is no evidence

of increased infant or fetal deaths associated with proximity to Weldon Springs Ordnance Works. There is no evidence of clustering shown in either choropleth or dot-density maps.

Case Series:

Demographics:

Mothers ranged in age from 26 to 33; none were Hispanic or Latino. All were White race, married, and had at least a twelfth grade education. Two were homemakers and two were employed outside the home. All had a family income of at least \$50,000 per year, all had medical care insurance through the period of the pregnancy of interest, and none had ever served on active duty with the military.

Residential History:

All mothers reported living in their current homes from 2 to 39 months prior to conception of the pregnancy in study. All used the public drinking water supply for cooking/drinking. Reported residences since January 1990 varied among six different states, with most of the variation reported by two mothers (i.e., each having resided in at least three states since 1990).

Work History:

Three mothers reported no chemical exposure in their jobs, while one reported only infrequent exposure to petrochemicals and sulfur dioxide.

Reproductive History:

All four pregnancies under study were delivered prematurely (gestational age from 17 to 35 weeks). One of the pregnancies produced two infants, delivered by Cesarean section, stillborn at an estimated gestational age of 17 weeks. The other three pregnancies resulted in live births with death occurring from one to 23 days after birth. Three of the four mothers had normal pregnancies with live birth infants still alive before the pregnancy in study (the other mother was *prima gravida* with the pregnancy in study). Three of the four mothers have had normal pregnancies with live birth infants still alive after the pregnancy in study (including the previously mentioned *prima gravida* mother).

Family Reproductive History:

MOTHER'S FAMILY-

Mother: 12 pregnancies resulting in 11 live births

Sisters: 5 pregnancies with 5 live births (all still alive)

Brothers: 7 pregnancies with 7 live births (all still alive)

FATHER'S FAMILY-

Mother: 26 pregnancies resulting in 24 live births (23 still alive),
18 from one mother (16 live births, 2 miscarriages)

Sisters: 9 pregnancies with 8 live births (all still alive)

Brothers: 13 pregnancies with 13 live births (all still alive)

Mother Only Questions:

Prescription Drugs—Two mothers reported no prescription drug usage for the pregnancy under study; one mother had steroid injections only to help the fetal lung development; and one mother used a number of prescription drugs during the pregnancy under study.

OTC Drugs—Three mothers used only Tylenol while the other mother used Tylenol and Sudafed.

Alcohol—Three mothers reported no consumption of alcohol before, during, or after the pregnancy under study; the other mother reported consuming one beer per week for the first two months of the pregnancy under study, but abstaining thereafter.

Caffeine—Three of the mothers reported no coffee, tea, or soft drink consumption during the pregnancy under study; the other mother consumed two cans of diet soda per week during the pregnancy under study.

Recreational Drugs—None of the four mothers reported using recreational drugs during the pregnancy under study

Cigarettes—None of the four mothers had ever smoked 100 or more cigarettes.

Special Diet—None of the four mothers were on a special diet during the pregnancy under study.

Supplements—All four mothers took prenatal vitamins while pregnant; one also took folic acid.

Special Foods—None reported.

Cravings—Two mothers reported cravings, while two reported no cravings.

Health Status—None of the mothers reported “Excellent” or “Very Good” health status during the pregnancy under study; of these mothers, seven other preceding/subsequent pregnancies, four were rated “Excellent” or “Very Good”.

Illness During Pregnancy—None of the mothers reported diabetes, high blood pressure or pre-existing illness for the pregnancy under study; two had no acute illnesses while the other two reported flu in one mother and streptococcus and yeast infection in the other.

Pregnancy-Related Illness—Two mothers reported no illnesses, while one reported severe daily headaches in the first trimester and the other reported “cervical circlage”.

IMPRESSION:

There was no consistent finding of occurrence or pattern of any potential risk factor in three of the four women, which would suggest a cause for the negative outcome of the pregnancy under study. The fourth mother was discovered to be carrying a rare genetic trait that resulted in her baby's death.

Discussion

In Missouri, infant deaths declined while fetal deaths remained stable over the past ten years. The causes of infant deaths are multiple and may include smoking during pregnancy, infection and other illnesses during pregnancy, low birth weight, premature birth and substance abuse during pregnancy, accidents during pregnancy and a mother's history of premature or congenitally malformed babies. A proportion of those infant deaths is attributed to SIDS, which is causally related to putting babies to sleep in prone position. In Missouri and the U.S., a great number of averted infant deaths have been attributed to the campaign to put" babies to sleep on their back". Environmental exposures have only been linked to infant or fetal deaths related to birth defects. Past studies by DHSS on the association between excess leukemia deaths and proximity to the Weldon Springs site did not find a relationship.

The pattern of mortality by specific causes in O'Fallon was similar to that experienced by St. Charles County, Missouri and the U.S. during the same period of time. The numbers of observed neonatal, post-neonatal and fetal deaths in O'Fallon in 2000 was either smaller or similar to what could be expected by chance alone. There was no excess of infant or fetal deaths in O'Fallon during the 10-year period between 1990 and 2000 that is statistically detectable using the methods described. There was no spatial clustering of infant or fetal deaths in O'Fallon, regardless of the way it is geographically defined. There were no predominant causes of deaths among all 40 deaths reported for St. Charles County and the four deaths for O'Fallon in 2000. The case series investigation revealed no predominant pattern of known or suspicious risk factors for negative pregnancy outcomes among all five pregnancies investigated.

Since there was no predominant cause(s) of death or predominant risk factor, it is unlikely that a common source exposure (i.e., single risk factor) was responsible for these deaths in O'Fallon. In other words, the 22 different causes of death point to multiple risk factors. Also, past environmental assessments in St. Charles County (Weldon Springs Hazardous Waste/Radiation Site) revealed no clear environmental contaminants or exposures in the community, which might be of concern in this situation. The DHHS' Section for Environmental Public Health has conducted sampling of over 150 private wells around the site for over ten years. During that time, radioactivity has only been found in four wells. These particular wells draw from a certain aquifer that contains naturally occurring radioactivity. Users of these wells have been instructed in ways to treat the water prior to consumption. DHSS believes no one is being exposed to radioactive contamination through groundwater in the area of the site. The results of past environmental assessments, and the absence of a predominant cause(s) of death, make it unlikely that an environmental exposure could be related to the observed infant and fetal deaths in the O'Fallon community.

These findings should be interpreted cautiously for two reasons. First, albeit non-significant statistically, the number of infant and fetal deaths in O'Fallon slightly increased between 1998 and 2000. Second, the analysis of known common causes of infant and fetal deaths for index cases did not reveal any association of these factors with studied deaths. Factors studied included inequalities in prenatal care, access to health care during pregnancy, specific health conditions in the mother (e.g., infection during pregnancy), and both the mother's and the family's history of premature or congenitally malformed babies.

Limitations

Geocoding for producing dot-density and dot over choropleth maps could not locate 15% of known live births and deaths in St. Charles County. Nevertheless, detailed counting of unidentified deaths and live births identified no specific pattern in the geographic distribution of such missed events.

The methodological approach used for testing clustering imposed multiple testing of same data by using different statistics for same purpose and multiple cut-off within a given statistical testing (e.g., sensitivity analysis). This strategy increases the chance of making type-I error beyond what is usually specified. However, only one out of fourteen statistical tests for clustering of adjacencies and none of the six statistics used for testing observed by expected counts were significant at the usually acceptable level (i.e., $p\text{-value} \leq 0.05$).

Statistical testing, specially testing for spatial and time clustering suffers not only from problems with multiplicity of testing but also from difficulty with assumptions of independence and homogeneity. The Ohno adjacency testing requires a large number of adjacencies by adjacent pair for valid interpretation of the results. In our calculations, this ratio was appropriate but not ideal. Also, geo-area counts and statistics were based on imperfect tally of all live births and deaths above described, compounding this assumption.

Due to the above reasons, most statistical textbooks recommend using stricter levels of significance and overall agreement across tests as evidence for or against clustering of events being studied.

Conclusion

The observed numbers of fetal, neonatal, post-neonatal and infant deaths in O'Fallon in 2000 were not significantly different from what would be expected based on the number of such deaths occurring in the other areas included in this analysis (St. Charles County, Missouri, and the U.S.). There is no evidence of geographic clustering of infant and fetal deaths in O'Fallon or St. Charles County. There are 22 different causes of death among all 40 deaths in St. Charles County for the study period. There is no indication that a single risk factor is related to the observed deaths in O'Fallon in 2000. There is no indication that an environmental exposure is related to the observed deaths. However, there is biological plausibility in the suspicion that environmental contaminants

could be linked to infant or fetal deaths, due to its linkage with birth defects. Also, there was a slightly, albeit non-significant, increase of infant and fetal deaths in O'Fallon (i.e., Zip code 63366) between 1998 and 2000.

Recommendations

We recommend active surveillance of birth outcomes in the next 24 months for the areas surrounding and including O'Fallon. This surveillance consists of repeating current analysis every year for the next two years as more data accumulates over time. If an environmental contaminant, that is present but undetected, is causing any infant or fetal deaths in the areas surrounding Weldon Springs, over time there will be an excess number of such deaths that will accumulate and be detectable by conventional statistical methods. We also recommend increased monitoring of radioactive levels of contamination in wells and other sources of usable water by the Section for Environmental Public Health. This two-sided strategy should minimize unnecessary anxiety by the O'Fallon community arising from their perception of an increased environmental contamination with radiation and its effect on birth outcomes.

Table 1. Trends in Infant and Fetal Death Rates* in United States, Missouri, St. Charles County and O'Fallon, 1990-2000

Type of Death	Area	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Neonatal	United States	5.80	5.60	5.40	5.30	5.30	4.90	4.80	4.80	4.80	N/A	N/A
	Missouri	5.66	6.23	5.22	5.12	4.89	4.59	4.84	4.73	4.92	5.06	4.77
	St. Charles County	3.34	3.21	2.68	3.76	3.26	2.68	3.78	5.38	3.42	3.93	4.95
	O'Fallon (zip code 63366)	1.66	3.15	3.26	5.85	6.68	1.36	2.33	3.43	2.02	3.02	6.83
	O'Fallon (zip code 63376)	0.00	2.11	2.92	2.12	3.19	1.09	1.11	3.14	4.48	4.21	4.52
	O'Fallon (zip code 63304)	N/A	0.00	0.00	4.40	0.00	1.83	5.40	9.96	3.55	4.97	0.00
	O'Fallon (combined zip codes)	0.67	2.31	2.41	3.84	3.66	1.36	2.59	4.72	3.27	3.93	4.51
Post-Neonatal	United States	3.40	3.40	3.10	3.10	2.90	2.70	2.50	2.50	2.40	N/A	N/A
	Missouri	3.77	3.94	3.29	3.26	3.26	2.82	2.73	2.87	2.70	2.65	2.40
	St. Charles County	0.51	2.67	1.87	1.34	1.63	2.68	1.76	1.54	2.20	1.47	1.41
	O'Fallon (zip code 63366)	0.00	0.00	1.63	1.46	1.34	2.71	0.00	0.00	1.01	1.01	0.85
	O'Fallon (zip code 63376)	0.00	4.21	2.92	1.06	1.06	2.18	2.22	1.05	3.36	3.15	1.13
	O'Fallon (zip code 63304)	N/A	0.00	0.00	2.20	0.00	3.66	3.60	0.00	1.78	0.00	1.66
	O'Fallon (combined zip codes)	0.00	2.31	1.92	1.44	0.91	2.73	1.73	0.43	2.04	1.57	1.13
Infant	United States	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Missouri	9.43	10.17	8.51	8.38	8.15	7.40	7.57	7.60	7.62	7.71	7.17
	St. Charles County	3.86	5.88	4.55	5.10	4.89	5.36	5.54	6.91	5.62	5.40	6.36
	O'Fallon (zip code 63366)	1.66	3.15	4.89	7.31	8.02	4.07	2.33	3.43	3.03	4.03	7.68
	O'Fallon (zip code 63376)	0.00	6.32	5.83	3.18	4.25	3.28	3.33	4.19	7.84	7.36	5.65
	O'Fallon (zip code 63304)	N/A	0.00	0.00	6.59	0.00	5.49	8.99	9.96	5.33	4.97	1.66
	O'Fallon (combined zip codes)	0.67	4.61	4.33	5.28	4.57	4.09	4.32	5.15	5.31	5.50	5.64
Fetal	United States	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Missouri	6.59	6.58	6.50	6.52	5.74	5.93	5.93	6.00	5.95	5.91	5.60
	St. Charles County	5.12	3.73	4.53	3.21	5.13	3.74	4.26	4.08	3.65	2.69	3.05
	O'Fallon (zip code 63366)	3.31	3.14	4.86	2.92	2.67	4.05	4.63	7.95	2.02	1.01	4.25
	O'Fallon (zip code 63376)	4.46	3.15	2.91	2.12	6.34	4.35	5.52	2.09	3.35	2.10	2.25
	O'Fallon (zip code 63304)	N/A	0.00	2.29	2.19	5.98	7.27	5.37	3.97	1.77	6.58	3.31
	O'Fallon (combined zip codes)	3.99	2.88	3.36	2.40	5.00	4.98	5.16	4.70	2.45	2.74	3.37

*Rate per 1,000 live births

**Combined zip codes: 63304, 63366 and 63376, except for 1990 which excludes zip code 63304.

Table 2. Infant and Fetal Deaths Observed and Expected* Ratios and Probability of Dying in St. Charles County and O'Fallon Between 1990 and 2000

Area	Type of Death	Observed Events	Expected Events	Observed/Expected	Z-Value**	P ($\chi \geq \chi^1$)†
St. Charles County	Fetal	168	262.86	0.64	-5.85	1.00
	Neonatal	158	197.54	0.80	-2.81	1.00
	Post-neonatal	74	118.77	0.62	-4.11	1.00
	Infant	232	316.31	0.73	-4.74	1.00
O'Fallon (Zip code 63366)	Fetal	33	54.70	0.60	-2.93	0.99
	Neonatal	33	45.46	0.73	-1.85	0.97
	Post-neonatal	8	27.33	0.29	-3.70	1.00
	Infant	41	72.79	0.56	-3.73	1.00
O'Fallon (Zip code 63376)	Fetal	36	62.96	0.57	-3.40	0.99
	Neonatal	27	52.33	0.52	-3.50	1.00
	Post-neonatal	21	31.46	0.67	-1.86	0.98
	Infant	48	83.79	0.57	-3.91	1.00
O'Fallon (Zip code 63304)	Fetal	21	30.20	0.70	-1.67	0.97
	Neonatal	16	25.08	0.64	-1.81	0.98
	Post-neonatal	7	15.08	0.46	-2.08	0.99
	Infant	23	40.16	0.57	-2.71	1.00
O'Fallon†† (combined zip codes)	Fetal	91	147.86	0.62	-4.68	1.00
	Neonatal	74	122.87	0.60	-4.41	1.00
	Post-neonatal	36	73.88	0.49	-4.41	1.00
	Infant	112	196.75	0.57	-6.04	1.00

*Expected deaths based on mortality experience in Missouri

**Standardized normal (Z) statistics for difference between observed and expected deaths

†Probability of observing χ or more number of deaths given expected number of deaths

††Combined zip codes 63304, 63366, and 63376

Table 3. Ohno Geographical Cluster Analysis of Infant and Fetal Deaths, St. Charles County, 1995-1999

Basis for Categorization of Observed/Expected Frequencies*	Type of Event	Observed Events	Expected Events	Chi** Square	P ($\chi \geq \chi^1$)^{††}
Natural Break by Zip Code	Infant Deaths	8.00	4.46	2.91	>0.05
	Fetal Deaths	7.00	4.77	1.74	>0.05
Quartile by Zip Code	Infant Deaths	6.00	4.14	2.04	>0.05
	Fetal Deaths	3.00	4.14	2.55	>0.05
Natural Break by Geo Area	Infant Deaths	6.00	10.33	7.51	>0.05
	Fetal Deaths	12.00	10.55	0.74	>0.05
Quartile by Geo Area	Infant Deaths	13.00	12.39	2.66	>0.05
	Fetal Deaths	19.00	12.60	5.47	<0.05

*Sensitivity analysis to minimize effect of arbitrary choice of cut offs

**Chi square statistic with one degree of freedom for testing whether the number of observed adjacencies is greater than expected

††Probability of observing χ number of events or more given on expected number of events χ^1

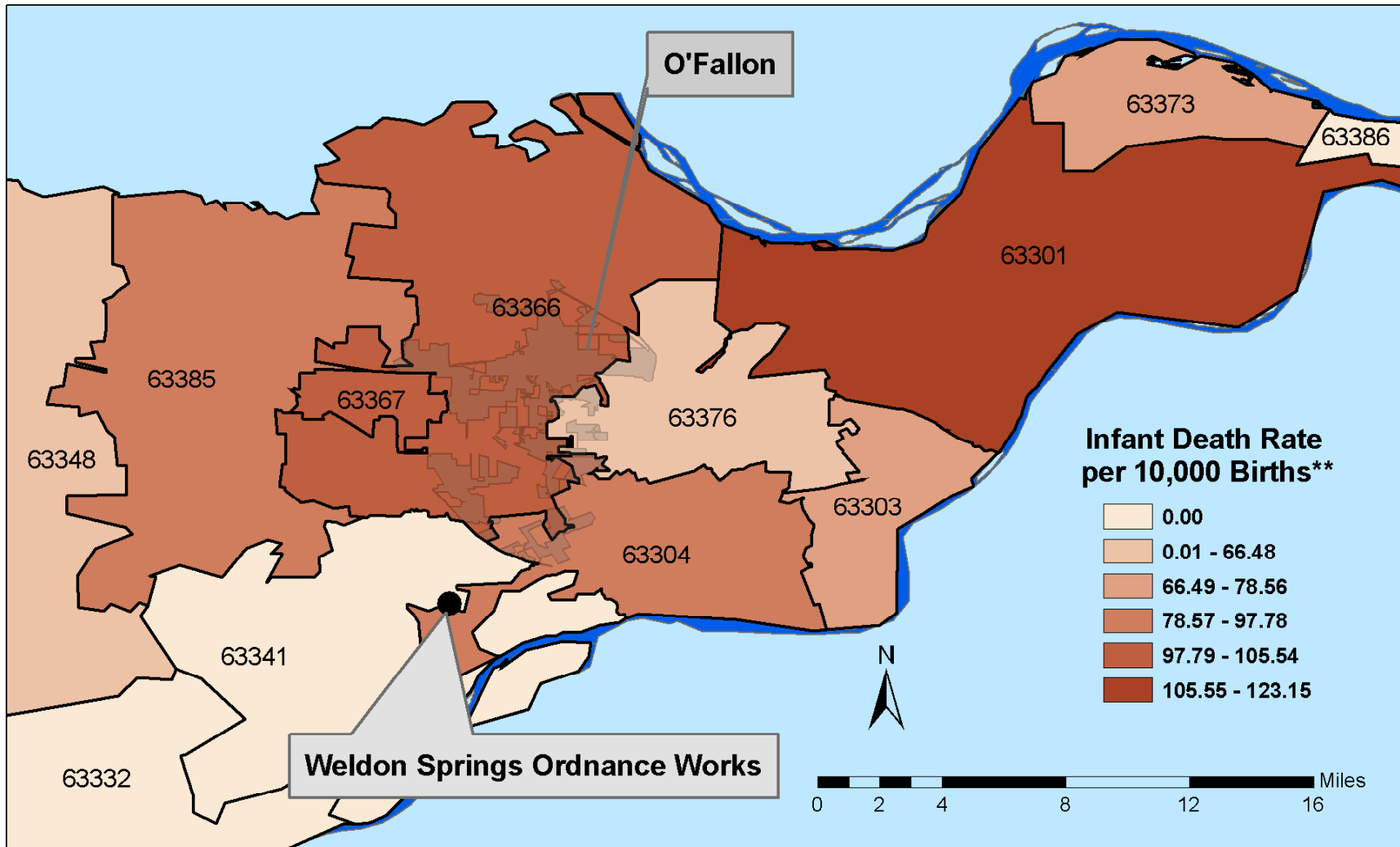
Table 4. Grimson Geographical Cluster Analysis of Infant and Fetal Deaths, St. Charles County, 1995-1999

Geographical Area	Type of Event	Observed Events	Expected Events	Standard Deviation	Z-value*	P ($\chi \geq \chi/\chi^1$)**
Zip Code	Infant Deaths	6	5.0000	1.6206	-0.6171	>0.05
	Fetal Deaths	1	1.1125	0.9125	-0.2354	>0.05
Geo Area	Infant Deaths	1	1.2391	0.9732	-0.2457	>0.05
	Fetal Deaths	0	0.2065	4.4048	-0.5102	>0.05

*Standardized normal statistic for testing whether the number of observed adjacencies is greater than expected

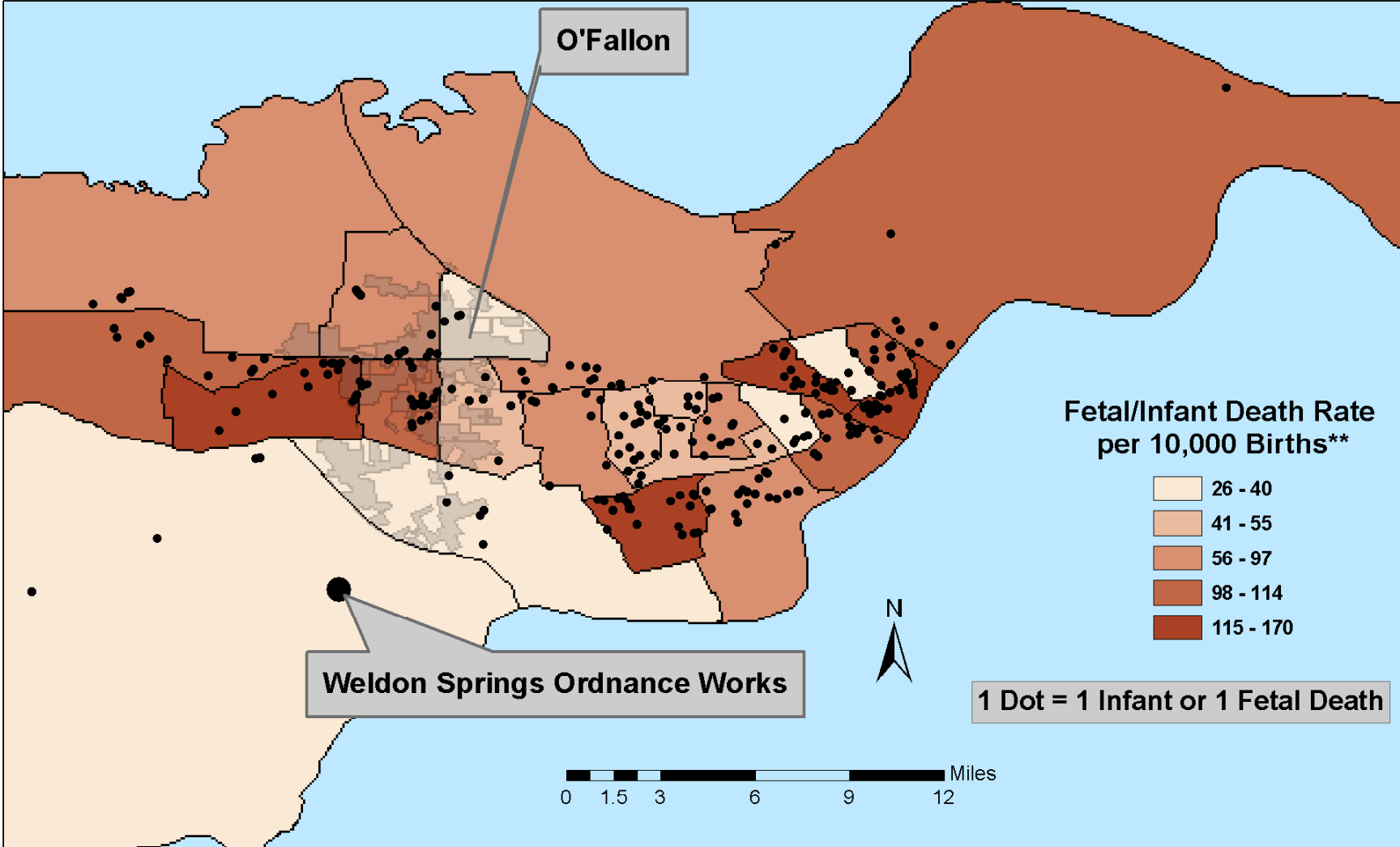
**Probability of observing χ number of events or more given on expected number of events χ^1

Fig. 1 Fetal/Infant Death Rates for St. Charles County* (1990 -2000)



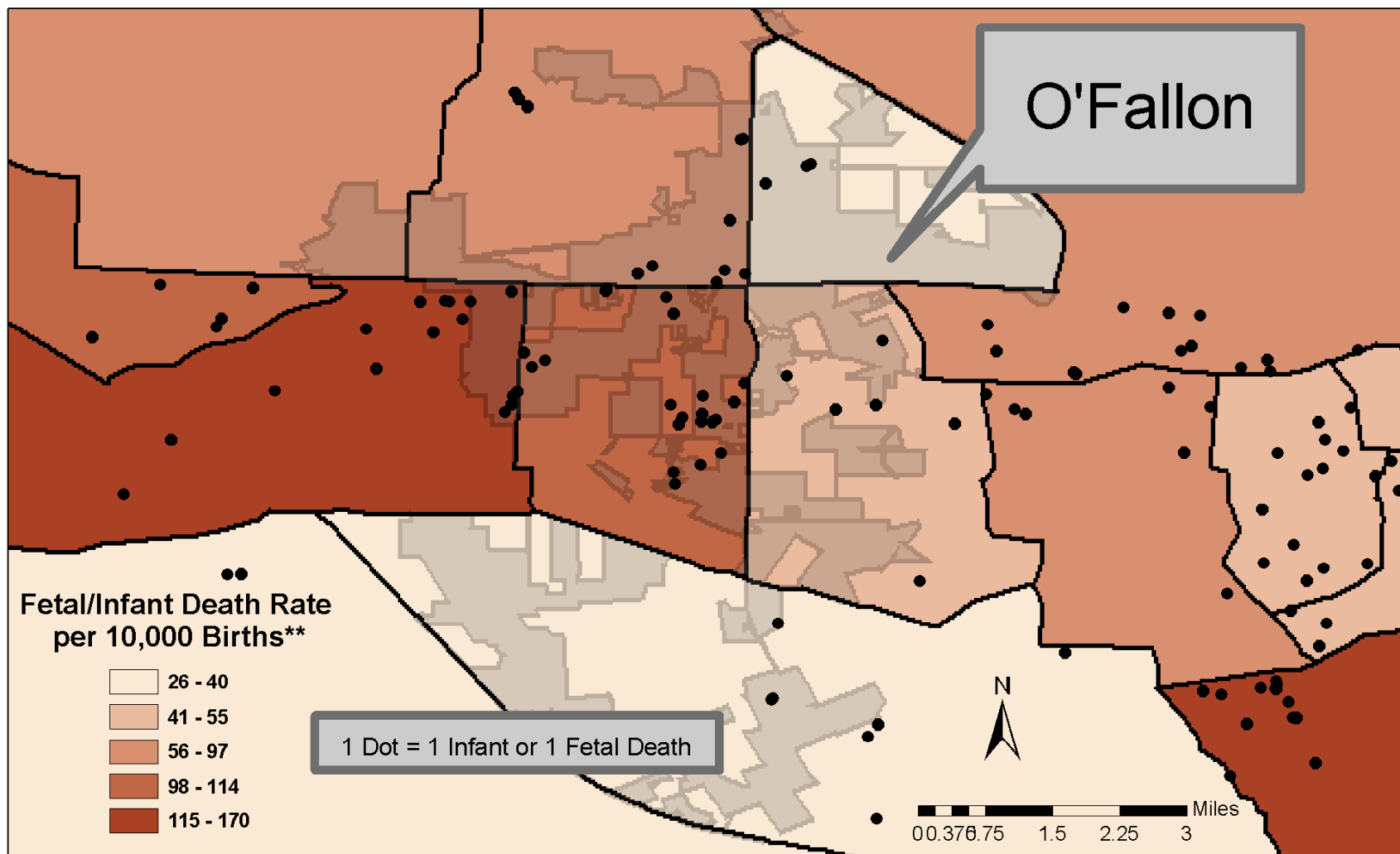
Source: Birth and Death Records 1990 - 2000
* Boundaries are St. Charles County Zip Codes
** Births = Fetal Deaths + Live Births

Fig. 2 Fetal/Infant Deaths and Rates for St. Charles County* (1990 -2000)



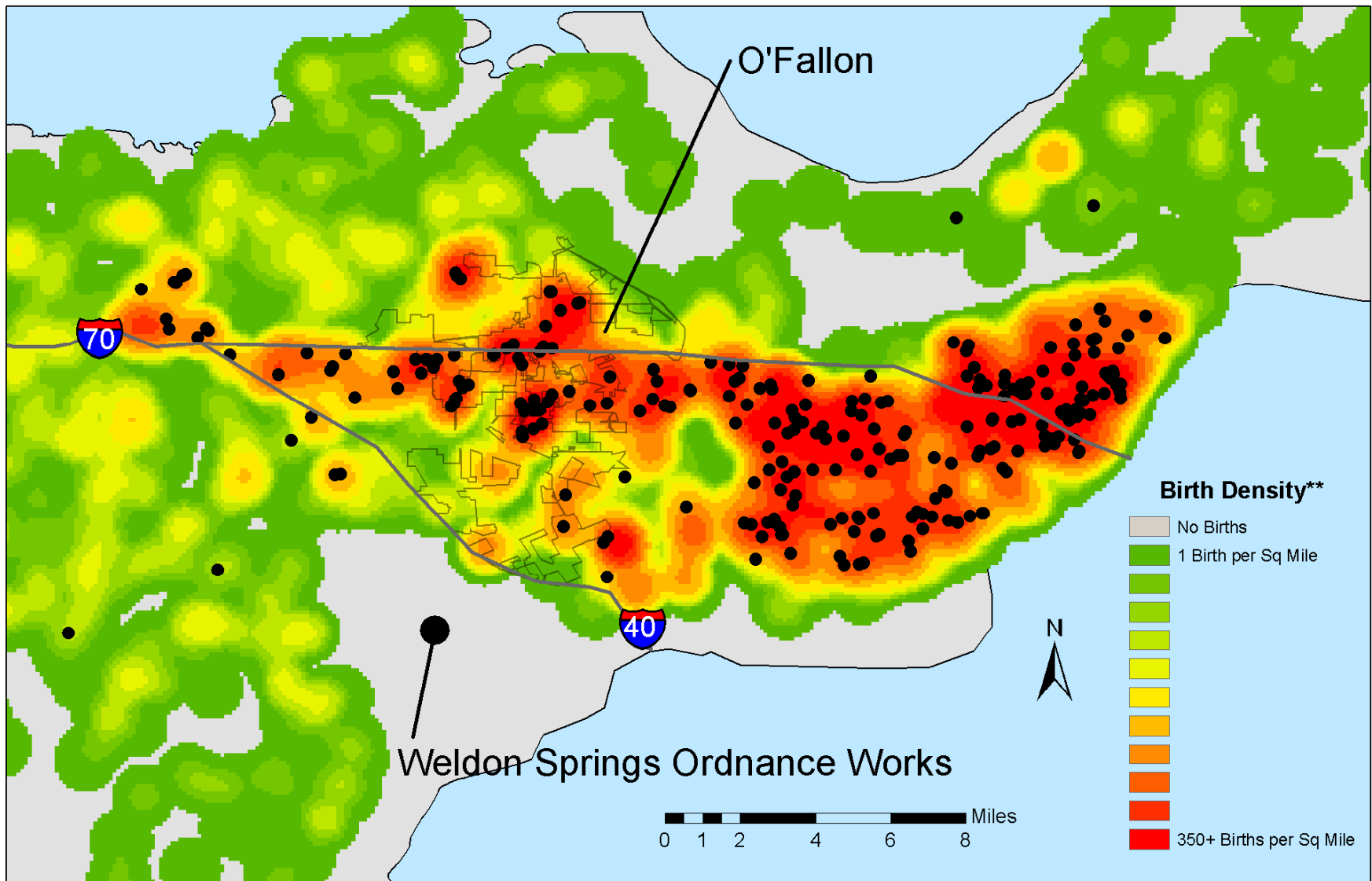
Source: Birth and Death Records 1990 - 2000
* Boundaries are made up of combined census tracts in order to achieve areas with a population of 8,500 or more residents.
** Births = Fetal Deaths and Live Births

Fig. 3 Fetal/Infant Deaths and Rates for St. Charles County* (1990 -2000)



Source: Birth and Death Records 1990 - 2000
* Boundaries are made up of combined census tracts in order to achieve areas with a population of 8,500 or more residents.
** Births = Fetal Deaths + Live Births

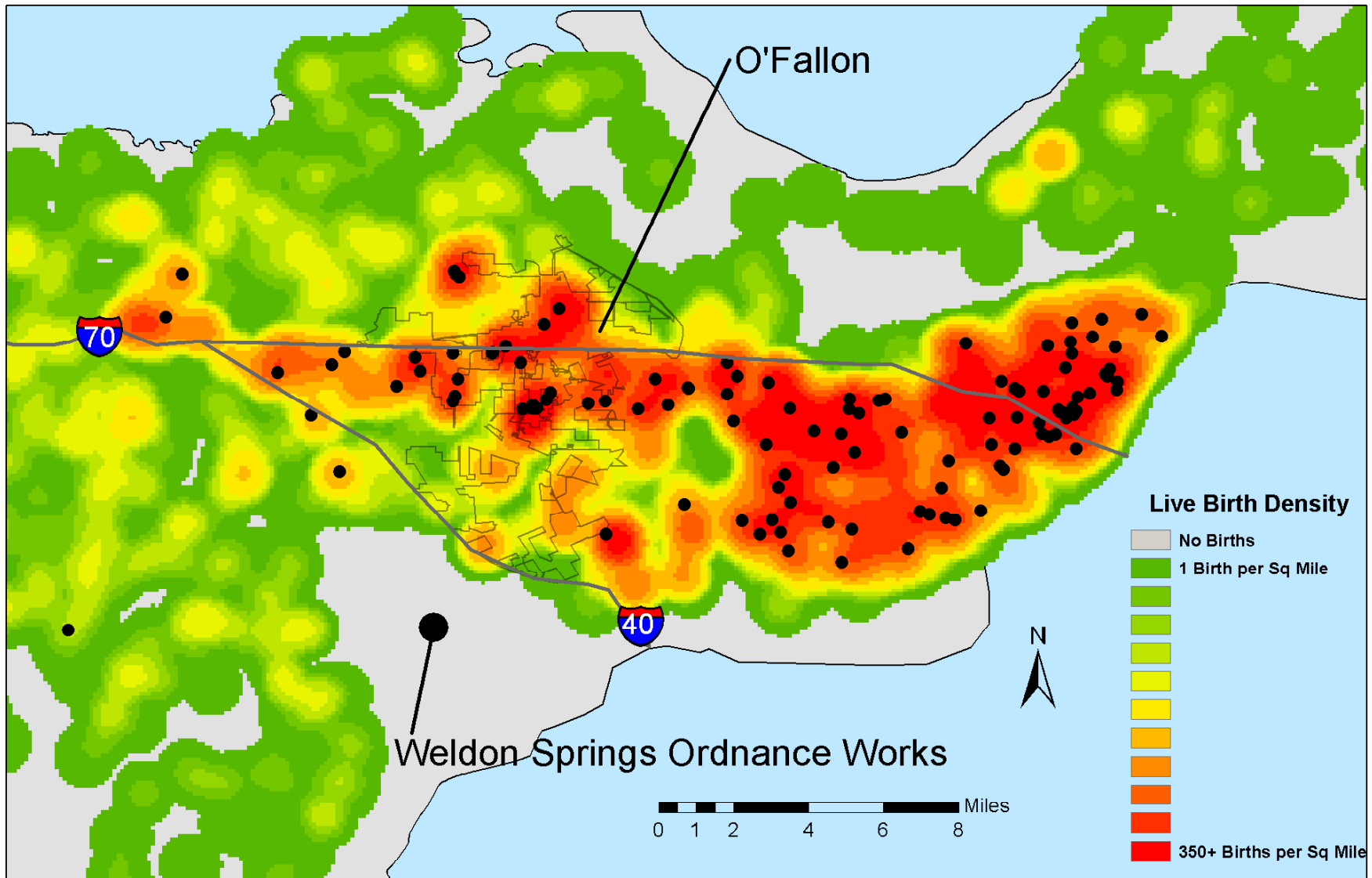
Fig. 4 Fetal/Infant Deaths and Birth Density in St. Charles County (1990 - 2000)



1 Dot = 1 Fetal or 1 Infant Death

Source: Birth and Death Records 1990 - 2000
** Births = Fetal Deaths + Live Births

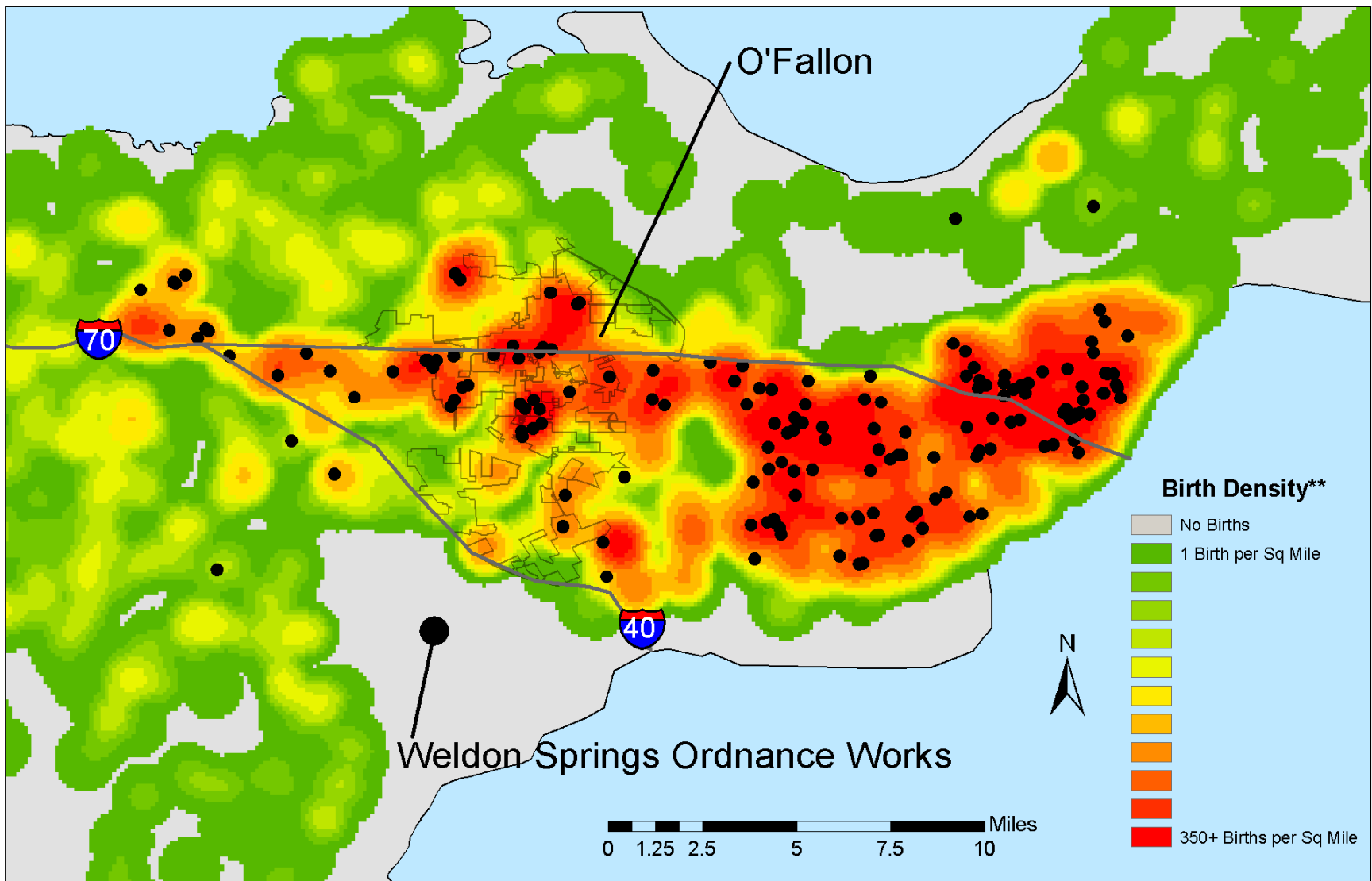
Fig. 5 Infant Deaths (Neonatal & Post-neonatal) and Live Birth Density in St. Charles County (1990 - 2000)



1 Dot = 1 Infant Death*

Source: Birth and Death Records 1990 - 2000
* Death between birth and one year of age.

Fig. 6 Fetal Deaths and Birth Density in St. Charles County (1990 - 2000)



1 Dot = 1 Fetal Death

Source: Birth and Death Records 1990 - 2000
** Births = Fetal Deaths + Live Births

